# MACHEREY-NAGEL

Chromatography

## Columns and supplies

**MACHEREY-NAGEL**

*www.mn-net.com*

MN Since 1

**CHROMATOGRAPHIC SPECIALTIES INC.**

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# MACHEREY-NAGEL – About us

## Quality since 1911

Since 1911 MACHEREY-NAGEL stands for high quality, innovation and reliability in chemical and biomolecular analysis. Friendly expert advice for our highly valued customers as well as outstanding product quality have been the cornerstones of our corporate success for more than 100 years. MACHEREY-NAGEL is a family-owned company run by the fourth generation. As one of today's leading manufacturers of products for analytical chemistry and life science we offer a broad range of products for Filtration, Rapid Tests, Water Analysis, Chromatography and Bioanalysis.

Filtration

Rapid Tests

Water Analysis

Chromatography

Bioanalysis

## MACHEREY-NAGEL – worldwide

Our customers can count on competent and reliable service all over the world.

- Headquarters and manufacturing site in Düren (Germany), further location in Oensingen (Switzerland)
- Branches in France, Switzerland and the United States with dedicated and expert staff
- Globally operating network of qualified and specially trained distributors in more than 150 countries

For a complete list of branches and authorized distributors see *www.mn-net.com/distributor*

**1952**

MN launches the first products for paper chromatography

**1961**

MACHEREY-NAGEL becomes one of the pioneers in TLC

**1970**

Expansion of the product range by column chromatography

**1974**

NUCLEOSIL® – one of the first spherical HPLC silicas leads to our core competence in silica technology

**1982**

Fused silica capillary columns for GC

## MACHEREY-NAGEL Chromatography – Complete solutions for your analysis

MACHEREY-NAGEL has grown from a pioneer in chromatography to a full-range supplier of laboratory consumables. We supply laboratories all over the world with HPLC, GC and SPE columns, TLC plates and sheets, syringe filters or suitable vials and closures. Our philosophy includes personal and competent support as well as outstanding product quality. We have the demand to fulfill the customer's individual needs and offer optimal and reliable solutions for your lab work in method development and routine analysis.

## How you can benefit from MACHEREY-NAGEL

- Competent and individual service
- More than 50 years of expertise in manufacturing of chromatographic adsorbents
- Comprehensive product portfolio covering all areas of chromatography consumables

## MN on the internet

- Detailed product information and technical data can be found at *www.mn-net.com*
- Online application database with more than 3000 practical applications *www.mn-net.com/apps*
- Safety data sheet, certificates of analysis, instruction leaflets, flyers and catalogs can be downloaded online
- VialFinder: Your alternative! Easy selection by updated cross references
- FilterFinder: Always the suitable syringe filter - directly from the manufacturer
- HPLC and GC troubleshooting online
- You can find MACHEREY-NAGEL also on exhibitions *www.mn-net.com/tradeshows*

SPE and Flash

Syringe filters

Vials and caps

HPLC

TLC

GC

1987

CHROMABOND® columns for SPE

2002


NUCLEODUR® high purity spherical silica for HPLC

2011

NUCLEOSHELL® core-shell silica for highest efficiency in HPLC

1994

OPTIMA® capillary columns for optimal GC separations

2007

CHROMAFIL® Xtra the syringe filters for sample preparation

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# Basics

Solid phase extraction (SPE) is a powerful method for sample preparation and is used by most chromatographers today.

About 25 years ago MACHEREY-NAGEL designed and introduced CHROMABOND® SPE cartridges containing silica-based adsorbents. Since then we have developed the widest range of phases and products for SPE based on silica and polymeric materials.

### SPE has capabilities in a broad range of applications

- Environmental analysis
- Pharmaceutical and biochemical analysis
- Organic chemistry
- Food analysis

SPE is a form of digital (step-wise) chromatography designed to extract, partition, and / or adsorb one or more components from a liquid phase (sample) onto a stationary phase (adsorbent or resin). An adsorbed substance can be removed from the adsorbent by stepwise increase of elution strength of the eluent (step gradient technique). SPE extends a chromatographic system's lifetime, improves qualitative and quantitative analysis, and the demand placed on an analytical instrument is considerably lessened.

### In general, SPE is used for three important purposes in state-of-the-art analysis

- Concentration of the analyte – up to factor 10.000 - increase of chromatographic sensibility and improved limits of detection
- Removal of interfering compounds – protection of subsequent analysis like HPLC, GC, TLC, UV or IR spectroscopy, …
- Changing an analyte's environment to a simpler matrix more suitable for subsequent analysis

### Advantages of SPE compared to classical liquid-liquid extraction

- Lower consumption of solvents
- Faster – enormous time savings
- Lower costs per sample
- Potential for automation
- High consistency in individual sample handling
- More specific selectivity because of the broad range of adsorbents and different retention mechanisms
- Optimization of extraction by the variation or adjusting of the solid phase and chromatographic conditions

### Separation of food additives

Since analytes can either be adsorbed on the SPE packing material or directly flown through while the interfering substances are retained, two general separation procedures are possible – both cases are shown in the figure above.

## Main steps of the SPE procedure

① Conditioning of the adsorbent

Conditioning of the adsorbent is necessary in order to ensure reproducible interaction with the analyte. Conditioning, also called solvation, results in a wetting of the adsorbent and thus produces an environment, which is suitable for adsorption of the analyte. Nonpolar adsorbents are usually conditioned with 2–3 column volumes of a solvent, which is miscible with water (methanol, THF, 2-propanol etc.), followed by the solvent in which the analyte is dissolved (pure matrix, e.g., water, buffer). Polar adsorbents are conditioned with nonpolar solvents.

After the conditioning step the adsorbent bed must not run dry, because otherwise solvation is destroyed (deconditioning).

② Sample application (adsorption)

Sample application can be performed with positive or negative pressure with a flow rate of ~3 mL/min. Sample volumes vary from a few mL up to liters.

③ Washing of the adsorbent

Washing of the adsorbent is usually achieved with a special wash solution; however, in some cases it may not be necessary. If the polarity difference between wash solution and eluent is very large, or if both are not miscible, drying of the adsorbent bed after washing is recommended to improve elution and recovery.

④ Elution

Elution with a suitable eluent should not be too fast. The elution speed depends on the column or cartridge dimension and the quantity of adsorbent (about 1 mL/min).

## Molecular interactions in SPE

SPE adsorbents are most commonly categorized by the nature of their primary interaction mechanism with the analyte of interest. The three most common extraction mechanisms used in SPE are reversed phase (RP), normal phase (NP) and ion exchange.

**Typical extraction mechanisms**

| | |
|---|---|
| · Reversed phase | extraction of hydrophobic or polar organic analytes from aqueous matrix |
| · Normal phase | extraction of polar analytes from nonpolar organic solvents |
| · Ion exchange | extraction of charged analytes from aqueous or nonpolar organic samples |

## Types of retention mechanisms

### Nonpolar interactions

| | |
|---|---|
| Silica-based: | $C_{18}$ ec, $C_{18}$, $C_{18}$ Hydra, $C_8$ |
| Polymer-based: | HR-X, HR-P, Easy, PS-RP |
| Interactions: | hydrophobic |
| Sample: | mostly aqueous |
| Elution: | solvents with lower polarity (compared to water)<br>$CH_3OH$, $CH_2Cl_2$, $CHCl_3$, hexane |

### Polar interactions

| | |
|---|---|
| Silica-based: | SiOH, CN, $NH_2$, OH (diol), $C_6H_5$ |
| Other: | Alox, Florisil® |
| Interactions: | hydrogen bonds, dipole-dipole and π-π interactions |
| Sample: | mostly organic |
| Elution: | polar solvents (compared to sample solvent), e.g.,<br>(nonprotic) ethers, ketones (MTBE, THF, acetone), $CH_2Cl_2$, $CHCl_3$ |

### Cation exchangers

| | |
|---|---|
| Silica-based: | SA (SCX), PCA (WCX), PSA |
| Polymer-based: | HR-XC, HR-XCW, PS-$H^+$ |
| Interaction: | between charged analytes and functional group of cation exchanger |
| Sample: | aqueous (pH 3–5) |
| Elution: | acidic: pH 2 (e.g., HCl, or 20 % AcOH in $CH_3OH$ – $CH_3CN$)<br>basic: pH 8–9 (e.g., 5 % $NH_3$ in $CH_3OH$ – $CH_3CN$) solvents or buffers with higher ionic strength and counter ions with high selectivity (e.g., $Ca^{2+}$) |

### Anion exchangers

| | |
|---|---|
| Silica-based: | SB (SAX), $NH_2$ |
| Polymer-based: | HR-XA, HR-XAW, PS-$OH^-$ |
| Interaction: | between charged analytes and functional group of anion exchanger |
| Sample: | aqueous (pH 8–9) |
| Elution: | basic: pH 10 (e.g., 20 % $NH_3$ in $CH_3OH$ – $CH_3CN$)<br>acidic: pH 4–5 (e.g., HCl, or 5 % AcOH in $CH_3OH$ – $CH_3CN$)<br>solvents or buffers with higher ionic strength and counter ions with high selectivity (e.g., citrate) |

It should be noted, that in SPE the interactions described on page 12 are not found in pure form, but in combination. For example, modified silicas, unless they have been subjected to endcapping (silanization of residual silanol groups with short-chain silanes), still possess free silanol groups, which can enter into secondary interactions.

## Sample pretreatment

For direct extraction with adsorbents the sample matrix (sample environment) has to fulfill three conditions:

- The matrix has to be liquid, if possible with low viscosity
- Solids should be removed from the liquid matrix
- The matrix (sample environment) should be suitable for retention of the analyte

For solid samples there are different methods to convert the sample into a suitable matrix:

- Dissolution of the solid sample in a suitable solvent
- Lyophilization of the sample and dissolution in a suitable solvent
- Extraction of the solid sample with a suitable solvent
- Homogenization of the sample in a suitable solvent

In order to find the suitable solvent, one has to consider all desired sample components. Also, the suitable solvent should enhance retention of the analyte. For example, samples with large contents of solids are often homogenized in nonpolar solvents like hexane, while for samples with high water content dissolution in acids, bases, buffers or very polar solvents such as methanol is recommended.

Additionally, SPE allows to alter the properties of the sample matrix. If, for example, natural products are extracted with methanol or acetone, the polarity of the extracts can be increased by dilution with water, in order to enhance nonpolar solid phase extraction on the $C_{18}$ material.

## Our CHROMABOND® QC policy

- Highest production standard – our facilities are EN ISO 9001:2008 certified
- All products are individually tested to meet our strict quality specifications, ensuring our outstanding product reproducibility, reliability and performance
- Perfect reproducibility from lot-to-lot and within every single batch:
  - → Careful attention to particle size distribution and pore diameters assures consistent column flow
  - → Chemical reproducibility is guaranteed by strict quality control throughout manufacturing
- Each product is supplied with a certificate of analysis stating the results of internal examinations and quality control

MACHEREY-NAGEL

**Certificate of analysis**

Phase: CHROMABOND® HR-X

Sorbent-LOT: 0416/2

Technical Data

Material: porous adsorptive resin based on polystyrene-divinylbenzene

Description: yellow powder

| Parameter | Specification | Result |
|---|---|---|
| Pore Diameter: | 50 - 70 Å | 56 |
| Particle Size – 50 % Volume: | 65 - 95 µm | 83 |
| Surface Area ($m^2/g$): | > 950 | 1034 |
| Capacity (mg caffeine/g sorbent): | >250 | 453 |

The packing quantity varies ± 5 % referred to the amount given on the label or in the catalogue.

Confirmation

Hereby we confirm that the above mentioned product has successfully passed our quality control system in accordance with ISO 9001:2008 and meets the specific quality criteria.

This document has been produced electronically and is valid without a signature.

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# CHROMABOND® hardware

## Design of columns, cartridges and 96-well plates

All CHROMABOND® columns, cartridges and 96-well plates are manufactured from polypropylene (PP) with lowest content of extractables (plasticizers, stabilizers, …) offering blank value free results when using most common solvents.

The high quality CHROMABOND® adsorbents are kept in place by chemically very inert polyethylene filter elements.

### CHROMABOND® polypropylene columns

- PP columns with PE filter elements
- Different sizes from 1, 3, 6 up to 150 mL
- Adsorbent weights from 20 mg to 50 g
- Male Luer tip as exit
- Compatible with most robots (e.g., Gilson® ASPEC™, Caliper AutoTrace®)

### CHROMABOND® glass columns

- Glass columns with chemically very inert glass fiber filter elements (nominal pore size 1 µm)
- Two different sizes: 3 and 6 mL
- Available with all CHROMABOND® phases
- Excludes any influence from the column material (e.g., plasticizers)

### CHROMAFIX® cartridges

- PP cartridges with PE filter elements
- Three different sizes with different adsorbent weights: Small (0.4 mL), Medium (0.8 mL), Large (1.8 mL)
- Female Luer fitting at the inlet, male Luer tip as exit
- Offers alternative way of handling using positive pressure by syringes or peristaltic pumps
- Especially suited for convenient solid phase extraction of small sample volumes

### CHROMABOND® LV columns

- Large volume PP columns with PE filter elements
- Three different adsorbent weights (100, 200 and 500 mg)
- Funnel-shaped reservoir with 15 mL volume
- Especially for clinical samples - the whole sample (e.g., urine, serum, blood) can be applied to the column in one step
- Can be directly used in the Zymate® lab robots of Zymark

### CHROMABOND® MULTI 96 · SPE in 96-well format

- 96-well PP plates with PE filter elements
- Cavity volume 1.5 mL
- Adsorbent weights 10, 25, 50 and 100 mg
- Supplied with any CHROMABOND® SPE adsorbents
- For the simultaneous preparation of 96 samples
- Easy method transfer from CHROMABOND® columns or CHROMAFIX® cartridges to CHROMABOND® MULTI 96
- Readily adaptable to all common automated / robotic handling systems (for details see page 69)

### On-line SPE (see page 68)

- Online columns and cartridges
- SPE columns with caps and needles for the Gerstel MultiPurposeSampler (MPS)
- Columns for Gilson® ASPEC™ systems (ASP)

CHROMABOND® SPE columns from page 23 onwards

CHROMABOND® Multi 96 page 14 and 69

CHROMABOND® Flash RS page 75

CHROMABOND® Flash BT page 76

CHROMABOND® Flash DL page 76

CHROMABOND® Flash FM page 77

# CHROMABOND® summary of MN phases

| CHROMABOND® Phase | Matrix | Modification / Application | Similar phases* | Page |
|---|---|---|---|---|
| **Reversed phases** | | | | |
| HR-X | PS/DVB | | ENVI-Chrom P · Strata™-X · Oasis® HLB · Nexus | 23 |
| Easy | PS/DVB | polar, bifunctional | Strata™-X · Oasis® HLB · Porapak™ RDX · Nexus, Bond Elut® PPL, Focus™ · Styre Screen® DVB Bakerbond™ $H_2O$-philic DVB · Isolute® ENV+ | 29 |
| HR-P | PS/DVB | | Strata™ SDB-L · Bond Elut® ENV, Bond Elut® LMS · DSC-PS/DVB, ENV PS-DVB · Bakerbond™ $H_2O$-phobic DVB · Isolute® 101 · LiChrolut® EN | 30 |
| PS-RP | PS/DVB | removal of organic components | like HR-P | 31 |
| $C_{18}$ ec | silica | octadecyl, endcapped | Strata™ C18-E · Sep-Pak® tC18 · Bond Elut® C18 · DSC-18(Lt), ENVI-18, LC-18 · CLEAN-UP® C18, Bakerbond® Octadecyl · Isolute® C18(EC), LiChrolut® RP-18 E | 32 |
| $C_{18}$ ec f | silica | as above, fast flow | | 32 |
| $C_{18}$ | silica | octadecyl, not endcapped | Strata™ C18-U · AccuBond® C18 · Bakerbond™ PolarPlus · Isolute® C18 · LiChrolut® RP-18 | 33 |
| $C_{18}$ f | silica | as above, fast flow | | 33 |
| $C_{18}$ Hydra | silica | octadecyl, not endcapped, for polar analytes | | 34 |
| $C_8$ | silica | octyl | Strata™ C8 · Sep-Pak® C8 · Bond Elut® C8 · DSC-8, ENVI-8, LC-8 · CLEAN-UP® C8 · AccuBond® C8 · Bakerbond™ Octyl · Isolute® C8(EC) | 35 |
| $C_4$ | silica | butyl | | 36 |
| $C_2$ | silica | dimethyl | Bond Elut® C2 | 36 |
| $C_6H_{11}$ ec | silica | cyclohexyl, endcapped | Bond Elut® CH | 37 |
| $C_6H_5$ | silica | phenyl | Strata™ PH · Bond Elut® PH · DSC-Ph · CLEAN-UP® Phenyl · AccuBond® Phenyl · Bakerbond™ Phenyl · Isolute PH(EC) | 38 |
| **Normal phases** | | | | |
| SiOH | silica | unmodified | Strata™ Si-1 · Bond Elut® silica · DSC-Si, LC-Si · CLEAN-UP® silica · AccuBond® silica, Bakerbond™ silica gel · Isolute® silica · LiChrolut® Si | 39 |
| $NH_2$ | silica | aminopropyl | Strata™ $NH_2$ · Sep-Pak® $NH_2$ · Bond Elut® $NH_2$ · DSC-$NH_2$, LC-$NH_2$ · CLEAN-UP® aminopropyl · AccuBond® $NH_2$ · Bakerbond™ amino · Isolute® $NH_2$ · LiChrolut® $NH_2$ | 40 |
| OH (Diol) | silica | diol | DSC-Diol, LC-Diol · AccuBond® Diol (OH) | 41 |
| CN | silica | cyano | Strata™ CN · Sep-Pak® CN · Bond Elut® CN-U · DSC-CN, LC-CN · CLEAN-UP® CN · AccuBond® CN · Bakerbond™ cyano · Isolute® CN · LiChrolut® CN | 41 |
| HILIC | silica | zwitterionic ammonium-sulfonic acid modification | ZIC® HILIC | 42 |
| Alox A | aluminum oxide | acidic | LC-Alumina-A · AccuBond® Aluminiumoxid A | 43 |
| Alox N | aluminum oxide | neutral | LC-Alumina-N · AccuBond® Aluminiumoxid N | 43 |
| Alox B | aluminum oxide | basic | LC-Alumina-B · AccuBond® Aluminiumoxid B | 43 |
| Florisil® | magnesium silicate | | Strata™ FL-PR · Sep-Pak® Florisil® · Bond Elut® Florisil® · ENVI-Florisil® · LC-Florisil® · CLEAN-UP® Florisil® · AccuBond® Florisil® · Bakerbond™ Florisil® · Isolute® FL · LiChrolut® Florisil® | 44 |
| PA | polyamide 6 | | DPA-6S | 44 |
| **Ion exchangers** | | | | |
| SA | silica | benzenesulfonic acid cation exchanger (SCX) | Strata™ SCX · Bond Elut® SCX · DSC-SCX, LC-SCX · CLEAN-UP® Benzenesulfonic Acid · AccuBond® SCX · Bakerbond™ Aromatic Sulfonic Acid · Isolute® SCX · LiChrolut® SCX | 45 |
| SB | silica | quaternary ammonium anion exchanger (SAX) | Strata™ SAX, Sep-Pak® SAX, Bond Elut® SAX · DSC-SAX, LC-SAX · CLEAN-UP® Quaternary Amine · AccuBond® SAX · Bakerbond™ Quaternary Amine · Isolute® SAX · LiChrolut® SAX | 46 |
| PCA | silica | propylcarboxylic acid cation exchanger (WCX) | Strata™ WCX · Bond Elut® CBA · DSC-WCX, LC-WCX · CLEAN-UP® Carboxylic Acid · Bakerbond™ Carboxylic Acid · Isolute® CBA | 47 |
| PSA** | silica | propylsulfonic acid cation exchanger | Isolute® SCX-2 · Bond Elut® PRS | 47 |

# CHROMABOND® summary of MN phases

| CHROMABOND® Phase | Matrix | Modification / Application | Similar phases* | Page |
|---|---|---|---|---|
| HR-XC | PS/DVB | strong mixed mode cation exchanger for basic analytes (MCX) | Oasis® MCX · Strata™-X-C · HyperSep™ Retain™-CX · Styre Screen® DBX | 25 |
| HR-XA | PS/DVB | strong mixed mode anion exchanger for acidic analytes (MAX) | Oasis® MAX · Strata™-X-A · HyperSep™ Retain™-AX · Styre Screen® QAX | 26 |
| HR-XCW | PS/DVB | weak mixed mode cation exchanger for basic analytes (WCX) | Oasis® WCX · Strata™-X-CW | 27 |
| HR-XAW | PS/DVB | weak mixed mode anion exchanger for acidic analytes (WAX) | Oasis® WAX · Strata™-X-AW | 28 |
| PS-$OH^-$ | PS/DVB | strong anion exchanger in $OH^-$ form | | 31 |
| PS-$H^+$ | PS/DVB | strong cation exchanger in $H^+$ form | | 31 |
| PS-Mix | PS/DVB | mixture of PS-$OH^-$ and PS-$H^+$ | | 31 |
| PS-$Ag^+$ | PS/DVB | strong cation exchanger in $Ag^+$ form | | 31 |
| PS-$Ba^{2+}$ | PS/DVB | strong cation exchanger in $Ba^{2+}$ form | | 31 |
| **Phases for special applications** | | | | |
| Drug | silica | bifunctional $C_8$/SA, for enrichment of drugs from urine | Strata™ Screen-C · Bond Elut® Certify I · DSC-MCAX · Clean Screen® DAU · AccuBond® Evidex · Bakerbond™ Narc-2 · Isolute® HCX · LiChrolut® TSC · HyperSep™ Verify CX | 48 |
| Drug II | silica | bifunctional $C_8$/SB, for extraction of THC and derivatives and of acidic analytes from biological fluids | Strata™ Screen-A · Bond Elut® Certify II · Clean Screen® THC · Bakerbond™ Narc-1 · Isolute® HAX · HyperSep™ Verify AX | 49 |
| Tetracycline | silica | special octadecyl phase, for enrichment of tetracyclines | | 50 |
| HR-P-AOX | PS/DVB | for extraction of AOX from water (DIN 38409 – H22) | | 51 |
| $C_{18}$ PAH | silica | special octadecyl phase, for enrichment of PAHs from water | Bakerbond™ Octadecyl Lightload | 51 |
| $NH_2/C_{18}$ | silica | combination phase for enrichment of PAHs from water | | 52 |
| CN/SiOH | silica | combination phase for enrichment of PAHs from soil | | 52 |
| $Na_2SO_4$/Florisil® | | combination phase for extraction of hydrocarbons from water (DIN H-53 / ISO DIS 9377-4) | | 53 |
| NAN | silica / $AgNO_3$ + $Na_2SO_4$ | combination phase for enrichment of PCBs from sludge | | 54 |
| SA/SiOH | silica | combination phase for enrichment of PCBs from waste oil | Bakerbond™ PCB-N | 55 |
| SiOH-$H_2SO_4$/SA | silica | combination phase, used together with SiOH for enrichment of PCB from oil | | 56 |
| QuEChERS / Diamino | silica | primary and secondary amine functions (PSA), for determination of pesticides in food samples (QuEChERS method) | Supelclean™ PSA · Bond Elut® PSA | 57 |
| ABC18 | silica | octadecyl, with ion exchange functions, for acrylamide analysis | Isolute® M-M (multimode) | 60 |
| Carbon A | activated carbon | determination of acrylamide from water according to DIN 38413-6 | Bakerbond™ Carbon · BEKOlut® Carbon SAC | 60 |
| PL | | specially developed SPE phase for the preparation of bioanalytical samples | Ostro™ · Phree™ · HybridSPE®-Phospholipid | 61 |
| Dry | $Na_2SO_4$ | for drying organic samples | | 61 |
| PTL/PTS | special membrane | phase separation | | 62 |
| XTR | kieselguhr | liquid-liquid extraction | EXtrelut® · Chem Elut™ · Hydromatrix™ · Isolute® SLE + | 63 |

* Phases which provide a similar selectivity based on chemical or physical properties (list not complete)

** For primary and secondary amine functions see QuEChERS / Diamino

# Method development kits

For the development kits as well as for all individual CHROMABOND®, CHROMABOND® LV and CHROMAFIX® types columns are sealed in units of five columns each to prevent adsorption of contaminants from the environment, e.g., laboratory air.

| Designation | Contents of the kit | REF |
|---|---|---|
| **Investigating the best separation mechanism for a clean-up procedure** | | |
| CHROMABOND® HR-*Xpert* development kit I | columns with 3 mL, 60 mg (particle size 45 µm):<br>10 columns with HR-X; 5 columns each with HR-XC, HR-XA, HR-XCW, HR-XAW | 730723 |
| CHROMABOND® HR-*Xpert* development kit II | columns with 3 mL, 200 mg (particle size 85 µm):<br>10 columns with HR-X; 5 columns each with HR-XC, HR-XA, HR-XCW, HR-XAW | 730726 |
| CHROMABOND® polymer development kit | 5 columns each with 3 mL, 200 mg:<br>HR-X, HR-XC (MCX), HR-XA (MAX), HR-P, Easy, PS-$H^+$, PS-OH- | 730288 |
| CHROMABOND® standard development kit | 5 columns each with 3 mL, 500 mg:<br>$C_{18}$, $C_{18}$ ec, $C_8$, $C_6H_5$, $NH_2$, DMA, OH (Diol), CN, SiOH, SA (SCX), SB (SAX) | 730496 |
| **Selecting the optimum RP phase for a clean-up procedure** | | |
| CHROMABOND® RP development kit I | 10 columns each with 3 mL, 500 mg: $C_{18}$, $C_{18}$ ec, $C_8$, $C_4$<br>and 10 columns each with 3 mL, 200 mg HR-P, HR-X | 730197 |
| CHROMABOND® RP development kit II | 10 columns each with 1 mL, 100 mg: $C_{18}$, $C_{18}$ ec, $C_8$, $C_4$, HR-P, HR-X | 730207 |
| CHROMAFIX® RP development kit I | 10 cartridges each CHROMAFIX® S: $C_{18}$, $C_{18}$ ec, $C_8$, $C_4$, HR-P, HR-X | 731883 |
| CHROMABOND® RP development kit III | 10 columns each with 3 mL, 500 mg: $C_{18}$, $C_{18}$ ec, $C_{18}$ Hydra, $C_8$<br>and 10 columns each with 3 mL, 200 mg HR-P, HR-X | 730490 |
| CHROMABOND® RP development kit IV | 10 columns each with 1 mL, 100 mg: $C_{18}$, $C_{18}$ ec, $C_{18}$ Hydra, $C_8$, HR-P, HR-X | 730491 |
| CHROMAFIX® RP development kit II | 10 cartridges each CHROMAFIX® S: $C_{18}$, $C_{18}$ ec, $C_{18}$ Hydra, $C_8$, HR-P, HR-X | 731886 |
| **Selecting the optimum polar phase for a clean-up procedure** | | |
| CHROMABOND® polar development kit I | 10 columns each with 3 mL, 500 mg: SiOH, Florisil®, $NH_2$, CN, OH (Diol) | 730199 |
| CHROMABOND® polar development kit II | 10 columns each with 1 mL, 100 mg: SiOH, Florisil®, $NH_2$, CN, OH (Diol) | 730208 |
| CHROMAFIX® polar development kit | 10 cartridges each CHROMAFIX® S: SiOH, Florisil®, $NH_2$, CN, OH (Diol) | 731884 |
| **Selecting the optimum ion exchanger for a clean-up procedure** | | |
| CHROMABOND® ion exchange development kit I | 10 columns each with 3 mL, 500 mg:<br>SA (SCX), SB (SAX), HR-XC (MCX), HR-XA (MAX), PS-$OH^-$, PS-$H^+$, DMA | 730206 |
| CHROMABOND® ion exchange development kit II | 10 columns each with 1 mL, 100 mg:<br>SA (SCX), SB (SAX), HR-XC (MCX), HR-XA (MAX), PS-$OH^-$, PS-$H^+$, DMA | 730209 |
| CHROMAFIX® ion exchange development kit I | 10 cartridges each CHROMAFIX® S:<br>SA (SCX), SB (SAX), HR-XC (MCX), HR-XA (MAX), PS-$OH^-$, PS-$H^+$, DMA | 731885 |
| CHROMABOND® cation exchange development kit I | 10 columns each with 3 mL, 500 mg:<br>SA (SCX), PSA, PCA, HR-XC (MCX), HR-XCW (WCX), PS-$H^+$ | 730494 |
| CHROMAFIX® cation exchange development kit | 10 cartridges each CHROMAFIX® S:<br>SA (SCX), PSA, PCA, HR-XC (MCX), HR-XCW (WCX), PS-$H^+$ | 731888 |
| **Phase selection for clean-up procedures for environmental samples** | | |
| CHROMABOND® kit I environmental sample preparation | 10 columns each with 3 mL, 200 mg HR-P; 6 mL, 1000 mg $C_{18}$ ec; 6 mL, 2000 mg $C_{18}$ PAH; 6 mL, 500/1000 mg CN/SiOH; 3 mL, 500/500 mg SA/SiOH | 730205 |
| CHROMABOND® kit II environmental sample preparation | 5 columns each with 3 mL, 500/500 mg SiOH-$H_2SO_4$/SA; 3 mL, 500 mg SiOH; 6 mL, 1000 mg Florisil®; 3 mL, 500/500 mg SA/SiOH; 6 mL, 700/2000/700 mg NAN | 730349 |

## The professional concept of innovative SPE phases

The CHROMABOND® HR-*Xpert* family comprises 5 polymer-based RP and mixed-mode ion exchange phases:

- CHROMABOND® HR-X — hydrophobic PS/DVB copolymer
- CHROMABOND® HR-XC — strong mixed-mode cation exchanger
- CHROMABOND® HR-XA — strong mixed-mode anion exchanger
- CHROMABOND® HR-XCW — weak mixed-mode cation exchanger
- CHROMABOND® HR-XAW — weak mixed-mode anion exchanger

### State-of-the-art spherical polymer

- Two particle sizes (45 µm and 85 µm) adequate for different sample volumes and matrices
- Broad spectrum of application with special suitability for the enrichment of pharmaceuticals from biological matrices
- Ideal flow properties due to low content of particulate matter

### Optimized pore structure and high specific surface

- High loadability and outstanding elution properties
- Low solvent consumption
- Rapid, economical analysis

### High-purity adsorber material

- Allows highest reproducibility with extremely low blind values
- Reliable analysis at ultra trace level
- No method adaptation for new batches necessary

## The HR-*Xpert* concept guarantees

- RP and mixed-mode SPE phases with distinct ion exchange and reversed phase properties: excellent enrichment of neutral, acidic and basic compounds
- Modern, spherical support polymer with optimized pore structure and high surface: good reproducibility, reliable and cost-efficient analysis
- Possibility for more aggressive washing procedures for matrix removal: cleaner samples and protection of your HPLC and GC instruments
- Quantification of analytes also from heavily contaminated samples: lower limits of detection also for critical matrices

CHROMABOND® HR-*Xpert* is the perfect combination for all tasks in sample preparation.

## Chemical structures of the phases

CHROMABOND® HR-X

hydrophobic polystyrene-divinylbenzene copolymer

spherical base material for efficient enrichment
and ideal flow behavior

CHROMABOND® HR-XCW

weak acidic
cation exchanger

CHROMABOND® HR-XA

strong basic
anion exchanger

CHROMABOND® HR-XAW

weak basic
anion exchanger

CHROMABOND® HR-XC

strong acidic
cation exchanger

### Similar phases

| | |
|---|---|
| CHROMABOND® HR-X: | Oasis® HLB, Strata™-X, Nexus, ENVI-Chrom P |
| CHROMABOND® HR-XC: | Oasis® MCX, Strata™-X-C, HyperSep™ Retain™-CX, StyreScreen® DBX |
| CHROMABOND® HR-XA: | Oasis® MAX, Strata™-X-A, HyperSep™ Retain™-AX, StyreScreen® QAX |
| CHROMABOND® HR-XCW: | Oasis® WCX, Strata™-X-CW |
| CHROMABOND® HR-XAW: | Oasis® WAX, Strata™-X-AW |

## 2 particle sizes - 1 goal: HR-*Xpert* for optimized sample preparation

For different application requirements the particle sizes complement each other perfectly.

Ideal for:

- Smaller sample volumes
- Smaller adsorbent weights
- Lower elution volumes

Recommended for:

- Large volume or viscous samples, heavy matrix load
- Operation without vacuum possible (e.g., for volatile analytes)
- Higher adsorbent weight without increase in back pressure

### Features of 45 µm particles

- About half the radius results in 8-fold particle number per volume for approx. equal adsorbent weight
- Same specific surface for both particle sizes: considerably larger freely accessible external surface for 45 µm particles
- Denser adsorbent packing: enhanced interaction of the analyte with the adsorbent, better extraction results

### Ideal elution characteristics

Method: 1 mL column with 30 mg CHROMABOND® HR-X, 1 mL standard solution (1 mg/mL hexobarbital), drying, elution in portions of 100 µL with methanol (see application 305490 at *www.mn-net.com/apps*)

Recovery rates 45 µm

Advantages of 45 µm particles:

- Faster elution
- Lower elution volumes required

Recovery rates 85 µm

### Breakthrough behavior in enrichment

Method: 1 mL column with 15 mg CHROMABOND® HR-X, apply portions of 1 mL standard solution (250 µg/mL hexobarbital in water), collect eluates (see application 305480 at *www.mn-net.com*)

45 µm (red) The analyte is completely retained up to fraction 10.

85 µm (blue) Small amounts even break through with fraction 4.

45 µm particles provide better enrichment and breakthrough behavior for small adsorbent weights. When using larger adsorbent weights this effect is less pronounced, since then analytes have sufficient contact with the 85 µm adsorbent particles as well.

45 µm particles are ideal for small sample and elution volumes, while for large amounts of sample and adsorbent 85 µm particles show advantages due to better flow properties.

## The CHROMABOND® HR-*Xpert* concept for neutral, acidic and basic analytes

### 3 paths - 1 goal: cleaner samples

Depending on the character of the analytes HR-*Xpert* offers suitable adsorbents and optimal methods for sample preparation, cleaning and concentration.

*** Under organic washing and elution conditions the following compounds will be also eluted**

| | |
|---|---|
| HR-X: | polar compounds such as organic acids and bases |
| HR-XC, HR- XCW: | acidic components and impurities |
| HR-XA, HR- XAW: | basic components and impurities |

## CHROMABOND® HR-X HR-X spherical, hydrophobic polystyrene-divinylbenzene adsorbent resin

### Key features

- High-purity material with highest reproducibility and lowest blank values due to an optimized manufacturing process
- Excellent recovery rates especially for the enrichment of pharmaceuticals and active ingredients due to the spherical structure of the particles, very homogeneous surface and optimized pore structure

### Technical characteristics

- Hydrophobic polystyrene-divinylbenzene copolymer, pH stability 1–14
- Spherical particles, size 45 µm and 85 µm (standard), pore size 55–60 Å, very high surface 1000 $m^2/g$, capacity 390 mg/g (caffeine in water)

### Recommended application

- Pharmaceuticals / active ingredients from tablets, creams and water / waste water
- Drugs and pharmaceuticals from urine, blood, serum and plasma
- Trace analysis of pesticides, herbicides, phenols, PAHs and PCBs from water

#### Drugs from water

MN Appl. No. 304240

**Column type:**
CHROMABOND® HR-X, 3 mL, 200 mg
REF 730931

**Sample:** 1 µg/mL each in water

**Column conditioning:** 5 mL methanol, 5 mL dist. water

**Sample application:**
slowly aspirate 500 mL water (pH 3) through the column

**Column washing:** 5 mL water

**Elution:** after drying 3 x 2 mL acetonitrile

Further analysis: HPLC on NUCLEODUR® $C_{18}$ Gravity, 5 µm; see MN Appl. No. 121690

Recovery rates [ %]

| Compound | HR-X | Strata™ X |
|---|---|---|
| Ketoprofen | 98 | 92 |
| Ibuprofen | 91 | 93 |
| Pentobarbital | 99 | 95 |
| Meclofenamic acid | 92 | 93 |
| Protriptyline | 63 | 45 |
| Nortriptyline | 53 | 39 |

#### Pesticides from water

MN Appl. No. 304250 / 304260

**Column type:**
CHROMABOND® HR-X, 3 mL, 200 mg
REF 730931

**Sample pretreatment:** samples are spiked with 500 ng of each pesticide in 1000 mL water, adjusted to pH 2 with HCl or pH 7

**Column conditioning:**
10 mL methanol, 10 mL dist. water

**Sample application:**
slowly pass 1000 mL spiked water sample through the column with the aid of a tubing adapter (REF 730243)

**Elution:** after drying 5 mL methanol – THF (1:1, v/v)

Further analysis: HPLC

Recovery rates [ %]

| Compound | HR-X pH 2 | Compound | HR-X pH 7 |
|---|---|---|---|
| Metamitron | 86 | Desisopropylatrazine | 90 |
| Quinmerac | 90 | 2,4-Dichlorobenzamide | 95 |
| Chloridazon | 93 | Desethylatrazine | 89 |
| Picloram | 83 | Hexazinone | 95 |
| Metribuzin | 84 | Bromacil | 103 |
| Cyanazine | 83 | Simazine | 91 |
| Metabenzthiazuron | 94 | Desethylterbuthylazine | 89 |
| Chlortoluron | 91 | Atrazine | 88 |
| Isoproturon | 89 | Metalaxyl | 97 |
| Diuron | 91 | Metazachlor | 93 |
| Dimethenamid-P | 89 | Propazine | 88 |
| Linuron | 94 | Terbuthylazine | 86 |
| Epoxyconazole | 85 | Metolachlor | 97 |
| Penconazole | 90 | | |
| Alachlor | 93 | | |
| Propiconazole-1 | 89 | | |
| Flufenacet | 91 | | |
| Diflufenicam | 58 | | |
| Triallate | 42 | | |

For further applications on CHROMABOND® phases visit our online application database at *www.mn-net.com/apps*

# CHROMABOND® HR-X*pert*

### Standard protocol for CHROMABOND® HR-X

MN Appl. No. 304310

**Column type:**
CHROMABOND® HR-X, 3 mL, 200 mg
REF 730931

**Sample pretreatment:** if necessary, adjust pH value
**Column conditioning:** 5 mL methanol
**Equilibration:** 5 mL water
**Sample application:** slowly aspirate the sample through the column
**Column washing:** 5 mL water – methanol (95:5, v/v)
**Elution:** after drying 3 x 2 mL methanol

Further analysis: if necessary, evaporate and redissolve in a suitable solvent; HPLC or GC

### Highest reproducibility
### Barbiturates from serum

MN Appl. No. 304290

**Column type:**
CHROMABOND® HR-X, 3 mL, 200 mg
REF 730931

**Sample:** 100 ng/mL each in serum
**Column conditioning:** 5 mL methanol, 5 mL dist. water
**Sample application:** 1 mL spiked serum
**Column washing:** 5 mL water
**Elution:** after drying 3 x 2 mL methanol

Further analysis: HPLC on NUCLEODUR® 100-5 $C_{18}$ ec, see MN Appl. No. 117820

· Within each batch
· From batch to batch

Compounds:

A phenobarbital
B pentobarbital
C hexobarbital

## Ordering information

| Volume | Adsorbent weight → 30 mg | 60 mg | 100 mg | 200 mg | 500 mg | 1 g | Pack of |
|---|---|---|---|---|---|---|---|
| **CHROMABOND® HR-X polypropylene columns (85 µm)** | | | | | | | |
| 1 mL | 730934 | | 730935 | | | | 30 |
| 3 mL | | 730936 | | 730931 | 730937 | | 30 |
| 6 mL | | | | 730938 | 730939 | | 30 |
| 15 mL | | | | | 730940 | 730941 | 20 |
| **CHROMABOND® HR-X polypropylene columns (85 µm) · BIGpacks** | | | | | | | |
| 3 mL | | | | 730931.250 | | | 250 |
| 6 mL | | | | 730938.250 | 730939.250 | | 250 |
| **CHROMABOND® HR-X polypropylene columns (45 µm)** | | | | | | | |
| 1 mL | 730934P45 | | 730935P45 | | | | 30 |
| 3 mL | | 730936P45 | | 730931P45 | | | 30 |
| **CHROMABOND® LV-HR-X (85 µm)** | | | | | | | |
| 15 mL | 732130 | 732131 | | 732132 | | | 30 |

| | 96 x 10 mg (45 µm) | 96 x 25 mg (45 µm) | 96 x 50 mg (85 µm) | 96 x 100 mg (85 µm) | Pack of |
|---|---|---|---|---|---|
| **CHROMABOND® MULTI 96 HR-X** | | | | | |
| | 738530.010M | 738530.025M | 738530.050M | 738530.100M | 1 |

Glass columns, LV columns and MULTI 96 on request.

For further applications on CHROMABOND® phases visit our online application database at *www.mn-net.com/apps*

## CHROMABOND® HR-XC strong cation exchanger

### Key features

- High purity material, highest reproducibility and lowest blank values due to an optimized production process
- Outstanding recovery rates especially for the enrichment of basic analytes

### Technical characteristics

- Strong acidic benzenesulfonic acid cation exchanger, exchange capacity 1.0 meq/g, base material polystyrene-divinylbenzene copolymer, pH stability 1–14
- Spherical particles, size 45 µm and 85 µm (standard), pore size 65–75 Å, very large specific surface 800 $m^2/g$, pore volume 1.4 $cm^3/g$, RP capacity 300 mg/g (caffeine in water)

### Recommended application

- Basic active ingredients from heavily matrix-contaminated samples like, e.g., urine, plasma, serum
- Fungicides from food
- Basic analytes like, e.g., amines
- Bases with pKa 2–10

### Standard protocol for CHROMABOND® HR-XC

MN Appl. No. 304790

**Column type:**
CHROMABOND® HR-XC, 3 mL, 200 mg
REF 730952

**Sample pretreatment:** adjust pH value if necessary

**Column conditioning:** 5 mL methanol

**Equilibration:** 5 mL water

**Sample application:** slowly aspirate sample through the column

**Column washing 1:** 2 mL 0.1 mol/L HCl in Wasser

**Column washing 2 / Elution 1:** 2 mL methanol (neutral and acidic compounds); if necessary, further washing steps

**Elution 2:** after drying 5 mL methanol – 5 % $NH_3$ (basic compounds)

Further analysis: if necessary, evaporate and redissolve in a suitable solvent; HPLC or GC

### Fractionation of acidic, neutral and basic analytes from serum

MN Appl. No. 304780

**Column type:**
CHROMABOND® HR-XC, 3 mL, 200 mg
REF 730952

**Sample:** 1 mL spiked matrix, acidified with 200 µL 2 % $H_3PO_4$

**Column conditioning:** 5 mL methanol, then 5 mL water

**Sample application:** slowly aspirate sample through the column

**Column washing:** 2 mL 0.1 mol/L HCl

**Elution:** 2.5 mL methanol (fraction A: neutral and acidic analytes); then 5 mL methanol – $NH_3$ 90:10, v/v (fraction B: basic analytes)

Further analysis:

**for fraction A:**
HPLC, e.g., on NUCLEODUR® $C_{18}$ Gravity, see MN Appl. No. 122230;

**for fraction B:**
HPLC on NUCLEODUR® $C_8$ Gravity, see MN Appl. No. 118520

Recovery rates [%]

| Fraction A: neutral and acidic analytes | | Fraction B: basic analytes | | | |
|---|---|---|---|---|---|
| Compound | HR-XC | Compound | HR-XC | Oasis® MCX | Strata™ X-C |
| Suprofen | 108 | Doxepin | 101 | 68 | 82 |
| Naproxen | 85 | Imipramine | 95 | 71 | 85 |
| Tolmetin | 73 | Amitriptyline | 94 | 72 | 78 |
| Phenobarbital | 108 | Trimipramine | 92 | 70 | 81 |
| Indomethacin | 33 | | | | |
| Hexobarbital | 80 | | | | |

## Ordering information

| Volume | Adsorbent weight → 30 mg | 60 mg | 100 mg | 150 mg | 200 mg | 500 mg | Pack of |
|---|---|---|---|---|---|---|---|
| **CHROMABOND® HR-XC polypropylene columns (85 µm)** | | | | | | | |
| 1 mL | 730969 | | 730049 | | | | 30 |
| 3 mL | | 730956 | | | 730952 | 730953 | 30 |
| 6 mL | | | | 730957 | | 730955 | 30 |
| **CHROMABOND® HR-XC polypropylene columns (45 µm)** | | | | | | | |
| 1 mL | 730969P45 | | 730049P45 | | | | 30 |
| 3 mL | | 730956P45 | | | 730952P45 | | 30 |

| Size → | S | M | L | |
|---|---|---|---|---|
| Minimum adsorbent weight → | 50 mg | 140 mg | 400 mg | Pack of |
| **CHROMAFIX® HR-XC cartridges (85 µm)** | | | | |
| | 731755 | 731756 | 731757 | 50 |

Glass columns, LV columns and MULTI 96 on request.

## CHROMABOND® HR-XA strong anion exchanger

### Key features

- High purity material with highest reproducibility and lowest blank values due to an optimized production process
- Outstanding recovery rates especially for the enrichment of acidic analytes

### Technical characteristics

- Strong basic quaternary ammonium anion exchanger, exchange capacity 0.25 meq/g, pKa ~ 18, base material polystyrene-divinylbenzene copolymer, pH stability 1–14
- Spherical particles, size 45 µm and 85 µm (standard), pore size 55–65 Å, very large specific surface 850 $m^2/g$, pore volume 1.4 $cm^3/g$, RP capacity 350 mg/g (caffeine in water)

### Recommended application

- Acidic active ingredients from heavily matrix-contaminated samples like, e.g., urine, plasma, serum
- Phenolic acids
- Acidic herbicides
- Weak / medium-strength acids with pKa 2–8

**Standard protocol for CHROMABOND® HR-XA**

MN Appl. No. 304970

**Column type:**
CHROMABOND® HR-XA, 3 mL, 200 mg
REF 730951

**Sample pretreatment:**
individual sample preparation with reference to analytes and matrix

**Column conditioning:** 5 mL methanol

**Equilibration:** 5 mL water

**Sample application:** slowly aspirate sample through the column

**Column washing 1:** 2 mL 0.1 mol/L NaOH in water

**Column washing 2 / Elution 1:** 2 mL methanol (neutral and basic compounds), if necessary, further washing steps

**Elution 2:** after drying 5 mL methanol – 1 to 10 % formic acid (acidic compounds)

Further analysis: if necessary, evaporate and redissolve in a suitable solvent; HPLC or GC MN Appl. No. 304970

## Ordering information

| | Volume | Adsorbent weight → 30 mg | 60 mg | 100 mg | 150 mg | 200 mg | 500 mg | Pack of |
|---|---|---|---|---|---|---|---|---|
| | **CHROMABOND® HR-XA polypropylene columns (85 µm)** | | | | | | | |
| | 1 mL | 730968 | | 730727 | | | | 30 |
| | 3 mL | | 730950 | | | 730951 | 730954 | 30 |
| | 6 mL | | | | 730958 | | 730966 | 30 |
| | **CHROMABOND® HR-XA polypropylene columns (45 µm)** | | | | | | | |
| | 1 mL | 730968P45 | | 730727P45 | | | | 30 |
| | 3 mL | | 730950P45 | | | 730951P45 | | 30 |
| | Size → | S | | M | | L | | |
| | Minimum adsorbent weight → | 70 mg | | 180 mg | | 510 mg | | Pack of |
| | **CHROMAFIX® HR-XA cartridges (85 µm)** | | | | | | | |
| | | 731768 | | 731769 | | 731770 | | 50 |

Glass columns, LV columns and MULTI 96 on request.

For further applications on CHROMABOND® phases visit our online application database at *www.mn-net.com/apps*

## CHROMABOND® HR-XCW weak cation exchanger

### Key features

- High purity material, highest reproducibility and lowest blank values due to an optimized production process
- Outstanding recovery rates especially for enrichment of strongly basic analytes

### Technical characteristics

- Weak acidic carboxylic acid cation exchanger, exchange capacity >0.7 meq/g, pKa ~ 5, base material spherical PS/DVB copolymer, pH stability 1–14
- Spherical particles, size 45 µm and 85 µm (standard), pore size 50–60 Å very large specific surface 850 $m^2/g$, pore volume 1.2–1.4 $cm^3/g$, RP capacity 350 mg/g (caffeine in water)

### Recommended application

- Basic compounds like quaternary amines
- Active ingredients from heavily matrix-contaminated samples like, e.g., urine, plasma, serum
- Strong bases with pKa > 10

**Standard protocol for CHROMABOND® HR-XCW**

MN Appl. No. 305300

**Column type:**
CHROMABOND® HR-XCW, 3 mL, 200 mg
REF 730739

**Sample pretreatment:**
individual sample preparation with reference to analytes and matrix

**Column conditioning:** 5 mL methanol, 5 mL water

**Sample application:**
slowly aspirate sample through the column

**Column washing 1:** 2 mL acidified water

**Column washing 2 / Elution 1:** 2 mL methanol (neutral and acidic compounds), further washing steps if necessary

**Elution 2:** after drying 2 x 2 mL methanol – 1 to 5 % formic acid (strongly basic compounds)

Further analysis: if necessary, evaporate and redissolve in a suitable solvent; HPLC or GC

## Ordering information

| Volume | Adsorbent weight → 30 mg | 60 mg | 100 mg | 150 mg | 200 mg | 500 mg | Pack of |
|---|---|---|---|---|---|---|---|
| **CHROMABOND® HR-XCW polypropylene columns (85 µm)** | | | | | | | |
| 1 mL | 730731 | | 730733 | | | | 30 |
| 3 mL | | 730735 | | | 730739 | 730741 | 30 |
| 6 mL | | | | 730737 | | 730743 | 30 |
| **CHROMABOND® HR-XCW polypropylene columns (45 µm)** | | | | | | | |
| 1 mL | 730731P45 | | 730733P45 | | | | 30 |
| 3 mL | | 730735P45 | | | 730739P45 | | 30 |

| Size → Minimum adsorbent weight → | S 60 mg | M 160 mg | L 450 mg | Pack of |
|---|---|---|---|---|
| **CHROMAFIX® HR-XCW cartridges (85 µm)** | | | | |
| | 731774 | 731775 | 731776 | 50 |

Glass columns, LV columns and MULTI 96 on request.

## CHROMABOND® HR-XAW weak anion exchanger

### Key features

- High purity material with highest reproducibility and lowest blank values due to an optimized production process
- Outstanding recovery rates especially for enrichment of acidic analytes

### Technical characteristics

- Weak basic secondary and tertiary ammonium anion exchanger, exchange capacity >0.5 meq/g, pKa ~ 6, base material spherical PS/DVB copolymer, pH stability 1–14
- Spherical particles, size 45 µm and 85 µm (standard), pore size 55–65 Å very large specific surface 850 $m^2/g$, pore volume 1.2–1.4 $cm^3/g$, RP capacity 350 mg/g (caffeine in water)

### Recommended application

- Perfluorinated surfactants
- Acidic compounds like sulfonates
- Active ingredients from heavily matrix-contaminated samples like, e.g., urine, plasma, serum
- Strong acids with pKa < 1

#### Standard protocol for CHROMABOND® HR-XAW

MN Appl. No. 305200

**Column type:**
CHROMABOND® HR-XAW, 3 mL, 200 mg
REF 730748

**Sample pretreatment:**
individual sample preparation with reference to analytes and matrix

**Column conditioning:** 5 mL methanol

**Equilibration:** 5 mL water

**Sample application:**
slowly aspirate sample through the column

**Column washing 1:** 25 mmol/L ammonium acetate

**Column washing 2 / Elution 1:** 2 mL methanol (neutral and basic compounds), if necessary, further washing steps

**Elution 2:** after drying 2 x 2 mL methanol – 1 to 5 % ammonia (strongly acidic compounds)

Further analysis: if necessary, evaporate and redissolve in a suitable solvent; HPLC or GC

#### Analysis of perfluorinated surfactants from water

MN Appl. No. 305140

Application in accordance with DIN 38407-42

**Column type:**
CHROMABOND® HR-XAW, 3 mL, 60 mg
REF 730747

**Sample:** 500 mL water, spiked with 1 mL standard solution (20 µg/L of each compound

**Column conditioning:**
2 mL methanol + 5 % ammonia, then 2 mL methanol, finally 2 mL water

**Sample application:**
slowly aspirate sample through the column

**Column washing:** 2 mL water, then 2 mL acetone – acetonitrile – formic acid (50:50:1, v/v/v), finally 2 mL methanol

**Elution:** 2 mL methanol with 5 % ammonia

Further analysis: evaporate to dryness in a stream of nitrogen under slight heating, and redissolve in a suitable solvent for HPLC

Recovery rates [ %]

| Compound | Recovery |
|---|---|
| Perfluoropropionic acid (PFPrA) | 103 |
| Perfluoropentanoic acid (PFPeA) | 94 |
| Perfluorohexanoic acid (PFHxA) | 94 |
| Perfluorooctanoic acid (PFOA) | 95 |
| Perfluorooctane sulfonate K salt (PFOS) | 81 |
| Perfluorododecanoic acid (PFDoDA) | 82 |

## Ordering information

| | Volume | Adsorbent weight → 30 mg | 60 mg | 100 mg | 150 mg | 200 mg | 500 mg | Pack of |
|---|---|---|---|---|---|---|---|---|
| | **CHROMABOND® HR-XAW polypropylene columns (85 µm)** | | | | | | | |
| | 1 mL | 730728 | | 730729 | | | | 30 |
| | 3 mL | | 730747 | | | 730748 | 730744 | 30 |
| | 6 mL | | | | 730749 | | 730745 | 30 |
| | **CHROMABOND® HR-XAW polypropylene columns (45 µm)** | | | | | | | |
| | 1 mL | 730728P45 | | 730729P45 | | | | 30 |
| | 3 mL | | 730747P45 | | | 730748P45 | | 30 |
| | Size → | S | | M | | L | | |
| | Minimum adsorbent weight → | 50 mg | | 120 mg | | 360 mg | | Pack of |
| | **CHROMAFIX® HR-XAW cartridges (85 µm)** | | | | | | | |
| | | 731771 | | 731772 | | 731773 | | 50 |

Glass columns, LV columns and MULTI 96 on request.

## CHROMABOND® Easy polar, bifunctionally modified polystyrene-divinylbenzene copolymer

### Key features

The Easy effect:

- Without preconditioning
- Due to bifunctional modification much more hydrophilic than conventional polystyrene-divinylbenzene polymers
- Easily wettable with water

### Technical characteristics

- Polar modified polystyrene-divinylbenzene copolymer with a weak anion exchanger, specific surface 650–700 $m^2/g$, particle size 80 µm, pore size 50 Å, pH stability 1–14

### Recommended application

- Polar herbicides and pesticides from water (acidic, neutral, basic), polar phenols from water, polyaromatic compounds, polychlorinated biphenyls
- Drug analysis from urine, blood, serum, plasma
- Pharmaceuticals and active ingredients from tablets, creams

### Recovery of pesticides

MN Appl. No. 303220

Private communication Mr. Kühn, GUB, Waldshut Tiengen, Germany

**Column type:**
CHROMABOND® Easy, 3 mL, 200 mg
REF 730754

**Column conditioning:**
1 mL water, 3 mL methanol, 1 mL water

**Sample application:**
aspirate the sample through the column

**Elution:**
3 x 1 mL acetone

Further analysis: HPLC with NUCLEOSIL® 120-5 $C_{18}$

Recovery rates [ %]

| Compound | Recovery | Compound | Recovery |
|---|---|---|---|
| Desisopropylatrazine | 90 | Metalaxyl | 96 |
| 2,6-Dichlorobenzamide | 93 | Isoproturon | 94 |
| Desethylatrazine | 93 | Diuron | 94 |
| Hexazinone | 69 | Metazachlor | 97 |
| Terbacil | 65 | Propazine | 95 |
| Simazine | 81 | Terbuthylazine | 93 |
| Cyanazine | 93 | Linuron | 96 |
| Desethylterbuthylazine | 91 | Metolachlor | 97 |
| Methabenzthiazuron | 94 | Triallate | 61 |
| Chlortoluron | 91 | Standard | 64 |
| Atrazine | 92 | | |

## Ordering information

| Volume | Adsorbent weight → 30 mg | 60 mg | 100 mg | 200 mg | 500 mg | 1 g | Pack of |
|---|---|---|---|---|---|---|---|
| **CHROMABOND® Easy polypropylene columns** | | | | | | | |
| 1 mL | 730751 | | 730752 | | | | 30 |
| 3 mL | | 730753 | | 730754 | 730759 | | 30 |
| 6 mL | | | | 730755 | 730756 | | 30 |
| 15 mL | | | | | 730757 | 730758 | 20 |
| **CHROMABOND® Easy polypropylene columns · BIGpacks** | | | | | | | |
| 3 mL | | | | 730754.250 | | | 250 |
| 6 mL | | | | 730755.250 | | | 250 |
| **CHROMABOND® LV-Easy** | | | | | | | |
| 15 mL | | | | 732472 | | | 30 |

| | 96 x 25 mg | 96 x 50 mg | 96 x 100 mg | Pack of |
|---|---|---|---|---|
| **CHROMABOND® MULTI 96 Easy** | | | | |
| | 738520.025M | 738520.050M | 738520.100M | 1 |
| **CHROMABOND® Easy adsorbent** | | | | |
| | | | 730661 | 20 g |

For further applications on CHROMABOND® phases visit our online application database at *www.mn-net.com/apps*

## CHROMABOND® HR-P polystyrene-divinylbenzene adsorbent resin

### Key features
- Very high binding capacity, up to 30 % of adsorbent weight (for comparison: silica adsorbents about 3 %)

### Technical characteristics
- Highly porous polystyrene-divinylbenzene copolymer, specific surface 1200 $m^2/g$, particle size 50–100 µm

### Recommended application
- Aromatic compounds, phenols from water, nitroaromatics from water, pesticides from water, PAHs from oil

**Aromatic amines from water samples**

MN Appl. No. 301810

Private communication M. Leß, T.C. Schmidt, Department of Chemistry, University Marburg, 1997

**Compounds investigated:** aromatic amines

**Column type:**
CHROMABOND® HR-P, 3 mL, 200 mg
REF 730108

**Sample pretreatment:** adjust to pH 9 using 10 mol/L NaOH

**Column conditioning:** 2 mL each of methanol, acetonitrile and $10^{-5}$ mol/L aqueous sodium hydroxide solution

**Sample application:** aspirate sample through the column with about 10 mL/min

**Column washing:** wash with 2 mL dist. water, dry 5 min under vacuum

**Elution:** 3 x 1 mL methanol – acetonitrile (1:1, v/v)

For recovery rates of numerous aromatic amines please see application 301810 at *www.mn-net.com/apps*

## Ordering information

| | Volume | Adsorbent weight → 100 mg | 200 mg | 500 mg | 1 g | Pack of |
|---|---|---|---|---|---|---|
| | **CHROMABOND® HR-P polypropylene columns** | | | | | |
| | 1 mL | 730280 | | | | 30 |
| | 3 mL | | 730108 | 730117 | | 30 |
| | 6 mL | | 730119 | 730111 | 730118 | 30 |
| | **CHROMABOND® HR-P polypropylene columns · BIGpack** | | | | | |
| | 3 mL | | 730108.250 | | | 250 |
| | **CHROMABOND® HR-P glass columns** | | | | | |
| | 3 mL | | 730108G | | | 30 |
| | 6 mL | | | 730111G | 730118G | 30 |
| | **CHROMABOND® LV-HR-P** | | | | | |
| | 15 mL | | 732108 | | | 30 |
| | | Size → | S | M | L | |
| | | Minimum adsorbent weight → | 50 mg | 130 mg | 380 mg | Pack of |
| | **CHROMAFIX® HR-P cartridges** | | | | | |
| | | | 731839 | 731840 | 731841 | 50 |
| | | | | | 96 x 100 mg | Pack of |
| | **CHROMABOND® MULTI 96 HR-P** | | | | | |
| | | | | | 738111.100M | 1 |
| | **CHROMABOND® HR-P adsorbent** | | | | | |
| | | | | | 730615 | 20 g |

For further applications on CHROMABOND® phases visit our online application database at *www.mn-net.com/apps*

## CHROMABOND® PS-RP / PS-OH⁻ / PS-H⁺ / PS-Mix / PS-Ag⁺ / PS-Ba²⁺

phases for RP and ion chromatography

### Key features

- Very low degree of swelling, thus very well suited for chromatography, reliable function over the whole pH range from 0–14

### Technical characteristics

- Base material high purity polystyrene-divinylbenzene copolymers (PS/DVB), pore size 100 Å, particle size 100 µm
- Different modifications for different applications from the elimination of nonpolar compounds up to the removal of specific polar components

### Recommended application

- Removal of interfering compounds
- Improves chromatographic separation, if the interfering components overlap with the analyte in the chromatogram
- Improves lifetime of the chromatographic column, since interfering components can irreversibly block the column packing
- Enrichment of the analytes

### Properties of the individual modifications

| | | |
|---|---|---|
| PS-RP | hydrophobic PS/DVB copolymer | removal of organic interfering components from water |
| PS-OH⁻ | strong PS/DVB anion exchanger, $OH^-$ form capacity 0.6 meq/g | removal or concentration of anions from water increasing the pH value in acidic samples |
| PS-H⁺ | strong PS/DVB cation exchanger, $H^+$ form capacity 2.9 meq/g | removal or concentration of cations from water decreasing the pH value of basic samples |
| PS-Mix | mixture of PS-OH⁻ and PS-H⁺ | desalting of water |
| PS-Ag⁺ | strong PS/DVB cation exchanger, $Ag^+$ form | removal of halide ions from water |
| PS-Ba²⁺ | strong PS/DVB cation exchanger, $Ba^{2+}$ form | removal of sulfate ions from water |

Removal of halides from aqueous samples shown for the trace analysis of nitrate besides an excess of chloride or bromide

MN Appl. No. 301930 / 302750

**Compounds investigated:**
20 ppm nitrate besides 2500 ppm chloride or 500 ppm bromide

**Column type:**
CHROMAFIX® PS-Ag⁺ (M) 0.8 mL, min. 250 mg
REF 731865

**Column conditioning:** 1 mL dist. water

**Sample application and Elution:**
apply 4 x 1 mL sample fractions to the cartridge, discard 1st mL, collect 2nd, 3rd and 4th mL separately

Further analysis: HPLC with column 250 x 4 mm NUCLEOSIL® Anion II; eluent 2 mmol/L potassium hydrogen phthalate pH 6, 2 mL/min; detection: indirect UV, 280 nm (see applications 110440 and 110450 at *www.mn-net.com/apps*)

### Ordering information

| Phases | Adsorbent weight → 3 mL / 200 mg | 3 mL / 500 mg | 6mL / 500 mg | 6 mL / 900 mg | | | Pack of |
|---|---|---|---|---|---|---|---|
| **CHROMABOND® PS polypropylene columns** | | | | | | | |
| PS-RP | 730765 | 730692 | 730693 | | | | 30 |
| PS-OH⁻ | 730396 | 730344 | 730378 | | | | 30 |
| PS-H⁺ | 730690 | 730376 | 730377 | | | | 30 |
| PS-Mix | | 730394 | | 730310 | | | 30 |

| Phases | Size S | Minimum adsorbent weight → | Size M | Minimum adsorbent weight → | Size L | Minimum adsorbent weight → | Pack of |
|---|---|---|---|---|---|---|---|
| **CHROMAFIX® PS cartridges** | | | | | | | |
| PS-RP | 731877 | 60 mg | 731875 | 160 mg | | | 50 |
| PS-OH⁻ | 731868 | 70 mg | 731860 | 180 mg | 731862 | 510 mg | 50 |
| PS-H⁺ | 731867 | 90 mg | 731861 | 220 mg | 731863 | 620 mg | 50 |
| PS-Mix | 731909 | 70 mg | | | | | 50 |
| PS-Ag⁺ | 731866 | 100 mg | 731865 | 250 mg | | | 50 |
| PS-Ba²⁺ | 731871 | 100 mg | 731870 | 250 mg | | | 50 |

# CHROMABOND® reversed phases

## CHROMABOND® $C_{18}$ ec / $C_{18}$ ec f (f = fast flow) octadecyl silica, endcapped

### Key features

- Very nonpolar, hydrophobic interactions with a wide variety of organic compounds
- Advantageous for the clean-up of samples with large structural variations (polarity differences)

### Technical characteristics

- Base material silica, pore size 60 Å, particle size 45 µm for $C_{18}$ ec, 100 µm for $C_{18}$ ec f (for fast flow), specific surface 500 $m^2/g$, pH stability 2–8
- Octadecyl phases, endcapped, carbon content 14 %

### Recommended application

- Nonpolar compounds aflatoxins, amphetamines, antibiotics, antiepileptics, barbiturates, caffeine, drugs, preservatives, fatty acids, nicotine, PAHs, pesticides, PCBs, heavy metals, vitamins
- Very well suited for desalting of samples
- $C_{18}$ ec f for viscous samples

### Ordering information

| Volume | Adsorbent weight → 100 mg | 200 mg | 500 mg | 1 g | 2 g | 5 g | 10 g | Pack of |
|---|---|---|---|---|---|---|---|---|
| **CHROMABOND® $C_{18}$ ec polypropylene columns** | | | | | | | | |
| 1 mL | 730011 | | | | | | | 100 |
| 3 mL | | 730012 | 730013 | | | | | 50 |
| 6 mL | | | 730014 | 730015 | 730141 | | | 30 |
| 15 mL | | | | | 730404 | | | 20 |
| 45 mL | | | | | | 730405 | | 20 |
| 70 mL | | | | | | | 730259 | 10 |
| **CHROMABOND® $C_{18}$ ec polypropylene columns · BIGpacks** | | | | | | | | |
| 3 mL | | | 730013.250 | | | | | 250 |
| 6 mL | | | 730014.250 | 730015.250 | | | | 250 |
| **CHROMABOND® $C_{18}$ ec glass columns** | | | | | | | | |
| 3 mL | | 730012G | 730013G | | | | | 50 |
| 6 mL | | | 730014G | 730015G | | | | 30 |
| **CHROMABOND® LV-$C_{18}$ ec** | | | | | | | | |
| 15 mL | | 732012 | 732013 | | | | | 30 |

| | Size → Minimum adsorbent weight → S 90 mg | M 230 mg | L 630 mg | Pack of |
|---|---|---|---|---|
| **CHROMAFIX® $C_{18}$ ec cartridges** | | | | |
| | 731804 | 731805 | 731806 | 50 |

| | 96 x 25 mg | 96 x 50 mg | 96 x 100 mg | Pack of |
|---|---|---|---|---|
| **CHROMABOND® MULTI 96 $C_{18}$ ec** | | | | |
| | 738011.025M | 738011.050M | 738011.100M | 1 |

| | | |
|---|---|---|
| **CHROMABOND® $C_{18}$ ec adsorbent** | | |
| | 730611 | 100 g |

| Volume | Adsorbent weight → 100 mg | 200 mg | 500 mg | 1 g | 2 g | 5 g | 10 g | Pack of |
|---|---|---|---|---|---|---|---|---|
| **CHROMABOND® $C_{18}$ ec f polypropylene columns (fast flow)** | | | | | | | | |
| 3 mL | | 730269 | 730018 | | | | | 50 |
| 6 mL | | | 730016 | 730010 | | | | 30 |
| **CHROMABOND® $C_{18}$ ec f adsorbent (fast flow)** | | | | | | | | |
| | | | | | | | 730613 | 100 g |

## CHROMABOND® $C_{18}$ / $C_{18}$ f (f = fast flow) octadecyl silica

### Key features

- Similar to $C_{18}$ ec, however possesses more free silanols (SiOH), which allow secondary interactions with polar groups of the analytes

### Technical characteristics

- Base material silica, pore size 60 Å, particle size 45 µm for $C_{18}$, 100 µm for $C_{18}$ f (for fast flow), specific surface 500 $m^2/g$, pH stability 2–8
- Octadecyl phases, not endcapped, carbon content 14 %

### Recommended application

- Nonpolar compounds, pesticides
- $C_{18}$ f for viscous samples

### Ordering information

| Volume | Adsorbent weight → 100 mg | 200 mg | 500 mg | 1 g | 2 g | 5 g | 10 g | Pack of |
|---|---|---|---|---|---|---|---|---|
| **CHROMABOND® $C_{18}$ polypropylene columns** | | | | | | | | |
| 1 mL | 730001 | | | | | | | 100 |
| 3 mL | | 730002 | 730003 | | | | | 50 |
| 6 mL | | | 730004 | 730005 | 730130 | | | 30 |
| 15 mL | | | | | 730028 | | | 20 |
| 45 mL | | | | | | 730400 | | 20 |
| 70 mL | | | | | | | 730261 | 10 |
| **CHROMABOND® $C_{18}$ polypropylene columns · BIGpacks** | | | | | | | | |
| 3 mL | | | 730003.250 | | | | | 250 |
| 6 mL | | | 730004.250 | 730005.250 | | | | 250 |
| **CHROMABOND® $C_{18}$ glass columns** | | | | | | | | |
| 3 mL | | | 730003G | | | | | 50 |
| 6 mL | | | 730004G | 730005G | | | | 30 |
| **CHROMABOND® LV-$C_{18}$** | | | | | | | | |
| 15 mL | | 732002 | | | | | | 30 |

| | Size → | S | M | L | Pack of |
|---|---|---|---|---|---|
| | Minimum adsorbent weight → | 90 mg | 200 mg | 560 mg | |
| **CHROMAFIX® $C_{18}$ cartridges** | | | | | |
| | | 731801 | 731802 | 731803 | 50 |

| | 96 x 25 mg | 96 x 100 mg | Pack of |
|---|---|---|---|
| **CHROMABOND® MULTI 96 $C_{18}$** | | | |
| | 738001.025M | 738001.100M | 1 |

| | | Pack of |
|---|---|---|
| **CHROMABOND® $C_{18}$ adsorbent** | | |
| | 730602 | 100 g |

| Volume | Adsorbent weight → 100 mg | 200 mg | 500 mg | 1 g | 2 g | 5 g | 10 g | Pack of |
|---|---|---|---|---|---|---|---|---|
| **CHROMABOND® $C_{18}$ f polypropylene columns (fast flow)** | | | | | | | | |
| 3 mL | | 730402 | 730008 | | | | | 50 |
| 6 mL | | | 730403 | 730009 | | | | 30 |
| **CHROMABOND® $C_{18}$ f adsorbent (fast flow)** | | | | | | | | |
| | | | | | | | 730612 | 100 g |

For further applications on CHROMABOND® phases visit our online application database at *www.mn-net.com/apps*

# CHROMABOND® reversed phases

## CHROMABOND® $C_{18}$ Hydra octadecyl silica for polar analytes

### Key features

- Special octadecyl phase for polar analytes, not endcapped, carbon content 15 %

### Technical characteristics

- Base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 $m^2/g$, pH stability 2–8

### Recommended application

- Polar compounds like pesticides and their polar degradation products, phenols, phenoxycarboxylic acids

Pesticides from water

MN Appl. No. 302060

**Compounds investigated:** triazines and carboxylic amides

**Column type:**
CHROMABOND® $C_{18}$ Hydra, 6 mL, 2 g
REF 730301

**Sample pretreatment:** adjust 1000 mL water to pH 7–8 with diluted $NH_3$ and add 100 µL of the internal standards (1 µg/L).

**Column conditioning:** 2 x 5 mL methanol, then 2 x 5 mL dist. water

**Sample application:** force or aspirate the sample through the column. Then dry for 2 h with 2 bar $N_2$.

**Elution:** slowly aspirate 10 mL methanol through the column. Evaporate the eluate to dryness in a tapered flask with a rotation evaporator at 30 °C and store in a refrigerator for ~15 min. Redissolve the residue in 200 µL cold, fresh *n*-hexane and transfer the solution to a conic HPLC vial (e.g., REF 702891). Store the solution in a refrigerator until chromatography.

**Recovery rates:** between 95 and 100 %

Further analysis: GC with OPTIMA® δ-3 or OPTIMA® δ-6 (e.g., application 250420) or HPLC in accordance with EN ISO 11369: 1997 on NUCLEOSIL® 120-3 $C_{18}$ (application 110880)

## Ordering information

| | Adsorbent weight → | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Volume | 50 mg | 100 mg | 200 mg | 500 mg | 1 g | 2 g | 3 g | Pack of |
| **CHROMABOND® $C_{18}$ Hydra polypropylene columns** | | | | | | | | |
| 1 mL | 730294 | 730295 | | | | | | 100 |
| 3 mL | | | 730296 | 730297 | 730298 | | | 50 |
| 6 mL | | | | 730299 | 730300 | 730301 | 730302 | 30 |
| **CHROMABOND® $C_{18}$ Hydra glass columns** | | | | | | | | |
| 3 mL | | | 730296G | 730297G | 730298G | | | 50 |
| 6 mL | | | | 730299G | 730300G | | | 30 |
| **CHROMABOND® LV-$C_{18}$ Hydra** | | | | | | | | |
| 15 mL | | | 732295 | | | | | 30 |

| Size → | S | M | L | |
|---|---|---|---|---|
| Minimum adsorbent weight → | 90 mg | 230 mg | 640 mg | Pack of |
| **CHROMAFIX® $C_{18}$ Hydra cartridges** | | | | |
| | 731730 | 731731 | 731732 | 50 |

| | 96 x 100 mg | Pack of |
|---|---|---|
| **CHROMABOND® MULTI 96 $C_{18}$ Hydra** | | |
| | 738294.100M | 1 |

| | | |
|---|---|---|
| **CHROMABOND® $C_{18}$ adsorbent** | | |
| | 730628 | 100 g |

For further applications on CHROMABOND® phases visit our online application database at *www.mn-net.com/apps*

## CHROMABOND® $C_8$ octyl silica

### Key features

- Similar to $C_{18}$, however slightly more polar
- Secondary interactions with polar compounds are more pronounced due to shorter alkyl chains

### Technical characteristics

- Base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 $m^2/g$, pH stability 2–8
- Octyl phase, not endcapped, carbon content 8 %

### Recommended application

- Pesticides, PCBs

### Ordering information

| | Volume | Adsorbent weight → 100 mg | 200 mg | 500 mg | 1 g | Pack of |
|---|---|---|---|---|---|---|
| | **CHROMABOND® $C_8$ polypropylene columns** | | | | | |
| | 1 mL | 730021 | | | | 100 |
| | 3 mL | | 730022 | 730023 | | 50 |
| | 6 mL | | | 730024 | 730134 | 30 |
| | **CHROMABOND® $C_8$ glass columns** | | | | | |
| | 6 mL | | | 730024G | | 30 |
| | **CHROMABOND® LV-$C_8$** | | | | | |
| | 15 mL | | | 732023 | | 30 |

| | | Size → Minimum adsorbent weight → | M 210 mg | | | Pack of |
|---|---|---|---|---|---|---|
| | **CHROMAFIX® $C_8$ cartridges** | | | | | |
| | | | 731808 | | | 50 |

| | | 96 x 100 mg | Pack of |
|---|---|---|---|
| | **CHROMABOND® MULTI 96 $C_8$** | | |
| | | 738021.100M | 1 |
| | **CHROMABOND® $C_8$ adsorbent** | | |
| | | 730601 | 100 g |

# CHROMABOND® reversed phases

## CHROMABOND® $C_4$ butyl silica

### Key features

- Slightly more polar than $C_{18}$ or $C_8$, due to shorter alkyl chains the silica surface is not completely shielded

### Technical characteristics

- Base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 $m^2/g$, pH stability 2–8
- Butyl phase, not endcapped, carbon content 7 %

### Recommended application

- Compounds, which are too strongly retained on $C_{18}$ or $C_8$ e.g., analgetics from blood

### Ordering information

| Volume | Adsorbent weight → | 100 mg | 500 mg | Pack of |
|---|---|---|---|---|
| **CHROMABOND® $C_4$ polypropylene columns** | | | | |
| 1 mL | | 730225 | | 100 |
| 3 mL | | | 730227 | 50 |

| | Size → | S | M | |
|---|---|---|---|---|
| | Minimum adsorbent weight → | 80 mg | 200 mg | Pack of |
| **CHROMAFIX® $C_4$ cartridges** | | | | |
| | | 731740 | 731741 | 50 |

| | | |
|---|---|---|
| **CHROMABOND® $C_4$ adsorbent** | | |
| | 730651 | 100 g |

Glass columns, LV columns and MULTI 96 on request.

## CHROMABOND® $C_2$ dimethyl silica

### Key features

- Similar to $C_4$

### Technical characteristics

- Base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 $m^2/g$, pH stability 2–8
- Dimethyl phase, not endcapped, carbon content 4 %

### Recommended application

- e.g., antiepileptics from plasma

### Ordering information

| Volume | Adsorbent weight → 100 mg | 500 mg | 1 g | Pack of |
|---|---|---|---|---|
| **CHROMABOND® $C_2$ polypropylene columns** | | | | |
| 1 mL | 730169 | | | 100 |
| 3 mL | | 730221 | | 50 |
| 6 mL | | 730409 | 730410 | 30 |

| | | |
|---|---|---|
| **CHROMABOND® $C_2$ adsorbent** | | |
| | 730652 | 100 g |

Glass columns, LV columns, CHROMAFIX® cartridges and MULTI 96 on request.

## CHROMABOND® $C_6H_{11}$ ec cyclohexyl silica, endcapped

### Key features

- Alternative phase for the midpolar range

### Technical characteristics

- Base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 $m^2/g$, pH stability 2–8
- Cyclohexyl phase, endcapped, carbon content 9 %

### Recommended application

- Phenols from water
- Chloroanilines from waste water
- Anthelmintics from tissue

Comparison of different phases for phenol analysis

MN Appl. No. 302150

**Compounds investigated:** phenol, 2,4-dinitrophenol, pentachlorophenol

**Column types:**
CHROMABOND® $C_{18}$, 6 mL, 2000 mg
REF 730130
CHROMABOND® $C_6H_{11}$ ec, 6 mL, 2000 mg
REF 730469

**Column conditioning:** 10 mL acetone, 10 mL methanol, and 10 mL dist. water (pH 2)
**Sample application:** aspirate the sample through the column.
**Elution:** 10 mL methanol

### Ordering information

| | Volume | Adsorbent weight → 500 mg | 1 g | Pack of |
|---|---|---|---|---|
| | **CHROMABOND® $C_6H_{11}$ ec polypropylene columns** | | | |
| | 3 mL | 730442 | | 50 |
| | 6 mL | 730443 | 730444 | 30 |
| | **CHROMABOND® $C_6H_{11}$ ec adsorbent** | | | |
| | | | 730631 | 100 g |

Glass columns, LV columns, CHROMAFIX® cartridges and MULTI 96 on request.

# CHROMABOND® reversed phases

## CHROMABOND® $C_6H_5$ phenyl silica

### Key features

- Polarity similar to $C_8$
- In addition to hydrophobic interactions more selective adsorption is possible by π-π interactions due to the electron density of the phenyl ring.

### Technical characteristics

- Base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 $m^2/g$, pH stability 2–8
- Phenyl phase, carbon content 8 %

### Recommended application

- Aflatoxins, caffeine, phenols

**Flavor compounds from brandy**

MN Appl. No. 300170

**Compounds investigated:** asarone, quinine, coumarin, quassin

**Column type:**
CHROMABOND® $C_6H_5$, 6 mL, 1000 mg
REF 730412

**Sample pretreatment:** mix 10 mL sample with 90 mL water and 10 g sodium chloride and adjust to pH 7 with 0.1 mol/L sodium hydroxide solution

**Column conditioning:** 10 mL methanol, then 10 mL dist. water

**Sample application:** slowly force or aspirate the sample through the column

**Column washing:** 2.5 mL water, then 2.5 mL pentane

**Elution:** 1) 2 x 2.5 mL pentane – diethyl ether (7:3, v/v): asarone, coumarin
2) 10 mL 1 mol/L basic methanol – diethyl ether (9:1, v/v): quinine
3) 5 mL chloroform: quassin

## Ordering information

| | Volume | Adsorbent weight → 100 mg | 200 mg | 500 mg | Pack of |
|---|---|---|---|---|---|
| | **CHROMABOND® $C_6H_5$ polypropylene columns** | | | | |
| | 1 mL | 730083 | | | 100 |
| | 3 mL | | 730411 | 730084 | 50 |
| | **CHROMABOND® $C_6H_5$ adsorbent** | | | | |
| | | | | 730606 | 100 g |

Glass columns, LV columns, CHROMAFIX® cartridges and MULTI 96 on request.

For further applications on CHROMABOND® phases visit our online application database at *www.mn-net.com/apps*

## CHROMABOND® SiOH unmodified silica

### Key features

- Very polar
- Adsorbs humidity from air, for this reason it should be kept well closed and if necessary dried before use
- Due to its high affinity for polar compounds it should not be conditioned with polar (e.g., methanol) or water-containing solvents.

### Technical characteristics

- Unmodified, weakly acidic silica, pore size 60 Å, particle size 45 µm, specific surface 500 $m^2/g$, pH stability 2–8

### Recommended application

- Aflatoxins, chloramphenicol, pesticides, steroids, vitamins

### Ordering information

| Volume | Adsorbent weight → 100 mg | 200 mg | 500 mg | 1 g | 2 g | 5 g | 10 g | 50 g | Pack of |
|---|---|---|---|---|---|---|---|---|---|
| **CHROMABOND® SiOH polypropylene columns** | | | | | | | | | |
| 1 mL | 730071 | | | | | | | | 100 |
| 3 mL | | 730214 | 730073 | | | | | | 50 |
| 6 mL | | | 730070 | 730075 | 730107 | | | | 30 |
| 15 mL | | | | | 730217 | | | | 20 |
| 45 mL | | | | | | 730406 | | | 20 |
| 70 mL | | | | | | | 730072 | | 10 |
| 150 mL | | | | | | | | 730473 | 10 |
| **CHROMABOND® SiOH polypropylene columns · BIGpacks** | | | | | | | | | |
| 3 mL | | | 730073.250 | | | | | | 250 |
| 6 mL | | | | 730075.250 | 730107.250 | | | | 250 |
| **CHROMABOND® SiOH glass columns** | | | | | | | | | |
| 3 mL | | 730214G | 730073G | | | | | | 50 |
| 6 mL | | | 730070G | 730075G | 730107G | | | | 30 |
| **CHROMABOND® LV-SiOH** | | | | | | | | | |
| 15 mL | | 732072 | 732073 | | | | | | 30 |

| | Size → Minimum adsorbent weight → | S 60 mg | M 190 mg | L 490 mg | Pack of |
|---|---|---|---|---|---|
| **CHROMAFIX® SiOH cartridges** | | | | | |
| | | 731828 | 731829 | 731830 | 50 |

| | 96 x 100 mg | Pack of |
|---|---|---|
| **CHROMABOND® MULTI 96 SiOH** | | |
| | 738071.100M | 1 |

| | | |
|---|---|---|
| **CHROMABOND® SiOH adsorbent** | | |
| | 730608 | 100 g |

For further applications on CHROMABOND® phases visit our online application database at *www.mn-net.com/apps*

## CHROMABOND® $NH_2$ aminopropyl silica

### Key features
- Polar, weak anion exchanger

### Technical characteristics
- Base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 $m^2/g$, pH stability 2–8
- Aminopropyl phase, carbon content 3.5 %

### Recommended application
- Trace elements, lipids

**Metals: trace elements from water**

MN Appl. No. 301910

**Compounds investigated:** Al, Be, Cu, Cr(VI), Mo(VI), V(V))

**Column type:**
CHROMABOND® $NH_2$, 3 mL, 500 mg
REF 730033

**Sample pretreatment:**
mix 100 mL water sample with 5 mL 0.001 % alizarinsulfonic acid solution and adjust to pH 5.5 with acetic acid or sodium acetate

**Column conditioning:** 2 column volumes 1 mol/L nitric acid, then 2 column volumes dist. water

**Sample application:** force or aspirate sample through the column with 3–4 mL/min

**Column washing:** 2 mL dist. water; dry column under vacuum for 4 min

**Elution:** 2 column volumes 2 mol/L nitric acid

### Ordering information

| | Volume | Adsorbent weight → 100 mg | 200 mg | 500 mg | 1 g | Pack of |
|---|---|---|---|---|---|---|
| | **CHROMABOND® $NH_2$ polypropylene columns** | | | | | |
| | 1 mL | 730031 | | | | 100 |
| | 3 mL | | 730413 | 730033 | | 50 |
| | 6 mL | | | 730180 | 730626 | 30 |
| | **CHROMABOND® $NH_2$ polypropylene columns · BIGpack** | | | | | |
| | 3 mL | | | 730033.250 | | 250 |
| | **CHROMABOND® $NH_2$ glass columns** | | | | | |
| | 3 mL | | | 730033G | | 50 |
| | 6 mL | | | 730180G | 730626G | 30 |
| | **CHROMABOND® LV-$NH_2$** | | | | | |
| | 15 mL | | | 732033 | | 30 |

| | | Size → Minimum adsorbent weight → | S 70 mg | | | Pack of |
|---|---|---|---|---|---|---|
| | **CHROMAFIX® $NH_2$ cartridges** | | | | | |
| | | | 731813 | | | 50 |

| | | 96 x 100 mg | Pack of |
|---|---|---|---|
| | **CHROMABOND® MULTI 96 $NH_2$** | | |
| | | 738031.100M | 1 |
| | **CHROMABOND® $NH_2$ adsorbent** | | |
| | | 730603 | 100 g |

## CHROMABOND® OH (Diol) diol silica

### Key features
- Polar, properties similar to SiOH

### Technical characteristics
- Base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 $m^2/g$, pH stability 2–8
- Diol phase, carbon content 5.5 %

### Recommended application
- Antibiotics, prostaglandins

### Ordering information

| Volume | Adsorbent weight → 100 mg | 200 mg | 500 mg | Pack of |
|---|---|---|---|---|
| **CHROMABOND® OH (Diol) polypropylene columns** | | | | |
| 1 mL | 730051 | | | 100 |
| 3 mL | | 730417 | 730053 | 50 |
| 6 mL | | | 730418 | 30 |
| **CHROMABOND® OH (Diol) adsorbent** | | | | |
| | | | 730605 | 100 g |

Glass columns, LV columns, CHROMAFIX® cartridges and MULTI 96 on request.

## CHROMABOND® CN cyanopropyl silica

### Key features
- In addition to weak hydrophobic interactions selective interactions are possible due to the high electron density of the CN group.
- Polar to midpolar

### Technical characteristics
- Base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 $m^2/g$, pH stability 2–8
- Cyanopropyl phase, carbon content 5.5 %

### Recommended application
- Cyclosporins, carbohydrates

### Ordering information

| Volume | Adsorbent weight → 100 mg | 200 mg | 500 mg | Pack of |
|---|---|---|---|---|
| **CHROMABOND® CN polypropylene columns** | | | | |
| 1 mL | 730061 | | | 100 |
| 3 mL | | 730420 | 730063 | 50 |
| 6 mL | | | 730421 | 30 |
| **CHROMABOND® CN adsorbent** | | | | |
| | | | 730607 | 100 g |

Glass columns, LV columns, CHROMAFIX® cartridges and MULTI 96 on request.

For further applications on CHROMABOND® phases visit our online application database at *www.mn-net.com/apps*

## CHROMABOND® HILIC zwitterionic polar phase with ammonium sulfonic acid modification

### Technical characteristics

- Basic material silica, pore size 60 Å, particle size 45 µm, specific surface 500 $m^2/g$, pH stability 2–8

### Recommended application

- Polar organic acids and bases, polar natural compounds, nucleosides, oligonucleotides, amino acids, peptides, water-soluble vitamins

### Hydrophilic interaction liquid chromatography

A water-rich layer is formed on the surface of the adsorbent, which enables stronger interactions for polar than for nonpolar analytes. Thus polar analytes are more strongly retained than nonpolar compounds. This behavior is inverse (orthogonal) to RP materials like, e.g., CHROMABOND® $C_{18}$ ec.

In HILIC-HPLC (e.g., NUCLEODUR® HILIC) increase of the portion of water in the eluent results in reduction of the retention times – consequently enrichment in SPE is the more difficult, the higher the portion of water in the sample matrix. Elution of the analytes is achieved with water.

#### Standard protocol

MN Appl. No. 305580

Column type:
CHROMABOND® HILIC, 3 mL, 500 mg
REF 730593

**Sample pretreatment:** A high part of acetonitrile in the sample is recommended. Aqueous samples must be diluted with acetonitrile (recommendable: water – acetonitrile (1:3, v/v). Dioxane or THF can be used instead of acetonitrile.

**Column conditioning:** 1 mL water (Do not let run the column dry!)

**Equilibration:** 6 mL acetonitrile or the organic solvent, dilute the sample

**Sample application:** prepared sample is passed dropwise through the column

**Column washing:** if necessary 0.5–2 mL acetonitrile or the organic solvent, dilute the sample

**Elution:** 1–2 mL water (dependent on analyte)

Further analysis: if necessary, evaporate and redissolve in a suitable solvent; HPLC or GC

#### Creatinine and creatine from water: variation of the organic solvent

MN Appl. No. 305590

Column type:
CHROMABOND® HILIC, 3 mL, 500 mg
REF 730593

**Sample pretreatment:** 250 µL of aqueous sample are diluted with 750 µL tetrahydrofurane, 1,4-dioxane or acetonitrile

**Column conditioning:** 1 mL water (Do not let run the column dry!)

**Equilibration:** 5 mL tetrahydrofurane, 1,4-dioxane or acetonitrile

**Sample application:** prepared sample is passed dropwise through the column

**Column washing:** 3 x 1 mL tetrahydrofurane, 1,4-dioxane or acetonitrile

**Elution:** 1 mL water

Further analysis: HPLC with NUCLEODUR® HILIC according to MN Appl. No. 122990 (injection volume: 5 µL)

Recovery rates [ %]

| Compound | Creatinine | Creatine |
|---|---|---|
| Tetrahydrofurane | 105 % | 101 % |
| 1,4-dioxane | 83 % | 95 % |
| Acetonitrile | 0 % | 97 % |

### Ordering information

| | Volume | Adsorbent weight → 500 mg | 1 g | Pack of |
|---|---|---|---|---|
| | **CHROMABOND® HILIC polypropylene columns** | | | |
| | 3 mL | 730593 | | 50 |
| | 6 mL | 730594 | 730596 | 30 |
| | **CHROMABOND® HILIC adsorbent** | | | |
| | | | 730643 | 100 g |

## CHROMABOND® Alox A / Alox N / Alox B aluminum oxide, acidic, neutral, basic

### Key features

- Alox A: aluminum oxide, acidic pH value 4 ± 0.5
- Alox N: aluminum oxide, neutral pH value 7 ± 0.5
- Alox B: aluminumoxide, basic pH value 9.5 ± 0.5

### Technical characteristics

- Aluminum oxide, high purity, pore volume 0.90 mL/g, particle size 60–150 µm, specific surface 150 $m^2/g$

### Ordering information

| Phases | Volume | Adsorbent weight → 500 mg | 1 g | 4 g | Pack of |
|---|---|---|---|---|---|
| **CHROMABOND® Alox polypropylene columns** | | | | | |
| Alox A | 3 mL | 730452 | | | 50 |
| Alox A | 6 mL | 730453 | 730017 | | 30 |
| Alox A | 45 mL | | | 730455 | 20 |
| Alox N | 3 mL | 730446 | | | 50 |
| Alox N | 6 mL | 730447 | 730139 | | 30 |
| Alox N | 45 mL | | | 730250 | 20 |
| Alox B | 3 mL | 730429 | | | 50 |
| Alox B | 6 mL | 730466 | 730020 | | 30 |
| Alox B | 45 mL | | | 730467 | 20 |
| **CHROMABOND® Alox glass columns** | | | | | |
| Alox N | 6 mL | | 730139G | | 30 |
| Alox B | 6 mL | | 730020G | | 30 |
| **CHROMABOND® LV-Alox** | | | | | |
| Alox A | 15 mL | | 732210 | | 30 |
| Alox N | 15 mL | | 732091 | | 30 |
| Alox B | 15 mL | | 732205 | | 30 |

| Phase | Size → Minimum adsorbent weight → | M 450 mg | L 1200 mg | | Pack of |
|---|---|---|---|---|---|
| **CHROMAFIX® Alox cartridges** | | | | | |
| Alox N | | 731844 | 731845 | | 50 |

| Phases | | | | 96 x 100 mg | Pack of |
|---|---|---|---|---|---|
| **CHROMABOND® MULTI 96 Alox** | | | | | |
| Alox A | | | | 738253.100M | 1 |
| Alox N | | | | 738251.100M | 1 |
| Alox B | | | | 738252.100M | 1 |
| **CHROMABOND® Alox adsorbents** | | | | | |
| Alox A | | | | 730642 | 100 g |
| Alox N | | | | 730641 | 100 g |
| Alox B | | | | 730640 | 100 g |

## CHROMABOND® Florisil® magnesium silicate

### Technical characteristics

- Matrix magnesium silicate (MgO - SiOH 15:85), high purity, particle size 150–250 µm

### Recommended application

- Organic tin compounds, aliphatic carboxylic acids, PCBs, PAHs

### Ordering information

| Volume | Adsorbent weight → 200 mg | 500 mg | 1 g | 2 g | Pack of |
|---|---|---|---|---|---|
| **CHROMABOND® Florisil® polypropylene columns** | | | | | |
| 3 mL | 730457 | 730081 | | | 50 |
| 6 mL | | 730238 | 730082 | 730239 | 30 |
| **CHROMABOND® Florisil® polypropylene columns · BIGpack** | | | | | |
| 6 mL | | | 730082.250 | | 250 |
| **CHROMABOND® Florisil® glass columns** | | | | | |
| 6 mL | | 730238G | 730082G | 730239G | 30 |
| | Size → | L | | | |
| | Minimum adsorbent weight → | 700 mg | | | Pack of |
| **CHROMAFIX® Florisil® cartridges** | | | | | |
| | | 731848 | | | 50 |
| **CHROMABOND® Florisil® adsorbent** | | | | | |
| | | | | 730622 | 100 g |

LV columns and MULTI 96 on request.

## CHROMABOND® PA polyamide 6

### Technical characteristics

- Matrix polyamide 6, unmodified, high purity, particle size 40–80 µm

### Recommended application

- Flavonoids, PAHs

### Ordering information

| Volume | Adsorbent weight → 200 mg | 500 mg | 1 g | Pack of |
|---|---|---|---|---|
| **CHROMABOND® PA polypropylene columns** | | | | |
| 3 mL | 730384 | 730126 | | 50 |
| 6 mL | | 730007 | 730127 | 30 |
| | Size → | S | L | |
| | Minimum adsorbent weight → | 30 mg | 260 mg | Pack of |
| **CHROMAFIX® PA cartridges** | | | | |
| | | 731849 | 731851 | 50 |
| **CHROMABOND® PA adsorbent** | | | | |
| | | | 730660 | 100 g |

Glass columns, LV columns and MULTI 96 on request.

## CHROMABOND® SA benzenesulfonic acid cation exchanger based on silica (SCX)

### Key features

- Adsorbent with hydrophobic and π-π interactions (benzene ring)
- Ion exchange of organic compounds from aqueous matrix
- Elution of interesting compounds with solvent systems, which compensate the ionic and nonpolar interactions, e.g., methanolic HCl

### Technical characteristics

- Base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 $m^2/g$, pH stability 2–8, benzene-sulfonic acid modified silica, strongly acidic cation exchanger (capacity ~ 0.5 meq/g)

### Recommended application

- Amino acids, amines, chlorophyll, PCBs

**Sulfonamides in meat and kidney**

MN Appl. No. 302710

B. Pacciarelli et al., Mitt. Gebiete Lebensm. Hyg. 82 (1991) 45–55

**Compounds investigated:**
sulfaguanidine, sulfanilamide, sulfadiazine, sulfathiazole, sulfapyridine, sulfamerazine, sulfamethizole, sulfadimidine, sulfamethoxypyridazine, sulfachlorpyridazine, sulfadoxine, sulfadimethoxine

**Column type:**
CHROMABOND® SA (≡ SCX), 3 mL, 500 mg
REF 730077

**Sample pretreatment:** homogenize 10 g sample and 60 mL dichloromethane – acetone (1:1, v/v) for 30 s with a Polytron. Centrifuge the homogenate for 10 min at 2500 rpm. Filter the organic phase and wash the filter residue with a little dichloromethane – acetone. Add 5 mL glacial acetic acid to the filtered extract.

**Column conditioning:** apply 6 mL hexane and suck air until the column is dry (10 min). Then apply 6 mL dichloromethane – acetone – glacial acetic acid (10:10:1, v/v/v). Now the column must not run dry.

**Sample application:**
1/10 of the extract volume, flow rate about 2 mL/min; the column must not run dry

**Column washing:** 5 mL water, then 5 mL methanol; dry for 10 min under vacuum. Now suck $NH_3$ gas through the column until the acid is neutralized. To control the neutralization process, press air through the column: a wet pH paper should indicate a neutral or basic pH value.

**Elution:** 3 mL methanol (1–2 mL/min); carefully concentrate the eluate on a rotation evaporator (40 °C/100 mbar), dissolve the residue in 0.5 mL of 5.5 % acetonitrile in buffer (1.641 g sodium acetate in 1 L water, adjusted to pH 5 with glacial acetic acid) and centrifuge.

Further analysis: HPLC

## Ordering information

| | Volume | Adsorbent weight → 100 mg | 200 mg | 500 mg | 1 g | Pack of |
|---|---|---|---|---|---|---|
| | **CHROMABOND® SA polypropylene columns** | | | | | |
| | 1 mL | 730076 | | | | 100 |
| | 3 mL | | 730275 | 730077 | | 50 |
| | 6 mL | | | 730425 | 730212 | 30 |
| | **CHROMABOND® SA polypropylene columns · BIGpack** | | | | | |
| | 3 mL | | | 730077.250 | | 250 |
| | **CHROMABOND® LV-SA** | | | | | |
| | 15 mL | | | 732083 | | 30 |
| | | Size → | S | M | L | |
| | | Minimum adsorbent weight → | 80 mg | 200 mg | 580 mg | Pack of |
| | **CHROMAFIX® SA cartridges** | | | | | |
| | | | 731831 | 731832 | 731833 | 50 |
| | | | | | 96 x 100 mg | Pack of |
| | **CHROMABOND® MULTI 96 SA** | | | | | |
| | | | | | 738141.100M | 1 |
| | **CHROMABOND® SA adsorbent** | | | | | |
| | | | | | 730609 | 100 g |

Glass columns on request.

## CHROMABOND® SB quaternary ammonium anion exchanger based on silica (SAX)

### Key features

- Not suited for very strong anions such as sulfonic acids because these are difficult to elute

### Technical characteristics

- Base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 $m^2/g$, pH stability 2–8, silica modified with quaternary amine, strongly basic anion exchanger (capacity ~ 0.3 meq/g)

### Recommended application

- Organic acids, caffeine, saccharin

Vitamins: folic acid from food (e.g., wheat germs)

MN Appl. No. 300650

Column type:
CHROMABOND® SB (≡ SAX), 3 mL, 500 mg
REF 730079

**Sample pretreatment:** homogenize 10 g food sample in 100 mL 0.01 mol/L phosphate buffer pH 7.4 and filter
**Column conditioning:** 2 column volumes *n*-hexane, then 2 column volumes methanol, finally 2 column volumes dist. water
**Sample application:** force or aspirate 10 mL of the filtrate through the column
**Column washing:** 2 column volumes dist. water
**Elution:** 5 mL 10 % sodium chloride in 0.1 mol/L sodium acetate buffer

### Ordering information

| | Adsorbent weight → | | | | |
|---|---|---|---|---|---|
| Volume | 100 mg | 200 mg | 500 mg | 1 g | Pack of |
| **CHROMABOND® SB polypropylene columns** | | | | | |
| 1 mL | 730078 | | | | 100 |
| 3 mL | | 730322 | 730079 | | 50 |
| 6 mL | | | 730426 | 730323 | 30 |
| **CHROMABOND® SB polypropylene columns · BIGpack** | | | | | |
| 3 mL | | | 730079.250 | | 250 |
| **CHROMABOND® LV-SB** | | | | | |
| 15 mL | | | 732088 | | 30 |

| | Size → | S | M | L | |
|---|---|---|---|---|---|
| | Minimum adsorbent weight → | 80 mg | 180 mg | 500 mg | Pack of |
| **CHROMAFIX® SB cartridges** | | | | | |
| | | 731834 | 731835 | 731836 | 50 |

| | 96 x 100 mg | Pack of |
|---|---|---|
| **CHROMABOND® MULTI 96 SB** | | |
| | 738101.100M | 1 |
| **CHROMABOND® SB adsorbent** | | |
| | 730610 | 100 g |

Glass columns on request.

## CHROMABOND® PCA propylcarboxylic acid cation exchanger based on silica (WCX)

### Key features
- Weakly acidic cation exchanger (WCX)

### Technical characteristics
- Base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 $m^2/g$, pH stability 2–8
- Propylcarboxylic acid modified silica

### Recommended application
- Strong cations

### Ordering information

| Volume | Adsorbent weight → 500 mg | 1 g | Pack of |
|---|---|---|---|
| **CHROMABOND® PCA polypropylene columns** | | | |
| 3 mL | 730482 | | 50 |
| 6 mL | 730483 | 730484 | 30 |
| **CHROMABOND® LV-PCA** | | | |
| 15 mL | 732482 | | 30 |
| **CHROMABOND® PCA adsorbent** | | | |
| | | 730629 | 100 g |

Glass columns, LV columns, CHROMAFIX® cartridges and MULTI 96 on request.

## CHROMABOND® PSA propylsulfonic acid cation exchanger based on silica

### Key features
- In contrast to the SA phase no π-π interactions

### Technical characteristics
- Base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 $m^2/g$, pH stability 2–8
- Propylsulfonic acid modified silica, very strong cation exchanger (capacity ~ 0.7 meq/g)

### Recommended application
- Weak cations

### Ordering information

| Volume | Adsorbent weight → 100 mg | 500 mg | 1 g | Pack of |
|---|---|---|---|---|
| **CHROMABOND® PSA polypropylene columns** | | | | |
| 1 mL | 730460 | | | 100 |
| 3 mL | | 730462 | | 50 |
| 6 mL | | | 730464 | 30 |
| **CHROMABOND® PSA adsorbent** | | | | |
| | | | 730630 | 100 g |

Glass columns, LV columns, CHROMAFIX® cartridges and MULTI 96 on request.

For further applications on CHROMABOND® phases visit our online application database at *www.mn-net.com/apps*

## CHROMABOND® Drug special silica phase for drug analysis

### Technical characteristics

- Base material silica, pore size 60 Å, particle size 45 µm, specific, surface 500 $m^2/g$, pH stability 2–8
- Special bifunctional modification - $C_8$: RP interaction SA: strong cation exchanger / benzenesulfonic acid

### Recommended application

- Enrichment of acidic, neutral and basic drugs from urine or plasma

**Drugs from blood serum**

MN Appl. No. 302020

W. Weinmann, M. Renz, C. Pelz, P. Brauchle, S. Vogt, S. Pollak, Blutalkohol 35 (1998), 1–9

**Compounds investigated:** benzoylecgonine, amphetamine, codeine, morphine

**Column type:**
CHROMABOND® Drug, 3 mL, 200 mg
REF 730168

**Sample pretreatment:** 0.1 mL blood serum are mixed with 1.4 mL of a 0.1 mol/L $KH_2PO_4$ buffer (pH 6) and centrifuged

**Column conditioning:** 2 mL methanol, then 2 mL 0.1 mol/L $KH_2PO_4$ buffer (pH 6)

**Sample application:** slowly force or aspirate the supernatant from the sample pretreatment through the column

**Column washing:** 2 mL 0.1 mol/L $KH_2PO_4$ buffer (pH 6), then 1 mL 0.1 mol/L acetic acid, then 2 mL methanol; finally dry the column first by centrifugation (2 min, 4000 U/min), then under vacuum for 10 min

**Elution:** 1.5 mL dichloromethane – 2-propanol – 25 % ammonia solution (80:20:2, v/v/v)

Further analysis: HPLC with NUCLEOSIL® 100-5 $C_{18}$ AB (application 110240) or GC/MS after derivatization with perfluoropropanoic acid pentafluoropropanol, e.g., with column OPTIMA® 5 MS, 0.25 µm film, 30 m x 0.25 mm ID, (REF 726220.30)

### Ordering information

| | Volume | Adsorbent weight → 100 mg | 200 mg | 500 mg | Pack of |
|---|---|---|---|---|---|
| | **CHROMABOND® Drug polypropylene columns** | | | | |
| | 1 mL | 730681 | | | 100 |
| | 3 mL | | 730168 | 730684 | 50 |
| | 6 mL | | | 730682 | 30 |
| | **CHROMABOND® Drug polypropylene columns · BIGpack** | | | | |
| | 3 mL | | 730168.250 | | 250 |
| | **CHROMABOND® LV-Drug** | | | | |
| | 15 mL | | 732168 | | 30 |
| | | | | 96 x 100 mg | Pack of |
| | **CHROMABOND® MULTI 96 Drug** | | | | |
| | | | | 738161.100M | 1 |

For further applications on CHROMABOND® phases visit our online application database at *www.mn-net.com/apps*

## CHROMABOND® Drug II extraction of THC and derivatives, acidic analytes from biological fluids (urine, blood, etc.)

### Key features

- Two primary retention mechanisms facilitate use of very strong interferant-eluting solvents, resulting in very pure extracts

### Technical characteristics

- Base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 $m^2/g$, pH stability 2-8
- Special bifunctional modification - $C_8$: RP interaction SB: strong anion exchanger/quaternary amine $–NR_3^+$

### Recommended application

- Extraction of THC and derivatives from urine, blood, serum, plasma
- Acidic analytes from biological fluids

11-nor-$\Delta^9$-THC-carboxylic acid from urine

MN Appl. No. 303880

**Compounds investigated:** tetrahydrocannabinol, 11-nor-$\Delta^9$-THC-carboxylic acid

**Column type:**
CHROMABOND® Drug II, 3 mL, 200 mg
REF 730680

**Sample pretreatment:**
add 300 µL 10 mol/L potassium hydroxide solution and internal standard (for GC/MS deuterium labeled 11-nor-$\Delta^9$-THC-carboxylic acid) to 5 mL urine. Vortex the sample and then hydrolyze at 60 °C for 15 min. Cool sample and add 200 µL glacial acetic acid and 2 mL 50 mmol/L ammonium acetate solution. If necessary, adjust sample pH to 6–7.

**Column conditioning:**
2 mL methanol, 2 mL dist. water; equilibrate column with 2 mL 50 mmol/L ammonium acetate buffer

**Sample application:** slowly force or aspirate the sample through the column (1–2 mL/min)

**Column washing:** elute interferants with 10 mL methanol – water (1:1, v/v); dry the column for 10 min at high vacuum; further wash the column with 2 mL acetonitrile and dry for another 2 min

**Elution:** elute THC metabolites with 3 mL hexane – ethyl acetate – glacial acetic acid (75:25:1, v/v/v)

**Recovery rates:** 70–80 %

Further analysis: we recommend GC/MS on an OPTIMA® 5 MS column after derivatization with 50 µL SILYL-991 (REF 701480; BSTFA – TMCS 99:1) at 70 °C for 20 min; inject 1–2 µL onto the GC column.

## Ordering information

| | Volume | Adsorbent weight → 100 mg | 200 mg | 500 mg | Pack of |
|---|---|---|---|---|---|
| | **CHROMABOND® Drug II polypropylene columns** | | | | |
| | 1 mL | 730685 | | | 100 |
| | 3 mL | | 730680 | 730686 | 50 |
| | 6 mL | | | 730683 | 30 |
| | **CHROMABOND® LV-Drug II** | | | | |
| | 15 mL | | 732681 | | 30 |
| | | | | 96 x 100 mg | Pack of |
| | **CHROMABOND® MULTI 96 Drug II** | | | | |
| | | | | 738680.100M | 1 |

For further applications on CHROMABOND® phases visit our online application database at *www.mn-net.com/apps*

## CHROMABOND® Tetracycline special phase for enrichment of tetracyclines

### Key features

- Silica phase with special $C_{18}$ modification, tested for tetracyclines
- Constant recovery rates for the title compounds (every batch individually tested)

### Recommended application

- Tetracyclines from biological samples

**Tetracyclines from musculature**

MN Appl. No. 302030

Private communication of Mr. Lippold, Chemisches Landesuntersuchungsamt (Chem. Research Agency) Freiburg, Germany

**Compounds investigated:** tetracycline, oxytetracycline, chlorotetracycline (100–500 mg/kg)

**Column type:**
CHROMABOND® Tetracycline, 6 mL, 500 mg
REF 730315

**Sample pretreatment:** see detailed description in appl. 302030 at *www.mn-net.com/apps*

**Column conditioning:** 1 column volume methanol, 1 column volume dist. water, then 1 column volume EDTA – succinate buffer

**CAUTION:** DO NOT LET THE COLUMN RUN DRY!

**Sample application:** force or aspirate 50 mL of the eluate from the sample pretreatment through the CHROMABOND® column

**Column washing:** 2 mL dist. water (removal of Cu ions), 2 mL *n*-hexane

**Elution:** 7.5 mL methanol into a 25-mL tapered flask. Add 1 mL of an ethylene glycol – methanol mixture (22 g ethylene glycol filled up to 100 mL with methanol) and evaporate to dryness with a rotation evaporator (max. 40 °C). Fill up the residue to 400 mL with 0.1 mol/L McIlvain-EDTA buffer (52.5 g citric acid · $H_2O$, 44.5 g $Na_2HPO_4 \cdot H_2O$ and 93 g Titriplex III dissolved in 2.5 L dist. water, adjusted to pH 4 with NaOH).

**Recovery rates:** tetracycline, chlorotetracycline ~50–70 %, oxytetracycline ~60–80 %

Further analysis: HPLC with column 250 x 4 mm NUCLEOSIL® 100-5 $C_{18}$ HD (application 110710))

### Ordering information

| Volume | Adsorbent weight → 500 mg | Pack of |
|---|---|---|
| **CHROMABOND® Tetracycline polypropylene columns** | | |
| 6 mL | 730315 | 30 |

Product for research purposes only (see page 395)

## CHROMABOND® HR-P-AOX AOX from waters with high salt loads (DIN 38409 – H22)

### Technical characteristics

- Special PS/DVB phase

### Recommended application

- Extraction of AOX (adsorbable organically bonded halogens) from waters containing high salt loads or organic pollutants in accordance with DIN 38409 – H22

AOX from water (DIN 38409 – H22)

MN Appl. No. 302080

**Column type:**
CHROMABOND® HR-P-AOX, 6 mL, 500 mg
REF 730111.AOX

**Column conditioning:** 5 mL methanol, 10 mL dist. water
Do not let the column run dry!

**Sample application:** force or aspirate 100 mL original or diluted sample (pH 1) through the column (3–5 mL/min). Do not let the column run dry!

**Column washing:** 50 mL nitrate rinsing solution (dissolve 17 g $NaNO_3$ in 100 mL dist. water, add 1.4 mL $HNO_3$ 10 mol/L, fill up to 1000 mL; take 50 mL and fill to 1000 mL with dist. water). Discard the flowthrough.

**Elution:** slowly aspirate 1 x 1 mL, then 1 x 4 mL methanol and 10 mL dist. water through the column.
Collect eluates in 100 mL volumetric flask and fill to 100 mL with dist. water.

### Ordering information

| Volume | Adsorbent weight → 200 mg | 500 mg | Pack of |
|---|---|---|---|
| **CHROMABOND® HR-P-AOX polypropylene columns** | | | |
| 6 mL | 730119.AOX | 730111.AOX | 30 |

## CHROMABOND® $C_{18}$ PAH octadecyl silica for PAH analysis

### Technical characteristics

- Base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 $m^2/g$, pH stability 2–8
- Special octadecyl modification for the enrichment of PAHs, not endcapped, carbon content 14 %

### Recommended application

- PAHs from water

PAHs from water

MN Appl. No. 301250

**Column type:**
CHROMABOND® $C_{18}$ PAH, 6 mL, 2 g
REF 730166

**Sample pretreatment:** mix 1000 mL water sample with 10 mL methanol

**Column conditioning:** 1 column volume methanol, then 1 column volume dist. water

**Sample application:** aspirate 1000 mL water sample through the column (~ 15–20 mL/min), then dry column (stream of nitrogen or 24 h in a desiccator over $P_2O_5$)

**Elution:** elute with 4 mL acetonitrile – benzene (3:1, v/v) and then evaporate or fill up to the volume required

**Recovery rates (50 ng/L per component):** Naphthaline 87 %, Acenaphthylene 89 %, Acenaphthene 90 %, Fluorene 82 %, Phenanthrene 85 %, Anthracene 90 %, Fluoranthene 89 %, Pyrene 89 %, Benz[*a*]anthracene 87 %, Chrysene 95 %, Benzo[*b*]fluoranthene 91 %, Benzo[*k*]fluoranthene 89 %, Benzo[*a*]pyrene 90 %, Dibenz[*ah*]anthracene 97 %, Benzo[*ghi*]perylene 91 %, Indeno[1,2,3-*cd*]pyrene 96 %

### Ordering information

| Volume | Adsorbent weight → 2 g | Pack of |
|---|---|---|
| **CHROMABOND® $C_{18}$ PAH polypropylene columns** | | |
| 6 mL | 730166 | 30 |
| **CHROMABOND® $C_{18}$ PAH glass columns** | | |
| 6 mL | 730166G | 30 |
| **CHROMABOND® $C_{18}$ PAH adsorbent** | | |
| | 730616 | 100 g |

## CHROMABOND® $NH_2/C_{18}$ combination phase for PAH analysis

### Key features

- Special combination phase:
  Aminopropyl phase for removal of interfering humic acids
  octadecyl phase for the enrichment of PAHs

### Recommended application

- PAHs from water containing humic acids

**PAHs from water containing humic acids**

MN Appl. No. 301260

**Column type:**
CHROMABOND® $NH_2/C_{18}$, 6 mL, 500 mg/1 g glass column
REF 730620G

**Sample pretreatment:** mix 500 mL water sample with 25 mL 2-propanol

**Column conditioning:** 10 mL dichloromethane, 10 mL methanol, then 10 mL dist. water – 2-propanol (9:1, v/v)

**Sample application:** aspirate 500 mL prepared water sample through the column (~ 5 mL/min)

**Column washing:** 2 mL dist. water – 2-propanol (9:1, v/v), then dry column (about 20 min, vacuum)

**Elution:** 4 x 0.5 mL $CH_2Cl_2$ (let percolate first 0.5 mL into the column packing without vacuum, then apply light vacuum), if necessary evaporate in a stream of $N_2$ and fill up with a suitable solvent

### Ordering information

| Volume | Adsorbent weight → 500/500 mg | 500 mg / 1 g | Pack of |
|---|---|---|---|
| **CHROMABOND® $NH_2/C_{18}$ polypropylene columns** | | | |
| 6 mL | 730618 | 730620 | 30 |
| **CHROMABOND® $NH_2/C_{18}$ glass columns** | | | |
| 6 mL | 730618G | 730620G | 30 |

## CHROMABOND® CN/SiOH combination phase for PAH analysis

### Key features

- Cyanopropyl phase for selective adsorption of polycyclic aromatics via π-π interactions
- Unmodified silica phase for removal of polar compounds

### Recommended application

- Extraction of the 16 PAHs according to EPA from soil samples

**PAHs from soil**

MN Appl. No. 301310

**Column type:**
CHROMABOND® CN/SiOH, 6 mL, 500/1000 mg
REF 730135

**Sample pretreatment:** dry 30 g soil with sodium sulfate and reflux 4 h with 250 mL petroleum ether in a Soxhlet extractor. For low PAH contents (colorless or weakly colored extracts) concentrate extract to 1/10 of its volume in a rotation evaporator.

**Column conditioning:** 4 mL petroleum ether

**Sample application:** aspirate 20 mL of the extract through the column

**Column washing:** 2 mL petroleum ether

**Elution:** 2 x 2 mL acetonitrile – toluene (3:1, v/v), then evaporate or fill to the volume required

Further analysis: HPLC, e.g., with column 100 x 4 mm NUCLEODUR® $C_{18}$ PAH, 3 µm, REF 760783.40 according to application 123820 (see page 227)

For recovery rates see application 301310 at *www.mn-net.com/apps*

### Ordering information

| Volume | Adsorbent weight → 500 mg / 1 g | Pack of |
|---|---|---|
| **CHROMABOND® CN/SiOH polypropylene columns** | | |
| 3 mL | 730112 | 50 |
| 6 mL | 730135 | 30 |
| **CHROMABOND® CN/SiOH glass columns** | | |
| 6 mL | 730135.250 | 250 |
| **CHROMABOND® CN/SiOH glass columns · BIGpack** | | |
| 6 mL | 730135G | 30 |

## CHROMABOND® $Na_2SO_4$/Florisil® hydrocarbons from water in accordance with DIN H-53 / ISO DIS 9377-4

### Key features

· Special combination phase of sodium sulfate and Florisil®

### Recommended application

· Hydrocarbons from drinking, surface and waste waters

Hydrocarbons from water

MN Appl. No. 302090

Column type:
CHROMABOND® $Na_2SO_4$/Florisil®, 6 mL, 2 g/2 g glass column
REF 730249G

**Internal standard solution:** dissolve 20 mg *n*-tetracontane ($C_{40}H_{82}$) in petroleum ether, add 20 mL *n*-decane ($C_{10}H_{22}$) and fill up to one liter with petroleum ether. For the preparation of the extraction solution dilute standard solution 1:10 with petroleum ether.

**Sample pretreatment:** adjust 900 mL water (10 °C) with HCl (12 mol/L) to pH 2 and add 80 g $MgSO_4$. Add 50 mL of the extraction solution, close the bottle and stir the suspension intensely for 30 min. Add enough dist. water to separate the organic from the aqueous phase.

**Column conditioning:** 5 mL petroleum ether

**Sample application:** slowly aspirate or force the sample through the column

**Elution:** wash with 10 mL petroleum ether. Evaporate the combined solution from sample application and elution to 1 mL at about 75 °C. If necessary, fill up to 1 mL again. (If the hydrocarbon content is high, evaporation to 1 mL may not be necessary.)

**Recovery rates:** must be > 80 % for *n*-tetracontane

### Ordering information

| Volume | Adsorbent weight → 2 g / 2 g | Pack of |
|---|---|---|
| **CHROMABOND® $Na_2SO_4$/Florisil® polypropylene columns** | | |
| 6 mL | 730249 | 30 |
| **CHROMABOND® $Na_2SO_4$/Florisil® glass columns** | | |
| 6 mL | 730249G | 30 |
| **CHROMABOND® $Na_2SO_4$/Florisil® glass columns · BIGpack** | | |
| 6 mL | 730249G.250 | 250 |

## CHROMABOND® NAN special phase for PCB analysis

### Key features

- N: sodium sulfate for removal of trace water
- A: SiOH/$AgNO_3$ phase for removal of sulfur, sulfur-containing and polar compounds

### Recommended application

- Extraction of PCBs from sludge

**PCB from sludge**

MN Appl. No. 301400

**Compounds investigated:** polychlorinated biphenyls (PCB)
This method can also be used for soil samples.

**Column type:**
CHROMABOND® NAN, 6 mL, 700/2000/700 mg
REF 730149

**Sample pretreatment:**
extract 2 g lyophilized sludge with 70 mL *n*-hexane, evaporate extract and fill to 10 mL with *n*-hexane

**Column conditioning:** 10 mL *n*-hexane

**Sample application:** aspirate 2 mL extract into the column

**Elution:** slowly aspirate 40 mL *n*-hexane through the column with light vacuum, then evaporate and fill to 5 mL with *n*-hexane

**Recovery rates:** PCB-28 104 %, PCB-52 100 %, PCB-101 99 %, PCB-138 98 %, PCB-153 101 %, PCB-180 98 %, PCB-209 104 %

### Ordering information

| Volume | Adsorbent weight → 400/1400/400 mg | 700/2000/700 mg | Pack of |
|---|---|---|---|
| **CHROMABOND® NAN polypropylene columns** | | | |
| 3 mL | 730109 | | 50 |
| 6 mL | | 730149 | 30 |
| **CHROMABOND® NAN polypropylene columns · BIGpack** | | | |
| 6 mL | | 730149.250 | 250 |
| **CHROMABOND® NAN glass columns** | | | |
| 6 mL | | 730149G | 30 |
| **CHROMABOND® NAN adsorbent*** | | | |
| | 730619 | | 100 g |

* This product contains harmful substances which must be specially labeled as hazardous. For detailed information please see SDS.

For further applications on CHROMABOND® phases visit our online application database at *www.mn-net.com/apps*

## CHROMABOND® SA/SiOH combination phase for PCB analysis

### Key features

- SA: strongly acidic cation exchanger based on silica with benzenesulfonic acid modification
- SiOH: unmodified silica for removal of polar compounds

### Recommended application

- Extraction of PCBs from waste oil (hexane extract)

**PCB from waste oil**

MN Appl. No. 301390

**Column type:**
CHROMABOND® SA/SiOH, 3 mL, 500/500 mg
REF 730132

**Column conditioning:** 1 mL *n*-hexane

**Sample application:** apply 250 µL waste oil sample to the column and aspirate or force it into the adsorbent with 2 x 1 mL *n*-hexane

**Elution:** aspirate or force another 2 x 500 µL *n*-hexane through the column; collect all *n*-hexane fractions and if necessary adjust concentration for subsequent analysis by either evaporating *n*-hexane in a stream of nitrogen or by dilution with *n*-hexane

**Recovery rates:** PCB-28 97 %, PCB-52 96 %, PCB-101 95 %, PCB-138 90 %, PCB-153 95 %, PCB-180 96 %, PCB-209 100 %

### Ordering information

| Volume | Adsorbent weight → 500/500 mg | Pack of |
|---|---|---|
| **CHROMABOND® SA/SiOH polypropylene columns** | | |
| 3 mL | 730132 | 50 |
| 6 mL | 730235 | 30 |
| **CHROMABOND® SA/SiOH polypropylene columns · BIGpack** | | |
| 3 mL | 730132.250 | 250 |

For further applications on CHROMABOND® phases visit our online application database at *www.mn-net.com/apps*

PCBs can be separated successfully with e.g., OPTIMA® XLB (see page 317).

## CHROMABOND® SiOH-$H_2SO_4$/SA combination phase for PCB analysis

### Key features

- SiOH-$H_2SO_4$: $H_2SO_4$-impregnated silica phase for oxidation of accompanying compounds to ionic and/or polar compounds
- SA: strongly acidic cation exchanger based on silica with benzenesulfonic acid modification for removal of ionic and sulfur-containing compounds
- This combination column is used together with a SiOH column. Both columns together are available as Kombi-Kit PCB.

### Recommended application

- Extraction of PCBs from oil with reference to German industrial standard DIN 51527, part 1

**PCB in oil samples**

MN Appl. No. 301380

determination with reference to German industrial standard DIN 51527

**Column type:**
CHROMABOND® SiOH-$H_2SO_4$/SA, 3 mL, 500/500 mg and
CHROMABOND® SiOH, 3 mL, 500 mg
REF 730085 and 730073
or Kombi-Kit PCB, REF 730125

**Sample pretreatment:** extract oil-contaminated solids with *n*-hexane. Homogenize other oil samples and dissolve 1.5 to 2.0 g in 50 mL *n*-hexane. Water which may cause turbidity can be removed with sodium sulfate.

**Column conditioning:** let 1 mL *n*-hexane flow through the CHROMABOND® SiOH-$H_2SO_4$/SA column

**Sample application:** aspirate or force 500 µL sample through the CHROMABOND® SiOH-$H_2SO_4$/SA column. This phase offers better removal of interfering substances due to sulfonation. Place CHROMABOND® SiOH-$H_2SO_4$/SA column on top of the SiOH column with the aid of an adapter and after at least 30 s flush sample into the SiOH column with 2 x 1 mL *n*-hexane.

**Elution:** elute SiOH column with 3 x 0.5 mL *n*-hexane; adjust to a suitable concentration for subsequent GC analysis by evaporation of *n*-hexane in a stream of nitrogen or by dilution with *n*-hexane

**Recovery rates:** PCB-28 99 %, PCB-52 95 %, PCB-101 99 %, PCB-138 94 %, PCB-153 99 %, PCB-180 96 %, PCB-209 101 %

### Ordering information

| Volume | Adsorbent weight → 500/500 mg | Pack of |
|---|---|---|
| **CHROMABOND® SiOH-$H_2SO_4$/SA polypropylene columns** | | |
| 3 mL | 730085 | 50 |
| **CHROMABOND® SiOH-$H_2SO_4$/SA polypropylene columns · BIGpack** | | |
| 3 mL | 730085.250 | 250 |
| **CHROMABOND® SiOH-$H_2SO_4$/SA glass columns** | | |
| 3 mL | 730085G | 50 |
| **Kombi-Kit for extraction of PCB from oil with reference to DIN 51527, part 1** | | |
| 25 columns each of CHROMABOND® SiOH-$H_2SO_4$/SA and CHROMABOND® SiOH | 730125 | 1 |

## CHROMABOND® QuEChERS special silica phase for determination of pesticides in food samples

**Key features**

- Reliable CHROMABOND® adsorbents
- Different packaging with mixes for all established methods
- Convenient to use - pre-weighed and mixed
- Saves time and money
- Increases efficiency in the laboratory
- Individual combination of mixes on request

**Recommended application**

- Special SPE phase for quick and cheap determination of pesticides in strongly matrix-contaminated samples by GC or HPLC
- QuEChERS methode = Quick Easy Cheap Effective Rugged Safe

## CHROMABOND® Diamino special silica phase for determination of pesticides in food samples

**Key features**

- Base material silica, pore size 60 Å
- Removes polar compounds (e.g., organic acids, pigments, sugars) from matrices like fruit or vegetables

**Technical characteristics**

- Particle size 45 µm, specific surface 500 $m^2/g$, pH stability 2–8
- Primary and Secondary Amine functions (PSA), 5 % C

**Similar phases**

- Supelclean™ PSA, Bond Elut® PSA

## Food analysis

### QuEChERS methods and ready-mixes

Within a few years after its development by Anastassiades et al. [1] the QuEChERS method has gained a leading position for determination of pesticide residues in food samples by GC-MS or LC-MS, allowing rapid and cheap clean-up of strongly matrix-contaminated samples.

Advantages of QuEChERS in comparison with classical clean-up methods:

- High through-put, due to easy handling and time-saving procedure
- Low consumption of solvents
- No need for chlorinated solvents
- Suitable for a variety of pesticides
- Rugged method with high and safe recovery rates
- Broad applications for various foods

To optimize the extraction of pH-dependent compounds, to minimize decomposition of sensitive substances, and to broaden the matrix spectrum, different modifications of the QuEChERS method have been elaborated. These mixes differ in the type of buffer agent used and in this way the resulting pH value of the aqueous sample during the extraction vary.

Today three methods are used:

- Original (non-buffered) [1]
- AOAC Standard 2007.1 (acetate buffered) [2]
- EN 15662 (citrate buffered) [3]

In particular the buffered versions are commonly used.

All methods require two proceeding steps:

- Extraction: pesticides are transferred from the aqueous to the organic layer (often acetonitrile)
- Clean-up: Interfering substances (like e.g., lipids, pigments), which were also extracted with the organic layer, are removed by special adsorbents

Analysis: Sample is analyzed by GC-MS or LC-MS/MS

The QuEChERS procedure is described in the following in accordance with EN 15662:2008. An extraction mix and a clean-up mix is required.

### Step 1 – Extraction and salting-out

1. Homogenize sample (e.g., with dry ice in a blender)
2. Weigh 10 g of the sample into a centrifuge tube
3. Add 10 mL of acetonitrile and internal standard
4. Shake vigorously for 1 minute
5. Add extraction mix to centrifuge tube

   Optional: check pH and adjust pH to 5.0–5.5 with 5 mol/L aqueous NaOH.
6. Shake vigorously for 1 minute
7. Centrifuge for 5 minutes at > 3000 g. For the determination of pesticides with acidic groups, the raw extract should be analyzed directly (preferably by LC/MS ESI neg.)

### Step 2 – Clean-up

1. Transfer an aliquot of the supernatant to a centrifuge tube containing a clean-up mix
2. Shake for 30 seconds
3. Centrifuge for 5 minutes at > 3000 g

### Analysis

Transfer supernatant to vial, acidify with 5 % formic acid in acetonitrile (10 µL/mL extract) and analyze the sample by LC-MS or GC-MS. MACHEREY-NAGEL offers a variety of pre-weighed and mixed extraction and clean-up mixes, which are in accordance with the above mentioned standardized methods, specially adapted to the different sample matrices. These matrices differ in their characteristics e.g., low or high fat content or different amounts of pigments.

If you require an individual mix, which differs in the composition from the below mentioned mixes, please contact us.

Additional MACHEREY-NAGEL offers the reliable adsorbent CHROMABOND® Diamino (PSA) as bulk material.

The following table provides guidance for the choice of different QuEChERS mixes:

**Step 1 – Extraction and salting-out**

| Method | Sample weight | Solvent | Content of mix | Mix |
|---|---|---|---|---|
| EN 15662:2008, citrate-buffered [2] | 10 g | 10 mL acetonitrile | 4 g $MgSO_4$, 1 g NaCl, 0.5 g $Na_2H$ citrat · 1.5 $H_2O$, 1 g $Na_3$ citrat · 2 $H_2O$ | Mix I |
| AOAC 2007.01, acetate-buffered [3] | 15 g | 15 mL 1 % acetic acid in acetonitrile | 6 g $MgSO_4$, 1.5 g NaOAc | Mix II |
| Original non-buffered [1] | 10 g | 10 mL acetonitrile | 4 g $MgSO_4$, 1 g NaCl | Mix XII |

**Step 2 – Clean-up**

| Sample property | Content of mix | EN 15662 | AOAC 2007.01 |
|---|---|---|---|
| Low fat content<br>e.g., apple, asparagus, broccoli, pear, pineapple, strawberry | $MgSO_4$<br>Diamino (PSA) | Mix III | Mix XX |
| Moderate content of chlorophyll and carotinoids<br>e.g., carrot, lettuce | $MgSO_4$<br>Diamino (PSA)<br>Carbon | Mix IV | Mix XVII |
| Higher content of chlorophyll and carotinoids<br>e.g., pepper, spinach, blackberry, raspberry | $MgSO_4$<br>Diamino (PSA)<br>Carbon | Mix V | – |
| Higher fat content<br>e.g., avocado, cereals, nuts, beef, chicken, pork, dairy products, soil, oils, baby food | $MgSO_4$<br>Diamino (PSA)<br>$C_{18}$ ec | Mix VI | Mix XIX |

**Adsorbents and what they are used for**

| | |
|---|---|
| $MgSO_4$ | removes excess of water |
| NaCl | for phase separation |
| CHROMABOND® Diamino (PSA)<br>(Primary Secondary Amine) | removes organic and fatty acids, sugars and anthocyanin pigments |
| CHROMABOND® $C_{18}$ ec<br>(reversed phase modified silica) | traps nonpolar compounds, e.g., lipids |
| CHROMABOND® Carbon (GCB)<br>(Graphitized Carbon Black) | removes pigments and sterols (please note: planar pesticides are also removed) |

Further information can be found online at *www.mn-net.com* or *www.quechers.com*

## Ordering information

| | Volume | Adsorbent weight → 200 mg | 500 mg | Pack of |
|---|---|---|---|---|
| | **CHROMABOND® Diamino polypropylene columns** | | | |
| | 3 mL | 730561 | | 50 |
| | 6 mL | | 730562 | 30 |
| | **CHROMABOND® Diamino adsorbent** | | | |
| | | 730653.20 | | 20 g |
| | | 730653 | | 100 g |

## Ordering information

| Method | Mix | Volume | Content | Pack of | REF |
|---|---|---|---|---|---|
| **Extraction mix** 15 mL centrifuge tubes with screw cap | | | | | |
| EN 15662 | Mix I | 15 mL | 4 g $MgSO_4$, 1 g NaCl, 0.5 g $Na_2H$ Citrate · 1.5 $H_2O$, 1 g $Na_3$ Citrate · 2 $H_2O$ | 50 | 730970 |
| AOAC 2007.01 | Mix II | 15 mL | 6 g $MgSO_4$, 1.5 g NaOAc | 50 | 730971 |
| Original | Mix XII | 15 mL | 4 g $MgSO_4$, 1 g NaCl | 50 | 730648 |
| **Clean-up-Mix** 15 mL and 2 mL centrifuge tubes with screw cap | | | | | |
| EN 15662 | Mix III | 15 mL | 0.90 g $MgSO_4$, 0.15 g CHROMABOND® Diamino | 50 | 730972 |
| EN 15662 | Mix IV | 15 mL | 0.90 g $MgSO_4$, 0.15 g CHROMABOND® Diamino, 15 mg CHROMABOND® Carbon | 50 | 730973 |
| EN 15662 | Mix V | 15 mL | 0.90 g $MgSO_4$, 0.15 g CHROMABOND® Diamino, 45 mg CHROMABOND® Carbon | 50 | 730975 |
| EN 15662 | Mix VI | 15 mL | 0.90 g $MgSO_4$, 0.15 g CHROMABOND® Diamino, 150 mg CHROMABOND® $C_{18}$ ec | 50 | 730974 |
| AOAC 2007.01 | Mix XVII | 2 mL | 0.15 g $MgSO_4$, 50 mg CHROMABOND® Diamino, 50 mg CHROMABOND® Carbon | 50 | 730996.2 |
| AOAC 2007.01 | Mix XIX | 15 mL | 0.15 g $MgSO_4$, 50 mg CHROMABOND® Diamino, 50 mg CHROMABOND® $C_{18}$ ec | 50 | 730657 |
| AOAC 2007.01 | Mix XX | 15 mL | 1.20 g $MgSO_4$, 0.40 g CHROMABOND® Diamino | 50 | 730658 |

Further information can be found online at *www.mn-net.com* or *www.quechers.com*

## CHROMABOND® ABC18 special phase for analysis of acrylamide in food

### Key features

- Octadecyl silica phase with ion exchange functions for acrylamide analysis

### Recommended application

- Clean-up of acrylamide from ultra-heated starch-containing food, such as potato chips and other snacks, french fries, crispbread, cereals etc.

### Ordering information

| Volume | Adsorbent weight → 500 mg | Pack of |
|---|---|---|
| **CHROMABOND® ABC18 polypropylene columns** | | |
| 6 mL | 730533 | 30 |

### Important notes

- For "Determination of Acrylamide in Foods, SPE Clean-up Procedure for LC-MS/MS" please see application 303580 at *www.mn-net.com/apps*
- Acrylamide is created at temperatures above 100 °C from sugar and proteins, e.g., from potatoes or grain during the process of frying, baking, roasting or grilling. The formation depends on temperature, starting at 120 °C and increasing with more elevated temperatures. In cooked food, no acrylamide is found.
- Minimum concentration of acrylamide should be 70 µg/kg.
- The procedure includes no concentration step.
- Acrylamide and the isotopically labeled form, is carcinogenic, mutagenic and neurotoxic.

## CHROMABOND® Carbon A

### Technical characteristics

- Base material activated carbon, highly porous, spherical particles, specific surface >1000 $m^2/g$

### Recommended application

- Acrylamide from water according to DIN 38413-6 (e.g., application 306140)

**Enrichment of acrylamide from water acc. to DIN 38413**

MN Appl. No. 306140

**Column type:**
CHROMABOND® Carbon A, 6 mL, 1000 mg
REF 730167

**Sample pretreatment:** A drinking water sample was taken according to DIN 38402. The sample was treated with 100 mg/L sodium thiosulfate pentahydrate to reduce oxidizing species. 40 mg/L sodium azide was then added to avoid microbiological degradation. An aliqout of 500 mL pretreated water sample was spiked with 50 ng acrylamide.

**Column conditioning:** 8 mL methanol and 8 mL water

**Sample application:** sample was aspirated at a flow of 20 mL/min

**Column washing:** 1 mL water

**Drying:** 15 min nitrogen or air flow

**Elution:** 5 x 2 mL methanol

**Concentration:** eluate was concentrated to 1 mL by heating at 40 °C under a slight nitrogen stream

**Recovery rates:** 81 % (SD: 5 % [n=6])

Further analysis: HPLC-MS/MS in reference to appl. no. 127530

### Ordering information

| Volume | Adsorbent weight → 500 mg | 1 g | Pack of |
|---|---|---|---|
| **CHROMABOND® Carbon A polypropylene columns** | | | |
| 6 mL | 730165 | 730167 | 30 |

## CHROMABOND® PL special phase for removal of phospholipids

### Key features

- CHROMABOND® PL products are designed for internal protein precipitation. External protein precipitation could be necessary in order to prevent upper frit adsorbent bed clogging.

### Recommended application

- Removal of phospholipids
- Standard protocol see application 306110

Standard protocol for removal of phospholipids with internal protein precipitation

MN Appl. No. 306110

**Column type:**
CHROMABOND® PL, 1 mL, 30 mg, REF 730703 or
CHROMABOND® Multi 96 PL, 96 x 30 mg, REF 738702.030M

**Column conditioning:** none

**Sample application:** add up to 100 µL sample onto column / into well
Protein precipitation (internal): add protein precipitation reagent (e.g., final ratio of 3:1 to 4:1 of 1 % formic acid in acetonitrile : sample)

**Mixing:** mix thoroughly, avoiding cross contamination

**Sample collection:** slowly elute using vacuum or positive pressure

### Ordering information

| | Volume | Adsorbent weight → 30 mg | Pack of |
|---|---|---|---|
| | **CHROMABOND® PL polypropylene columns** | | |
| | 1 mL | 730703 | 100 |
| | | 96 x 30 mg | |
| | **CHROMABOND® MULTI 96 PL** | | |
| | | 738702.030M | 1 |

## CHROMABOND® Dry ($Na_2SO_4$) special phase for drying of organic samples

### Key features

- Anhydrous high-purity sodium sulfate which forms Glauber's salt with traces of water

### Recommended application

- Removal of traces of water from organic solutions.
- For removal of larger quantities of water several cartridges can be combined in series.

### Ordering information

| | Size → | S | M | L | |
|---|---|---|---|---|---|
| | Minimum adsorbent weight → | 360 mg | 760 mg | 2000 mg | Pack of |
| | **CHROMAFIX® Dry cartridges** | | | | |
| | | 731852 | 731853 | 731854 | 50 |

For further applications on CHROMABOND® phases visit our online application database at *www.mn-net.com/apps*

## CHROMABOND® PTS and PTL PTS and PTL columns for phase separation

### Key features

- Automatic separation of a two-phase mixture without separation funnel
- Two-phase mixtures are completely applied to the column and the phase boundary is determined without further work. The special membrane automatically stops the flow when the lower phase has passed. The upper phase remains in the column, thus both phases are available for further analysis.
- Columns must not be run with vacuum or pressure

### Recommended application

- PTS: for solvents heavier than water, e.g., trichloromethane, dichloromethane maximum size 150 mL
- PTL: for solvents lighter than water, e.g., diethyl ether, hexane maximum size 70 mL

### Ordering information

| Column volume | Pack of [columns] | REF |
|---|---|---|
| **CHROMABOND® PTS** for solvents heavier than water | | |
| 1 mL | 100 | 730710 |
| 3 mL | 100 | 730712 |
| 6 mL | 100 | 730714 |
| 15 mL | 100 | 730716 |
| 30 mL | 100 | 730718 |
| 45 mL | 50 | 730720 |
| 70 mL | 50 | 730722 |
| 150 mL | 20 | 730724 |
| **CHROMABOND® PTL** for solvents lighter than water | | |
| 1 mL | 100 | 730730 |
| 3 mL | 100 | 730732 |
| 6 mL | 100 | 730734 |
| 15 mL | 100 | 730736 |
| 30 mL | 100 | 730738 |
| 45 mL | 50 | 730740 |
| 70 mL | 50 | 730742 |

Ideal tool for breaking emulsions

CHROMABOND® PTL in action: organic upper phase (colorless), aqueous lower phase (red)

## CHROMABOND® XTR for liquid-liquid extraction

### Key features

- Base material coarse-grained kieselguhr (also known as diatomaceous earth, hydromatrix, celite), large pore size, high pore volume, constantly high batch-to-batch quality, pH working range 1–13
- Advantages:

  Fast, reproducible and economical
  Simultaneous preparation of several samples
  No problems with phase separation
  No formation of emulsions
  High recovery rates
  Saving of time and solvents
  Organic solutions need not to be dried after separation

### Recommended application

- Liquid-liquid extraction of highly viscous aqueous solutions such as physiological fluids (blood, plasma, and serum) in clinical chemistry, dyes in textiles, environmental and food analysis without use of a separation funnel
- High water loadability without breakthrough of water during elution with organic solvents also suited for removing small amounts of water from solvents which are not miscible with water

### Solvents applicable for elution

- Diethyl ether
- *tert* butyl methyl ether
- Ethyl acetate
- *n*-hexane
- Cyclohexane
- Toluene
- Dichloromethane (methylene chloride)
- Trichloromethane (chloroform)
- Trichloromethane – methanol (90:10, v/v)
- Trichloromethane – methanol (85:15, v/v)
- Diethyl ether – ethanol (90:10, v/v)
- Diethyl ether – ethanol (80:20, v/v)
- Dichloromethane – 2-propanol (90:10, v/v)
- Dichloromethane – 2-propanol (85:15, v/v)

Eluents with too high alcohol contents cause an increase in volume of the aqueous phase on the CHROMABOND® XTR. Here the column could be overloaded and the aqueous phase displaced from the column. In this case, a greater capacity column should be used.

Depending on the concentration of the analytes eluates can be analyzed immediately, or the organic solvent is evaporated. The pH value of the aqueous solution can be altered on the column, which enables elution of different compounds of a sample under optimized conditions. Under certain circumstances, acidic, neutral, and basic compounds can be fractionated in this way.

### General column parameters

| Volume | Adsorbent weight | Max. volume capacity of aq. solution | Waiting period before elution | Elution volume |
|---|---|---|---|---|
| **CHROMABOND® XTR** | | | | |
| 1 mL | 250 mg | 0.25 mL | 5 min | 3 mL |
| 3 mL | 500 mg | 0.5 mL | 5 min | 6 mL |
| 6 mL | 1 g | 1 mL | 5–10 min | 8 mL |
| 15 mL | 3 g | 3 mL | 5–10 min | 12 mL |
| 30 mL | 4.5 g | 5 mL | 5–10 min | 16 mL |
| 45 mL | 8.3 g | 10 mL | 10–15 min | 24 mL |
| 70 mL | 14.5 g | 20 mL | 10–15 min | 40 mL |
| 150 mL | 37.5 g | 50 mL | 10–15 min | 90 mL |

### Determination of azo dyes and aromatic amines in colored textile materials with reference to § 64 LFGB (formerly § 35 LMBG)

MN Appl. No. 302100

**Column type:**
CHROMABOND® XTR, 70 mL, 14.5 g, for max. 20 mL aqueous solution
REF 730507

**Sample pretreatment:** Weigh about 1 g cut-up textile sample (colored textiles about 0.1 g) in a 100 mL threaded vial. (Degrease leather samples before processing: cover sample with technical purity *n*-hexane and put the vial in an ultrasonic bath for 20 min. After decanting the *n*-hexane rinse with little *n*-hexane and dry sample by gentle heating and blowing with air or $N_2$).

Add 250 µL internal standard (IS: 1.2 mg/mL tetramethylbenzidine in methanol – ethyl acetate (1:1, v/v)), 17.0 mL citrate buffer (pH 6) (25.05 g citric acid and 12.64 g NaOH, fill up with deionized water to 2 L) and heat 30 min at 70 °C.

Then add 3 mL of a freshly prepared solution of 0.2 g/mL sodium dithionite in water and heat for exactly 30 min to 70 °C while shaking occasionally.

**Sample application:** Cool the solution immediately (put vial in water – stopping of reductive cleavage). After 5–10 min pour it onto the CHROMABOND® XTR column (squeeze textile remains).

**Elution:** Allow solution to be soaked up by the adsorbent for 15 min. Then elute four times with 20 mL each of diethyl ether or diethyl ether – ethanol (90:10, v/v) (depending on recovery rates), using the first 40 mL to rinse the sample remains.

Evaporate eluates to 3 mL with a rotation evaporator and transfer the solution into a 10 mL measuring flask using a pasteur pipette and rinsing with methanol. Fill up to the marking with methanol, shake, and pipette about 1 mL into a vial.

Further analysis:
Fast GC on OPTIMA® δ-3, 10 m, 0.1 mm ID, 0.1 µm film, REF 726410.10 (application 210820) or HPLC on NUCLEOSIL® 100-5 $C_{18}$ HD (application 110500 at *www.mn-net.com/apps*)

## Ordering information

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Column volume | 1 mL | 3 mL | 6 mL | 15 mL | 30 mL | 45 mL | 70 mL | 150 mL |
| Adsorbent weight | 250 mg | 500 mg | 1 g | 3 g | 4.5 g | 8.3 g | 14.5 g | 37.5 g |
| Max. volume capacity of aqueous solution | 0.25 mL | 0.5 mL | 1 mL | 3 mL | 5 mL | 10 mL | 20 mL | 50 mL |
| Pack of → | 100 | 50 | 30 | 30 | 30 | 30 | 30 | 10 |
| **CHROMABOND® XTR polypropylene columns** (glass columns on request) | | | | | | | | |
| | 730501 | 730502 | 730487 | 730489 | 730505 | 730506 | 730507 | 730509 |
| **CHROMABOND® XTR polypropylene columns · BIGpacks** | | | | | | | | |
| | | | 730487.250 | (250 col.) | | | 730507.100 | (100 col.) |
| **CHROMABOND® MULTI 96 XTR** | | | | | | | | |
| 96-well plates 96 x 150 mg, packs of 1 plate, for max. 96 x 0.2 mL aqueous solution | | | | | | | | |
| | | | 738131.150M | | | | | |
| **CHROMABOND® XTR adsorbent** | | | | | | | | |
| 50 bags of 14.5 g, (for max. 20 mL aqueous solution each) | | | | | | | | |
| for 70 mL PP columns with 100 PE filter elements | for NT20 with 50 PE filter elements (10 mm dia.) | | | | | | | |
| | | | | 500 g | 1 kg | 5 kg | | |
| 730585 | 730586 | | | 730595.500 | 730595.1000 | 730595.5000 | | |
| **Accessories for liquid-liquid extraction with CHROMABOND® XTR** | | | | | | | | |
| variable polypropylene rack for 24 positions, incl. 24 PP stopcocks and 24 PP needles | | | | | | | | 730508 |

For parallel processing of up to 24 CHROMABOND® XTR columns 1–150 mL we recommend the polypropylene rack REF 730508 consisting of: two side walls, middle part including stopcocks and needles, bottom part, top part for stabilizing 45 mL and 70 mL CHROMABOND® XTR columns.
This rack can be adjusted to various heights depending on the CHROMABOND® XTR columns and the collection vials used.

Each position of the middle part is equipped with a polypropylene stopcock on the top (REF 730185) and a polypropylene needle on the bottom (REF 730154).

For collection of the sample, vessels such as vials, test tubes, round bottom or tapered flasks, can be used. For our program of sample vials, please see the chapter "Vials and accessories" from page 97.

For further applications on CHROMABOND® phases visit our online application database at *www.mn-net.com/apps*

## CHROMABOND® Vacuum manifold

**Key features**

- For the simultaneous preparation of up to 12, 16 or 24 samples
- Replacement parts and accessories for special applications

### Vacuum manifold for 12 columns

① Rectangular glass cabinet; 2 sizes available: small for up to 12 CHROMABOND® columns or CHROMAFIX® cartridges; large for up to 16 CHROMABOND® LV columns or up to 24 CHROMABOND® columns or CHROMAFIX® cartridges (depending on lid)

② Polypropylene lid

③ Vacuum gauge for pressure reading

④ Control valve for adjustment of vacuum

⑤ Replaceable valves for vacuum control of individual SPE columns

⑥ Variable rack with exchangeable partitions, which accept a wide variety of vessels like test tubes, measuring flasks, scintillation vials, autosampler vials, plastic vials etc.

⑦ CHROMABOND® LV columns with 15 mL sample reservoir for medium size samples

⑧ Polypropylene sample reservoirs (30 or 70 mL)*

⑨ Adapter for sample reservoirs*

⑩ CHROMABOND® tubing adapters

Full description and manual can be downloaded at *www.mn-net.com*

### Ordering information

| Description | Pack of | REF |
|---|---|---|
| **Vacuum manifold complete** | | |
| consists of glass cabinet with lid and lid gasket, removable needles on lower side of lid, vacuum gauge, control valve, valves and caps, variable rack: | | |
| for up to 12 columns or cartridges (including PP tank) | 1 | 730150 |
| for up to 16 LV columns | 1 | 730360 |
| for up to 24 columns or cartridges | 1 | 730151 |
| **Glass cabinets without accessories ①** | | |
| for 12 columns | 1 | 730173 |
| for 16 LV or 24 columns (large) | 1 | 730174 |
| **Lids with gaskets ②** | | |
| for 12 columns (including Luer fittings and valves ⑤) | 1 | 730175 |
| for 16 LV columns (including Luer fittings and valves ⑤) | 1 | 730365 |
| for 24 columns (including Luer fittings and valves ⑤) | 1 | 730176 |
| Gaskets for lid, for 12 columns | 2 | 730177 |
| Gaskets for lid, for 16 or 24 columns | 2 | 730178 |

* Ordering information see on page 67.

# SPE vacuum manifolds and accessories

## Ordering information

| Description | Pack of | REF |
|---|---|---|
| **General accessories for vacuum manifolds** | | |
| Luer stoppers for vacuum manifold, blue | 12 | 730194 |
| Luer fittings for lid, female | 12 | 730183.12 |
| Luer fittings for lid, male | 12 | 730184.12 |
| Valves, plastic ⑤ | 12 | 730185 |
| Stainless steel needles | 12 | 730152 |
| Polypropylene needles | 12 | 730154 |
| PP tanks for vacuum manifold for 12 columns (not available for 16- or 24-position manifold) | 2 | 730233 |
| Vacuum gauge, complete with accessories ③ + ④ | 1 | 730179 |
| **Drying attachment and collecting racks** | | |
| for evaporation of eluates (application see below) | | |
| Drying attachment, with 12 positions ⑪ | 1 | 730187 |
| Drying attachment, with 16 positions | 1 | 730990 |
| Drying attachment, with 24 positions | 1 | 730188 |
| Collecting rack for 12 columns ⑥ | 1 | 730157 |
| Collecting rack for 16 LV columns | 1 | 730366 |
| Collecting rack for 24 columns | 1 | 730153 |
| **Products for protection from cross contamination** | | |
| Valve, brass, tarnished | 1 | 730189.1 |
| Valves, as above | 12 | 730189.12 |
| Stainless steel connectors | 12 | 730106 |
| PTFE connectors | 12 | 730564 |
| **Tubing adapters for application of large sample volumes ⑩** | | |
| for 3 and 6 mL glass columns | 4 | 730387 |
| for 1, 3 and 6 mL polypropylene columns | 4 | 730243 |
| for 15, 45 and 70 mL polypropylene columns (material: PTFE tube length approx. 1 m) | 4 | 730386 |

## Protection from cross contamination

For special applications which require maximum protection from cross contamination we supply chrome-plated brass valves and stainless steel or PTFE connectors. Their application is shown on the right side. These special connectors are fitted through the lid; thus the sample only has contact with the inert connector and can flow directly into the receptacle.

## Drying attachment

If the eluate has to be evaporated, this can be performed with the so-called drying attachment ⑪. This special lid has a gas connector ⑫ on one side, from which the gas is fed simultaneously to the 12, 16, or 24 stations ⑬. Thus 12, 16, or 24 eluates can be evaporated simultaneously by just changing the lid and applying a stream of inert gas, e.g., nitrogen.

## For individual packing of SPE columns with CHROMABOND® adsorbents

### Ordering information

| Description | | Pack of | REF |
|---|---|---|---|
| Empty polypropylene columns with 2 PE filter elements, 1 mL | one filter element is already inserted in the polypropylene column | 100 | 730159 |
| Empty polypropylene columns with 2 PE filter elements, 3 mL | | 50 | 730160 |
| Empty polypropylene columns with 2 PE filter elements, 6 mL | | 30 | 730161 |
| Empty polypropylene columns with 2 PE filter elements, 15 mL | | 20 | 730230 |
| Empty polypropylene columns with 2 PE filter elements, 30 mL | | 20 | 730380 |
| Empty polypropylene columns with 2 PE filter elements, 45 mL | | 20 | 730355 |
| Empty polypropylene columns with 2 PE filter elements, 70 mL | | 20 | 730158 |
| Empty polypropylene columns with 2 PE filter elements, 150 mL | | 20 | 730474 |
| PE filter elements for polypropylene columns 1 mL | | 250 | 730164 |
| PE filter elements for polypropylene columns 3 mL | | 250 | 730162 |
| PE filter elements for polypropylene columns 6 mL | | 250 | 730163 |
| PE filter elements for polypropylene columns 15 mL | | 250 | 730351 |
| PE filter elements for polypropylene columns 30 mL | | 250 | 730034 |
| PE filter elements for polypropylene columns 45 mL | | 250 | 730356 |
| PE filter elements for polypropylene columns 70 mL | | 250 | 730026 |
| PE filter elements for polypropylene columns 150 mL | | 250 | 730475 |
| Empty glass columns with 2 glass fiber filter elements, 3 mL | one filter element is already inserted in the polypropylene column | 50 | 730171 |
| Empty glass columns with 2 glass fiber filter elements, 6 mL | | 30 | 730172 |
| Glass fiber filter elements for glass columns 3 mL | | 250 | 730191 |
| Glass fiber filter elements for glass columns 6 mL | | 250 | 730192 |
| Empty LV polypropylene columns with PE filter elements, 15 mL, for 100 mg adsorbent weight | | 50 | 732500 |
| Empty LV polypropylene columns with PE filter elements, 15 mL, for 200/500 mg adsorbent weight | | 50 | 732501 |
| PE filter elements for LV polypropylene columns 15 mL for 100 mg adsorbent weight | | 250 | 732019 |
| PE filter elements for LV polypropylene columns 15 mL for 200/500 mg adsorbent weight | | 250 | 732020 |
| Adapters (PVDF) for glass columns | | 4 | 730104.4 |
| Adapters as above | | 10 | 730105 |
| Adapters (PP) for polypropylene columns (1, 3 and 6 mL) | | 4 | 730100.4 |
| Adapters as above | | 10 | 730101 |
| Adapters (PE) for polypropylene columns (15, 45, 70 mL) | | 4 | 730350.4 |
| Adapters as above | | 10 | 730385 |
| Adapter (PE) for polypropylene columns (30 and 70 mL) | | 1 | 730566 |
| **Reservoir columns for application of medium-size samples ⑧ + ⑨** | | | |
| Reservoir column 30 mL, polypropylene, with one adapter for 1, 3, 6 mL CHROMABOND® polypropylene columns | | 1 | 730102 |
| 10 Reservoir columns 30 mL, polypropylene, with one adapter for 1, 3, 6 mL CHROMABOND® polypropylene columns | | 1 kit | 730103 |
| Reservoir column 70 mL, polypropylene, with one adapter for 1, 3, 6 mL CHROMABOND® polypropylene columns | | 1 | 730381 |
| 10 Reservoir columns 70 mL, polypropylene, with one adapter for 1, 3, 6 mL CHROMABOND® polypropylene columns | | 1 kit | 730382 |
| Reservoir column 70 mL, polypropylene, with one adapter for 15, 45, 70 mL CHROMABOND® polypropylene columns | | 1 | 730388 |
| 10 Reservoir columns 70 mL, polypropylene, with one adapter for 15, 45, 70 mL CHROMABOND® polypropylene columns | | 1 kit | 730389 |

# High throughput SPE

## Automated and on-line SPE

Performing Solid Phase Extraction (SPE) manually can be time consuming and nerve-racking, especially when recovery and reproducibility are lacking due to sample variability. If SPE can be reliably automated it becomes a much more efficient and reproducible process.

On-line SPE is a powerful method in automated sample preparation where the SPE hardware is technically integrated into a HPLC system. Crude samples are placed in an autosampler and processed fully automatically prior to injection into a GC (MS) or LC (MS) system.

MN offers different on-line column configurations designed to fit your on-line SPE needs and filled with a choice of different adsorbents, modifications and particle sizes:

- Ready-to-use EC columns or ChromCart® cartridges for on-line SPE (standard dimensions 20 x 2 mm or 20 x 4 mm, resp.), filled with CHROMABOND® HR-*Xpert* phases (15 µm particles) or with NUCLEODUR® $C_{18}$ ec, $C_8$ ec, CN (20 µm particles)

EC column

CC-cartridges

- Columns for Gilson® ASPEC™ systems are ready to use assembled with caps. In addition to the columns and phases listed below, all 1, 3 and 6 mL CHROMABOND® polypropylene columns from our program can be supplied assembled with ASP caps.

Columns for the Gilson® ASPEC™

**Ordering information Gilson® ASPEC™ columns**

| Volume | Adsorbent weight | Pack of [columns] | REF |
|---|---|---|---|
| **CHROMABOND® SiOH** | | | |
| 1 mL | 100 mg | 100 | 730071ASP |
| 3 mL | 500 mg | 100 | 730073ASP |
| 6 mL | 1000 mg | 100 | 730075ASP |
| **CHROMABOND® $C_{18}$ ec** | | | |
| 1 mL | 100 mg | 100 | 730011ASP |
| 3 mL | 500 mg | 100 | 730013ASP |
| 6 mL | 1000 mg | 100 | 730015ASP |

- SPE columns equipped with caps and needles to be used in the SPE unit of the Gerstel MultiPurposeSampler (MPS)

SPE cartridges for Gerstel MPS system

Gerstel MPS system

**Ordering information Gerstel MPS columns**

| Volume | Adsorbent weight | Pack of [columns] | REF |
|---|---|---|---|
| **CHROMABOND® SiOH** | | | |
| 3 mL | 200 mg | 50 | 730214MPS |
| 3 mL | 500 mg | 50 | 730073MPS |
| 6 mL | 1000 mg | 30 | 730075MPS |
| **CHROMABOND® $C_{18}$ ec** | | | |
| 1 mL | 100 mg | 100 | 730011MPS |
| 3 mL | 200 mg | 50 | 730012MPS |
| 3 mL | 500 mg | 50 | 730013MPS |
| **CHROMABOND® HR-X** | | | |
| 1 mL | 100 mg | 30 | 730935MPS |
| 3 mL | 200 mg | 30 | 730931MPS |
| 6 mL | 500 mg | 30 | 730939MPS |

Other dimensions and adsorbents on request.

## CHROMABOND® MULTI 96 for robot systems

Alternatively CHROMABOND® MULTI 96 plates provide a means of high throughput sample preparation by processing 96 samples in a standard 8 x 12 microcolumn plate format compatible with standard 96-well plate liquid handling technologies and injection systems. MULTI 96 plates are available for solid phase extraction (SPE) and for filtration (see page 95)

### CHROMABOND® MULTI 96

- 96-well PP microtiter plates with PE filter elements
- Cavity volume 1.5 mL
- Adsorbent weights 10, 25, 50, 100 mg per microcolumn
- Supplied with any CHROMABOND® SPE adsorbents
- For the simultaneous preparation of 96 samples
- Easy method transfer from CHROMABOND® columns or CHROMAFIX® cartridges to CHROMABOND® MULTI 96

### Advantages of this high-throughput system

- Simultaneous preparation of 96 samples; this means a 4-fold increase over traditional 24-position SPE processors
- Economical by saving time and solvent
- Use of multi-channel pipettors facilitates liquid transfer steps
- Readily adaptable to all common automated and robotic handling systems
- Minimized dead volume (≤ 40 µL)

### Instrument compatibility

CHROMABOND® MULTI 96 SPE microtiter plates as well as CHROMAFIL® MULTI 96 filtration plates are compatible with, e.g., the following liquid handling and SPE automation systems:

- Perkin Elmer MultiProbe® II
- Tomtec Quadra 3® and Quadra 3® SPE
- Hamilton Microlab® SPE Workstation
- Beckman Coulter Biomek® 2000
- Caliper Life Science RapidTrace®
- Gilson® ASPEC™ XL4 and ASPEC™ XL
- Gilson® 215 SPE Liquid Handler
- Tecan Genesis™ FE500
- Eppendorf ep*Motion*®

## CHROMABOND® MULTI 96 vacuum manifold

### For handling of CHROMABOND® MULTI 96 SPE plates for up to 96 samples

CHROMABOND® MULTI 96 is designed for use in common robotic workstations or commercially available liquid handling systems. Alternatively, use of multichannel pipettors facilitates a manual liquid transfer. Extraction is carried out using the CHROMABOND® MULTI 96 vacuum manifold.

With the help of the control valve the vacuum of the manifold can be adjusted leading to an optimum flow rate through the CHROMABOND® MULTI 96 SPE plate.

A reservoir tank and 96-well collection plates (96 x 0.5 or 96 x 2 mL) made of polypropylene can be supplied as accessories.

An interesting alternative for collection of the eluates is a collection rack, which can be fitted with twelve 8-well strips of polypropylene tubes (each 1 mL).

If you have to work on less than 96 samples, you can seal individual rows of the 96-well plate with a PTFE-covered rubber pad.

### Ordering information

| Description | Pack of | REF |
|---|---|---|
| **CHROMABOND® MULTI 96 accessories** | | |
| CHROMABOND® MULTI 96 vacuum manifold with reservoir tank, vacuum gauge, and control valve | 1 | 738630.M |
| 96-well microtiter plates (polypropylene) 96 x 0.25 mL | 10 | 738651 |
| 96-deep-well collecting plate (polypropylene) 96 x 2 mL | 5 | 738650.5 |
| Collection racks with polypropylene tube strips (twelve 8-well strips) 96 x 1.0 mL | 5 | 738637 |
| Polypropylene tube strips (twelve 8-well strips) 96 x 1.0 mL | 10 | 738652 |
| 8-well strip sealing caps for PP tube strips (REF 738652) | 30 | 738638 |
| Reservoir tanks (polypropylene) | 2 | 738639.M |
| Butyl rubber pad, PTFE covered for sealing of individual rows of the 96-well plate, 125 x 85 mm | 1 | 738645 |

For CHROMAFIL® MULTI 96 filter plates see page 95. The ordering information of 96-well plates packed with individual CHROMABOND® adsorbents is listed with the respective phases.

## MN Flash adsorbents a unique variety of phases

### Key features

- Flash columns and cartridges from MACHEREY-NAGEL are available with all CHROMABOND® SPE / Flash packings (more than 40 phases, e.g., $C_{18}$, $C_8$, OH, Alox). Additionally you can choose from our range of POLYGOPREP silica packings in particle sizes from 20 to 130 µm and pore sizes from 60 to 4000 Å.
- For high performance Flash separations spherical silica featuring very high separation efficiency can be requested

### Technical characteristics

- Specification of modified and plain silica, acid-washed irregular silica, pore size 60 Å, particle size 45 µm, specific surface 500 $m^2/g$, pH stability 2–8

Comparison of separation efficiency and price of irregular versus spherical silica

## Separation efficiency and reproducibility

Our optimized automatic packing process leads to an excellent packing quality, irrespective of the phase or particle size distribution (normal phase or reversed phase, spherical or irregular particles). MACHEREY-NAGEL, as a manufacturer of silicas, has decades of experience in the production of first class separation phases and columns. This leads to highest separation efficiencies of the columns, a constant back pressure (via controlled narrow particle size distribution) and good reproducibilities from cartridge to cartridge.

The separation efficiency is in the first place not influenced by the dimension or the geometry of the Flash RS cartridges. The chromatograms below show an identical resolution and peak form for different column dimensions, when flow and sample amount is adjusted correctly. This is advantageous for optimization and upscaling experiments.

## Resolution and peak shape for different column dimensions

4 g SiOH: 0.25 mL sample, 10 mL/min

15 g SiOH: 1 mL sample, 40 mL/min

25 g SiOH: 1 mL sample, 80 mL/min

40 g SiOH: 1 mL sample, 160 mL/min

## MN TLC and Flash products

- Same selectivity and easy upscaling from TLC to Flash separations
- Saving time and money, because expensive optimizations are not required

TLC is often used for the development of a selective and reproducible method in Flash chromatography, because it is often necessary to test a large number of eluent and / or adsorbent combinations. MN TLC plates and sheets are coated with the same base silica, which is used in our CHROMABOND® Flash cartridges. This is an important prerequisite for the reproducible transfer of a TLC separation to the Flash column, because the parameters are identical in both systems.

## TLC screening

For TLC separation you should start with an unmodified silica and a nonpolar eluent of low viscosity (e.g., mixtures of *n*-hexane – ethyl acetate or *n*-hexane – acetone). By changing the composition of the eluent the $R_f$ value of the TLC separation is adjusted to approx. 0.3. Increasing polarity of the eluent decreases the $R_f$ values. The difference in $R_f$ values between the substances to be separated should be at least 0.1 to allow a reliable separation in the subsequent flash chromatography. Variation of the eluent components (e.g., acetone, dichloromethane) can be used to enhance the separation by eluent specific selectivity.

Our program of TLC plates can be found from page 273 onwards.

## Technical support for Flash RS and Flash BT

### Loadability

- Due to the narrow particle size distribution, the excellent packing quality and the optimized stationary phases (acid washed silica, reduced particulate matter) our cartridges can realize highest loadability at best possible separation efficiency.
- Additionally, the large range of different cartridge lengths and diameters eases to find the optimum in loadability for a given sample amount.

### Rule of thumb for the loadability

| Separation | Loadability | g sample / g adsorbent |
|---|---|---|
| difficult | low | ≤ 1 % |
| easy | high | ≥ 10 % |

### Loadability table CHROMABOND® Flash RS and BT

| SiOH cartridge | Average loadability per cartridge [g] | |
|---|---|---|
| | difficult separation | easy separation |
| RS / BT 4 | 0.04 | 0.4 |
| RS / BT 15 | 0.15 | 1.5 |
| RS / BT 25 | 0.25 | 2.5 |
| RS / BT 40 | 0.4 | 4 |
| RS / BT 80 | 0.8 | 8 |
| RS / BT 120 | 1.2 | 12 |
| RS / BT 200 | 2 | 20 |
| RS / BT 330 | 3.3 | 33 |
| RS 800 | 8 | 80 |
| RS 1600 | 16 | 160 |

### Upscaling of the optimum flow rate

This depends on the eluent, the separation problem, the amount of adsorbent and also on the dimensions of the column.

In the simplest case the upscaling relation is proportional to the amount of adsorbent (for equal eluent polarity).

For the flow rate the following would apply e.g.,

4 g silica → optimum flow: ~ 6–12 mL/min

40 g silica → optimum flow: ~ 60–120 mL/min

Upscaling of the flow rate

### Back pressure and pressure stability

The back pressure always depends on flow rate and viscosity of the eluent mixture, column length and diameter and the particle size. The high performance CHROMABOND® Flash RS cartridges up to 200 g silica are stable up to 15 bar (220 psi, > 200 g: 12 bar).

We recommend using a pressure guard, because short time pressure peaks (viscosity of eluent or gradient changes) can exceed the pressure limit.

Back pressure of CHROMABOND® Flash RS SiOH cartridges (eluent hexane – ethyl acetate 9:1 or 8:2)

| Flow rate | | | | | | | |
|---|---|---|---|---|---|---|---|
| Cartridge | 20 mL/min | 40 mL/min | 80 mL/min | 120 mL/min | 160 mL/min | 200 mL/min | 240 mL/min |
| RS / BT 4 | 0.75 bar | 1.5 bar | | | | | |
| RS / BT 15 | 0.25 bar | 0.75 bar | 1.5 bar | 2.0 bar | | | |
| RS / BT 25 | 0.5 bar | 1.0 bar | 1.75 bar | 3.0 bar | 4.0 bar | 5.0 bar | |
| RS / BT 40 | | 0.75 bar | 1.5 bar | 2.25 bar | 3.0 bar | 3.25 bar | 3.5 bar |
| RS / BT 80 | | | 1.5 bar | 2.5 bar | 3.0 bar | 3.5 bar | 4.0 bar |
| RS / BT 120 | | | 1.0 bar | 1.5 bar | 2.0 bar | 2.5 bar | 3.0 bar |
| RS / BT 200 | | | 1.0 bar | 1.5 bar | 2.0 bar | 2.5 bar | 3.0 bar |
| RS / BT 330 | (typical flow rate) | | 1.5 bar | 2.25 bar | 3.0 bar | 3.5 bar | 4.0 bar |

Conditioning volumes for CHROMABOND® Flash RS cartridges (normally 1.5 column volumes of the eluent)

| Cartridge | Volume of eluent for conditioning |
|---|---|
| RS / BT 4 | 20 mL |
| RS / BT 15 | 60 mL |
| RS / BT 25 | 90 mL |
| RS / BT 40 | 140 mL |
| RS / BT 80 | 280 mL |

| Cartridge | Volume of eluent for conditioning |
|---|---|
| RS / BT 120 | 440 mL |
| RS / BT 200 | 750 mL |
| RS / BT 330 | 1100 mL |
| RS 800 | 2900 mL |
| RS 1600 | 5000 mL |

## CHROMABOND® Flash cartridges

### Ideal for Flash separations from 10 mg up to 160 g

Convenient operation and reliable upscaling; Complete program of ready-to-use Flash cartridges for:

- Isco Companion® and other Teledyne Isco CombiFlash® systems
- Biotage® Isolera™, Biotage® FlashMaster™
- Or as stand-alone version for all pump / detector combinations, e.g., from Biotage®, Büchi

Enhanced flexibility

- All common RP and NP phases available on request
- Adsorbent weights from 4 g to 1600 g (up to 300 g for BT)

Outstanding price-performance ratio

Increased analytical safety

- Low bleed polypropylene cartridges, organic solvent resistant, thick column walls, one piece body, sophisticated length-to-diameter ratio for high plate numbers and excellent separation efficiencies, optimal ratio of length and diameter
- Distribution of eluent stream via highly porous frits
- High pressure stability of 21 bar / 300 psi (15 bar for 80 g and 120 g cartridges, 12 bar for cartridges > 200 g, 7 bar for 3000 g), good reproducibility

High quality standard

- All flash cartridges and adsorbents undergo comprehensive during- and after-production quality assurance measures to ensure that the products conform to the specification.

CHROMABOND® Flash RS - pictures of CHROMABOND® Flash BT, DL and FM hardware can be found on page 15.

## CHROMABOND® Flash RS solutions for Isco® Flash instruments

### Key features

- Heavy-duty polypropylene cartridges designed for use in Teledyne Isco CombiFlash® systems (Companion®, $R_f$ etc.) without additional connectors or capillaries.
- Column connection:
  cartridges up to RS 330: female Luer lock inlet and male Luer outlet RS 800 and RS 1600: maxi Luers

### Recommended application

- Using the CHROMABOND® Flash Starter Kit, REF 730798 or the CHROMABOND® Flash Stand Alone Kit, REF 732903 (see page 78) CHROMABOND® Flash RS cartridges can also be used as stand alone system with any pump / detector / fraction collector combination (except RS 800, RS 1600 and RS 3000 with maxi Luers).

### Ordering information

| Description | Column length [cm] | ID [mm] | Adsorbent weight [g] | Pack of | REF |
|---|---|---|---|---|---|
| **CHROMABOND® Flash RS columns with Luer exit** | | | | | |
| Filled with standard silica, unmodified (SiOH) or endcapped octadecyl modified ($C_{18}$ ec), 40–63 µm, specific surface 500 $m^2/g$, pH stability 2–8 | | | | | |
| CHROMABOND® Flash RS 4 SiOH | 9.8 | 12.4 | 4 | 20 | 732800 |
| CHROMABOND® Flash RS 15 SiOH | 11.6 | 21.2 | 15 | 20 | 732801 |
| CHROMABOND® Flash RS 25 SiOH | 16.5 | 21.2 | 25 | 15 | 732802 |
| CHROMABOND® Flash RS 40 SiOH | 17.1 | 26.4 | 40 | 15 | 732803 |
| CHROMABOND® Flash RS 80 SiOH | 24.0 | 30.8 | 80 | 12 | 732804 |
| CHROMABOND® Flash RS 120 SiOH | 25.5 | 36.0 | 120 | 10 | 732805 |
| CHROMABOND® Flash RS 200 SiOH | 20.0 | 60.0 | 200 | 6 | 732806 |
| CHROMABOND® Flash RS 330 SiOH | 27.0 | 60.0 | 330 | 4 | 732807 |
| CHROMABOND® Flash RS 800 SiOH | 38.5 | 82.0 | 800 | 2 | 732808 |
| CHROMABOND® Flash RS 1600 SiOH | 43.0 | 104.0 | 1600 | 2 | 732809 |
| CHROMABOND® Flash RS 3000 SiOH | 51.0 | 127.5 | 3000 | 1 | 732850 |
| Corresponding TLC plates: silica (see page 273) | | | | | |
| CHROMABOND® Flash RS 4 $C_{18}$ ec | 9.8 | 12.4 | 4.3 | 2 | 732810 |
| CHROMABOND® Flash RS 15 $C_{18}$ ec | 11.6 | 21.2 | 16.4 | 1 | 732811 |
| CHROMABOND® Flash RS 25 $C_{18}$ ec | 16.5 | 21.2 | 26 | 1 | 732812 |
| CHROMABOND® Flash RS 40 $C_{18}$ ec | 17.1 | 26.4 | 43 | 1 | 732813 |
| CHROMABOND® Flash RS 80 $C_{18}$ ec | 24.0 | 30.8 | 86 | 1 | 732814 |
| CHROMABOND® Flash RS 120 $C_{18}$ ec | 25.5 | 36.0 | 130 | 1 | 732815 |
| CHROMABOND® Flash RS 200 $C_{18}$ ec | 20.0 | 60.0 | 220 | 1 | 732816 |
| CHROMABOND® Flash RS 330 $C_{18}$ ec | 27.0 | 60.0 | 360 | 1 | 732817 |
| CHROMABOND® Flash RS 800 $C_{18}$ ec | 38.5 | 82.0 | 880 | 1 | 732818 |
| CHROMABOND® Flash RS 1600 $C_{18}$ ec | 43.0 | 104.0 | 1760 | 1 | 732819 |
| Corresponding TLC plates: RP-18 W/$UV_{254}$ (see page 284) | | | | | |

On request, all column types listed above can be packed with any adsorbent from our program of CHROMABOND® adsorbents (starting from page 16). Please note that other packings often result in differing adsorbent weights.

# CHROMABOND® Flash BT · DL

## CHROMABOND® Flash BT solutions for Biotage® Flash instruments

### Key features

- Heavy-duty polypropylene cartridges designed for use in the Biotage® Isolera™ systems without additional connectors or capillaries.
- Column connection:
  female Luer lock inlet and male Luer lock outlet

### Recommended application

- Using the CHROMABOND® Flash Starter Kit, REF 730798 or the CHROMABOND® Flash Stand Alone Kit, REF 732903 (see page 78) CHROMABOND® Flash BT cartridges can also be used as stand alone system with any pump / detector / fraction collector combination.

### Ordering information

| Description | Column length [cm] | ID [mm] | Adsorbent weight [g] | Pack of | REF |
|---|---|---|---|---|---|
| **CHROMABOND® Flash BT columns with Luer lock exit** | | | | | |
| Filled with unmodified standard silica, 40–63 µm, specific surface 500 $m^2/g$, pH stability 2–8 | | | | | |
| CHROMABOND® Flash BT 4 SiOH | 9.8 | 12.4 | 4 | 20 | 732960 |
| CHROMABOND® Flash BT 15 SiOH | 11.6 | 21.2 | 15 | 20 | 732961 |
| CHROMABOND® Flash BT 25 SiOH | 16.5 | 21.2 | 25 | 15 | 732962 |
| CHROMABOND® Flash BT 40 SiOH | 17.1 | 26.4 | 40 | 15 | 732963 |
| CHROMABOND® Flash BT 80 SiOH | 24.0 | 30.8 | 80 | 12 | 732964 |
| CHROMABOND® Flash BT 120 SiOH | 25.5 | 36.0 | 120 | 10 | 732965 |
| CHROMABOND® Flash BT 200 SiOH | 20.0 | 60.0 | 200 | 6 | 732966 |
| CHROMABOND® Flash BT 330 SiOH | 27.0 | 60.0 | 330 | 4 | 732967 |

On request, all column types listed above can be packed with any adsorbent from our program of CHROMABOND® adsorbents (starting from page 16). Please note that other packings often result in differing adsorbent weights.

Partly filled CHROMABOND® Flash BT cartridges (e.g., filled up to 80 %) are available on request. By removal of the top cap the sample can be applied directly on to the cartridges (see page 77).

## CHROMABOND® Flash DL cartridges solutions for direct loading

### Key features

- Column connection:
  female Luer lock inlet and male Luer lock outlet.
  Each cartridge comes with 3 filter elements: one already inserted, two more filters aside.
- Suitable as solid injection system
- For individual self-filling and packing of flash cartridges

### Ordering information

| Description | Column length [cm] | ID [mm] | For adsorbent weight [g] SiOH | For adsorbent weight [g] Kieselguhr | Volume [mL] | Empty column Pack of | Empty column REF | PE filter elements Pack of | PE filter elements REF |
|---|---|---|---|---|---|---|---|---|---|
| **CHROMABOND® Flash DL empty cartridges** | | | | | | | | | |
| CHROMABOND® Flash DL 4 | 9.8 | 12.4 | 4 | 3 | 8 | 50 | 732980 | 250 | 732980FE |
| CHROMABOND® Flash DL 15 | 11.6 | 21.2 | 15 | 10 | 30 | 50 | 732981 | 250 | 732981FE |
| CHROMABOND® Flash DL 25 | 16.5 | 21.2 | 25 | 15 | 45 | 50 | 732982 | 250 | 732982FE |
| CHROMABOND® Flash DL 40 | 17.1 | 26.4 | 40 | 30 | 75 | 20 | 732983 | 250 | 732983FE |
| CHROMABOND® Flash DL 80 | 24.0 | 30.8 | 80 | 60 | 160 | 20 | 732984 | 250 | 732984FE |
| CHROMABOND® Flash DL 120 | 25.5 | 36.0 | 120 | 80 | 220 | 20 | 732985 | 250 | 732985FE |
| CHROMABOND® Flash DL 200 | 20.0 | 60.0 | 200 | 150 | 410 | 10 | 732986 | 100 | 732986FE |
| CHROMABOND® Flash DL 330 | 27.0 | 60.0 | 330 | 250 | 600 | 10 | 732987 | 100 | 732987FE |

① CHROMABOND® Flash DL cartridge filled with sample on CHROMABOND® XTR on top of CHROMABOND® Flash RS or BT silica cartridge

② CHROMABOND® Flash BT cartridge partly filled with silica topped with sample on CHROMABOND® XTR

## Options for solid injection

The sample is dissolved in a suitable solvent and adsorbed onto CHROMABOND® XTR (diatomaceous earth, see page 63). After removal / evaporation of the residual solvent, the adsorbent is put on top of a partly filled CHROMABOND® Flash BT cartridge or into an empty CHROMABOND® Flash DL cartridge.

Our XTR adsorbents can be found on page 63.

## CHROMABOND® Flash FM solutions for FlashMaster™ instruments

### Key features

- Column connection:
  open-tubular inlet and male Luer outlet

### Recommended application

- Polypropylene cartridges designed for use in the Biotage® FlashMaster™ systems without additional connectors or capillaries

### Ordering information

| Description | Column length [cm] | ID [mm] | Adsorbent weight [g] | Pack of | REF |
|---|---|---|---|---|---|
| **CHROMABOND® Flash FM columns** | | | | | |
| Filled with standard silica, unmodified (SiOH) or endcapped octadecyl modified ($C_{18}$ ec), 40–63 µm, specific surface 500 $m^2/g$, pH stability 2–8 | | | | | |
| CHROMABOND® Flash FM 15/2 SiOH | 9.0 | 15.8 | 2.0 | 50 | 730881 |
| CHROMABOND® Flash FM 25/5 SiOH | 10.0 | 20.5 | 5.0 | 50 | 730891 |
| CHROMABOND® Flash FM 25/10 SiOH | 10.0 | 20.5 | 10.0 | 50 | 730666 |
| CHROMABOND® Flash FM 70/10 SiOH | 15.4 | 26.8 | 10.0 | 30 | 730885 |
| CHROMABOND® Flash FM 70/20 SiOH | 15.4 | 26.8 | 20.0 | 30 | 730915 |
| CHROMABOND® Flash FM 70/25 SiOH | 15.4 | 26.8 | 25.0 | 30 | 730892 |
| CHROMABOND® Flash FM 150/25 SiOH | 17.0 | 38.2 | 25.0 | 20 | 730667 |
| CHROMABOND® Flash FM 150/50 SiOH | 17.0 | 38.2 | 50.0 | 20 | 730887 |
| CHROMABOND® Flash FM 150/70 SiOH | 17.0 | 38.2 | 70.0 | 10 | 730880 |
| CHROMABOND® Flash FM 15/2 $C_{18}$ ec | 9.0 | 15.8 | 2.0 | 50 | 730890 |
| CHROMABOND® Flash FM 25/5 $C_{18}$ ec | 10.0 | 20.5 | 5.0 | 20 | 730884 |
| CHROMABOND® Flash FM 70/10 $C_{18}$ ec | 15.4 | 26.8 | 10.0 | 20 | 730886 |
| CHROMABOND® Flash FM 150/50 $C_{18}$ ec | 17.0 | 38.2 | 50.0 | 10 | 730888 |

On request, all column types listed above can be packed with any adsorbent from our program of CHROMABOND® adsorbents (starting from page 16). Please note that other packings often result in differing adsorbent weights.

Custom filling sizes are available on request.

# CHROMABOND® Flash connecting kits

CHROMABOND® Flash connecting kits allow to use CHROMABOND® Flash RS and BT cartridges as stand-alone system with any pump, detection, fraction collector combination.

REF 730798 CHROMABOND® Flash Starter Kit

Female Luer lock for column inlet

Male Luer lock for column exit

REF 732903 CHROMABOND® Flash Stand Alone Kit, Luer

## Ordering information

| Description | Pack of | REF |
|---|---|---|
| **CHROMABOND® Flash Starterkit** | | |
| consists of 1/8” PTFE tubing, 1.5 mm ID, 3 m long; 5 x 1/4”-28 PP nuts; 5 x 1/8” ETFE ferrules; 5 x 1/4”-28 nylon unions; 2 x 1/4”-28 PP Luer lock, female; 1 x 1/4”-28 PP Luer lock, male; 1 x 1/4”-28 PP Luer tip, male | 1 Kit | 730798 |
| **CHROMABOND® Flash “Stand Alone” Kit, Luer** | | |
| consists of 1 x 1/4”-28 PP Luer lock, female; 1 x 1/4”-28 PP Luer lock, male; 2 x 1/8” ETFE ferrules; 2 x 1/4”-28 nylon unions; 2 x 1/4”-28 PP nuts | 1 Kit | 732903 |

# Flash glass columns and accessories

## Glass columns and accessories for Flash chromatography

### Key features

- MN flash chromatography kits include a glass column, eluent reservoir, silica 60 and accessories. Glass columns of different sizes and accessories can be ordered separately.
- These columns are normally filled to a height of about 15 cm, working pressures are 1.5 to 2 bar.
- The most used adsorbent is silica 60 with particle size 40–63 µm (see page 259), however, you may also use our ranges of other LC adsorbents and of POLYGOPREP silica phases (see page 258). Particle sizes < 25 µm should only be used with very low-viscosity mobile phases, because otherwise flow rates will be very low.
- This columns are packed by the user.
- No expensive equipment required

### Recommended application

- Economic low-tech method for the synthesis laboratory
- Suited for the separation of compounds up to gram levels

### Ordering information

| Description | Pack of | REF |
|---|---|---|
| **Flash chromatography kits** | | |
| Flash chromatography kit I<br>consists of 1 glass column 20 mm ID x 400 mm length, one 1-L eluent reservoir, 100 g silica 60 (40–63 µm), sea sand, silanized glass fiber wadding, 1 m PTFE tubing | 1 kit | 727450 |
| Flash chromatography kit II<br>consists of 1 glass column 40 mm ID x 450 mm length, one 2-L eluent reservoir, 100 g silica 60 (40–63 µm), sea sand, silanized glass fiber wadding, 1 m PTFE tubing | 1 kit | 727451 |
| **Flash chromatography glass columns** | | |
| complete with adapter and PTFE tap, fitted with a polyethylene net to protect against bursting | | |
| 20 mm ID x 200 mm length | 1 column | 727400 |
| 20 mm ID x 400 mm length | 1 column | 727401 |
| 25 mm ID x 200 mm length | 1 column | 727402 |
| 25 mm ID x 400 mm length | 1 column | 727403 |
| 30 mm ID x 300 mm length | 1 column | 727404 |
| 30 mm ID x 400 mm length | 1 column | 727405 |
| 40 mm ID x 300 mm length | 1 column | 727406 |
| 40 mm ID x 450 mm length | 1 column | 727407 |
| **Accessories for flash chromatography glass columns** | | |
| 1-L eluent reservoir with adapter, covered with a protective plastic sleeve for burst protection; this also prevents build-up of UV-induced radicals in the eluent | 1 piece | 727420 |
| 2-L eluent reservoir as above | 1 piece | 727421 |
| Pressure gauge for controlling flow rates | 1 piece | 727422 |
| PTFE tubing, 3 mm OD, 2 mm ID, length 1 m | 1 m | 727424 |
| Sea sand, acid washed and calcined | 1 kg | 727423 |
| Glass fiber wadding, silanized | 25 g | 718002 |

CHROMAFIL®
MN
PET-

## Contents

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## Sample filtration

Syringe filters are used for filtration of suspended matter from liquid samples or gases. With CHROMAFIL® rapid purification and removal of particles is very simple: just place the filter on the syringe and you are ready for filtration. Special manipulations are not required. The contamination of sensitive instrumentation by solid impurities can be avoided, which leads to an increase of lifetime of chromatographic columns and equipment.

## Advantages

Polypropylene housing

- Considerably better solvent stability compared to acrylate and polystyrene filters, featuring a low content of extractable substances

Lowest content of extractable substances

- The housing of every CHROMAFIL® filter is ultrasonically sealed (welded), not glued, because glue may have extractable ingredients. Welding leads to a tight connection between both parts, thus the filter can be used in both directions. The special thick rim of the housing is ideal for use in laboratory robots (e.g., SOTAX®, Benchmate™).

Luer lock on the side of entry

- For a safe connection on the high-pressure side every filter provides a Luer lock on the side of entry.

Luer exit

- For 3, 13 and 25 mm filters: standard Luer exit
- For 15 mm filters: minispike · This Luer configuration offers a low hold-up volume and easy filtration into autosampler vials and NMR tubes.
- With the aid of a special adapter, filter inlet and filter exit can be fitted to all CHROMABOND® columns and accessories for selective sample preparation.

No rupture of membrane due to the impact plate

- The input solvent stream is broken and distributed by the impact plate and does not directly hit the membrane: this prevents rupture of the membrane. The high pressure stream is diverted into four lanes.

Optimum flow geometry because of the starshaped distribution device

- The stream of liquid is broken into 4 lanes by the impact plate and then further distributed to 8 slots in the form of a star connected with 5 or 8 circular channels (for 13, 15 and 25 mm filters, respectively). Thus, the fluid is able to penetrate the membrane on the whole surface, not only on a small region; the filter is not plugged up rapidly, which results in a high-flow efficiency.

Color coded filters

- Filters with 0.2 µm pores have a yellow upper shell, that of filters with 0.45 µm pores is colorless; the different membrane types are distinguished by different colors of the lower shell.

Different pore sizes for versatile filtration

- Standard pore sizes 0.2 and 0.45 µm (additionally: PET filters with 1.2 µm, glass fiber filters with 1 µm, PES filters with 5 µm). Filters with 0.45 µm pore size efficiently remove fine particles that can plug chromatography columns. Filters with 0.2 µm pore size are excellent for filtration of UHPLC samples or other techniques requiring high purity samples.

Filter sizes

- 3, 13, 15 and 25 mm diameter: the small diameter filters are especially recommended for very small samples, which require extremely low dead volumes: 5 µL for 3 mm Ø, 30 µL for 13 mm Ø, 35 µL for 15 mm Ø, 80 µL for 25 mm Ø

Recommended filter size depending on sample volume

| Sample volume | Recommended filter diameter |
|---|---|
| ≤ 1 mL | 3 mm |
| 1–5 mL | 13 mm, 15 mm |
| 5–100 mL | 25 mm |

Filters can be autoclaved at 121 °C, 1.1 bar for 30 min.

All 25 mm CHROMAFIL® filters are designed to be 100 % compatible and reliable for use with the SOTAX® AT70 smart fully automated dissolution testing systems.

Depending on your filtration task you can choose filter membranes made from different materials:

| Material | Page |
|---|---|
| Combi filters with glass fiber prefilters | |
| Polyester (GF/PET) | 85 |
| Regenerated cellulose (GF/RC) | 85 |
| Polyvinylidene difluoride (GF/PVDF) | 85 |
| Syringe filters without prefilters | |
| Polyester (PET) | 86 |
| Regenerated cellulose (RC) | 87 |
| Polytetrafluoroethylene (PTFE) | 88 |
| Hydrophilized polytetrafluoroethylene (H-PTFE) | 88 |
| Cellulose mixed esters (MV) | 89 |
| Cellulose acetate (CA) · sterile and non-sterile | 89 |
| Polyamide / Nylon (PA) | 90 |
| Polyethersulfone (PES) | 90 |
| Polyvinylidene difluoride (PVDF) | 91 |
| Glass fiber (GF) | 91 |
| Special filter for ion chromatography (IC) | 92 |

## CHROMAFIL® BIGbox

- 400 color-coded quality syringe filters or 400 labeled Xtra syringe filters (25 mm)
- Food safe PE box with screw cap

## CHROMAFIL® Xtra

Labeled for method validation and certification

Xtra: imprint for direct identification of the membrane type, diameter and pore size

Xtra: low bleeding PP housing

Xtra: color-free plain polypropylene

## CHROMAFIL® combi filters

Combi syringe filters with a coarse glass fiber prefilter and a small pore membrane as main filter

User benefits:

- For solutions with a high load of particulate matter: lower back pressure, easy filtration
- For high yields of filtrate: more mL of pure filtrate per filter

### The technology

The glass fiber membrane (1.0 µm) removes coarse particles, before they can block the fine main membrane. This results in a better filtration efficiency, especially for highly contaminated samples.

- Housing: Solvent-resistant, ultra low bleeding polypropylene
- Inlet: Luer lock
- Exit: Luer
- Pore size: 1.0 / 0.20 µm or 1.0 / 0.45 µm
- Filter diameter: 25 mm
- Dead volume: < 80 µL
- Packing unit: 100 filters; BIGbox with 400 filters

# Selection guide for syringe filters

## How to select the optimal CHROMAFIL® syringe filter

### 1. Filter size

| | | | |
|---|---|---|---|
| Sample volume | 5–100 mL | 1–5 mL | < 1 mL |
| Filter size | 25 mm | 13 mm, 15 mm | 3 mm |

### 2. Pore size of filter membrane

| | | |
|---|---|---|
| Sample size | For general purpose<br>HPLC columns packed with particles ≥ 3 µm, GC, SFC, ... | 0.45 µm |
| | Recommended for<br>UHPLC-, core-shell and HPLC columns, packed with particles ≤ 3 µm, GC, SFC, ... | 0.20 µm |

### 3. Membrane type

| Properties of sample | Recommended | Alternatives | | |
|---|---|---|---|---|
| Aqueous, polar hydrophilic | | | | |
| low particle-load | PET | H-PTFE | MV | RC |
| high particle-load<br>prefiltration required | GF/PET | GF/RC | GF/PVDF | |
| Mid-polar e.g. HPLC eluents | PET | PA | RC | |
| Proteins | | | | |
| low binding capacity of proteins | CA | PVDF | PES | |
| high binding capacity of proteins | GF | GF/PET | GF/PVDF | |
| Strong acids and bases | H-PTFE | PTFE | | |
| Organic, nonpolar, hydrophobic | | | | |
| low particle-load | PTFE | PET | | |
| high particle-load<br>prefiltration required | GF/PET | GF/PVDF | | |
| Aqueous, for ion chromatography determinations | IC | | | |

## MACHEREY-NAGEL
## FilterFinder · easy switching to first-class filters

### It is that simple

1. Choose previously used manufacturer
2. Choose previously used part number
3. Start searching
4. Suitable CHROMAFIL® syringe filter will be suggested

Use our FilterFinder online at *www.mn-net.com/filterfinder*

## Polyester with glass fiber prefilter (GF/PET)

### Key features

- Hydrophilic multipurpose membrane
- For polar as well as nonpolar samples
- The HPLC filter with glass fiber prefilter, especially suited for mixtures of water and organic solvents
- Recommended for solutions with a high load of particulate matter or for highly viscous samples. Glass fiber exhibits a high protein-binding capacity.

### Ordering information

| Type | Pore size [µm] | Membrane diameter [mm] | Color code | | Standard pack | | BIGbox | |
|---|---|---|---|---|---|---|---|---|
| | | | Top | Bottom | Filters/Pack | REF | Filters/Pack | REF |
| GF/PET-20/25 | 1.0/0.20 | 25 | blue | orange | 100 | 729032 | 400 | 729032.400 |
| GF/PET-45/25 | 1.0/0.45 | 25 | black | orange | 100 | 729033 | 400 | 729033.400 |

## Regenerated cellulose with glass fiber prefilter (GF/RC)

### Key features

- Hydrophilic membrane
- For aqueous and organic-aqueous liquids, i.e. polar and medium polar sample solutions
- Recommended for solutions with a high load of particulate matter or for highly viscous aqueous solutions. Glass fiber exhibits a high protein-binding capacity.

### Ordering information

| Type | Pore size [µm] | Membrane diameter [mm] | Color code | | Standard pack | | BIGbox | |
|---|---|---|---|---|---|---|---|---|
| | | | Top | Bottom | Filters/Pack | REF | Filters/Pack | REF |
| GF/RC-20/25 | 1.0/0.20 | 25 | blue | blue | 100 | 729050 | 400 | 729050.400 |
| GF/RC-45/25 | 1.0/0.45 | 25 | black | blue | 100 | 729051 | 400 | 729051.400 |

## Polyvinylidene difluoride with glass fiber prefilter (GF/PVDF)

### Key features

- Hydrophilic membrane
- Recommended for the filtration of biological samples with high particle loads. Glass fiber exhibits a high protein-binding capacity.
- Also suited for the filtration of aqueous samples

### Ordering information

| Type | Pore size [µm] | Membrane diameter [mm] | Color code | | Standard pack | | BIGbox | |
|---|---|---|---|---|---|---|---|---|
| | | | Top | Bottom | Filters/Pack | REF | Filters/Pack | REF |
| GF/P-45/25 | 1.0/0.45 | 25 | black | white | 100 | 729039 | 400 | 729039.400 |

# CHROMAFIL® syringe filters

## Polyester (PET)

### Key features

- Hydrophilic multipurpose membrane
- For polar as well as nonpolar solvents
- The HPLC filter, especially suited for mixtures of water and organic solvents
- For TOC/DOC determination
- Not cytotoxic, does not inhibit the growth of microorganisms and higher cells

### Ordering information

| Type | Pore size [µm] | Membrane diameter [mm] | | Standard pack | | BIGbox | |
|---|---|---|---|---|---|---|---|
| | | | | Filters/Pack | REF | Filters/Pack | REF |
| **CHROMAFIL® Xtra** | | | | | | | |
| PET-20/13 | 0.20 | 13 | labeled | 100 | 729222 | | |
| PET-45/13 | 0.45 | 13 | labeled | 100 | 729223 | | |
| PET-20/25 | 0.20 | 25 | labeled | 100 | 729221 | 400 | 729221.400 |
| PET-45/25 | 0.45 | 25 | labeled | 100 | 729220 | 400 | 729220.400 |
| PET-120/25 | 1.2 | 25 | labeled | 100 | 729229 | 400 | 729229.400 |

| Type | Pore size [µm] | Membrane diameter [mm] | Color code | | Standard pack | | BIGbox | |
|---|---|---|---|---|---|---|---|---|
| | | | Top | Bottom | Filters/Pack | REF | Filters/Pack | REF |
| **CHROMAFIL®** | | | | | | | | |
| PET-20/15 MS | 0.20 | 15 | yellow | orange | 100 | 729022 | | |
| PET-45/15 MS | 0.45 | 15 | colorless | orange | 100 | 729023 | | |
| PET-20/25 | 0.20 | 25 | yellow | orange | 100 | 729021 | 400 | 729021.400 |
| PET-45/25 | 0.45 | 25 | colorless | orange | 100 | 729020 | 400 | 729020.400 |

MS = minispike on filter exit

## Regenerated cellulose (RC)

### Key features

- Hydrophilic membrane with very low adsorption
- For aqueous and organic–aqueous liquids, i.e. polar and medium polar sample solutions
- Binding capacity for proteins 84 µg per 25 mm filter

### Ordering information

| Type | Pore size [µm] | Membrane diameter [mm] | | Standard pack | | BIGbox | |
|---|---|---|---|---|---|---|---|
| | | | | Filters/Pack | REF | Filters/Pack | REF |
| **CHROMAFIL® Xtra** | | | | | | | |
| RC-20/13 | 0.20 | 13 | labeled | 100 | 729236 | | |
| RC-45/13 | 0.45 | 13 | labeled | 100 | 729237 | | |
| RC-20/25 | 0.20 | 25 | labeled | 100 | 729230 | 400 | 729230.400 |
| RC-45/25 | 0.45 | 25 | labeled | 100 | 729231 | 400 | 729231.400 |

| Type | Pore size [µm] | Membrane diameter [mm] | Color code | | Standard pack | | BIGbox | |
|---|---|---|---|---|---|---|---|---|
| | | | Top | Bottom | Filters/Pack | REF | Filters/Pack | REF |
| **CHROMAFIL®** | | | | | | | | |
| RC-20/15 MS | 0.20 | 15 | yellow | blue | 100 | 729036 | | |
| RC-45/15 MS | 0.45 | 15 | colorless | blue | 100 | 729037 | | |
| RC-20/25 | 0.20 | 25 | yellow | blue | 100 | 729030 | 400 | 729030.400 |
| RC-45/25 | 0.45 | 25 | colorless | blue | 100 | 729031 | 400 | 729031.400 |

MS = minispike on filter exit

# CHROMAFIL® syringe filters

## Polytetrafluoroethylene (PTFE)

### Key features

- Hydrophobic membrane
- For nonpolar liquids and gases
- Very resistant towards all kinds of solvents as well as acids and bases
- Flushing with alcohol, followed by water, makes the originally hydrophobic membrane more hydrophilic

### Ordering information

| Type | Pore size [µm] | Membrane diameter [mm] | | Standard pack Filters/Pack | Standard pack REF | BIGbox Filters/Pack | BIGbox REF |
|---|---|---|---|---|---|---|---|
| **CHROMAFIL® Xtra** | | | | | | | |
| PTFE-20/13 | 0.20 | 13 | labeled | 100 | 729208 | | |
| PTFE-45/13 | 0.45 | 13 | labeled | 100 | 729209 | | |
| PTFE-20/25 | 0.20 | 25 | labeled | 100 | 729207 | 400 | 729207.400 |
| PTFE-45/25 | 0.45 | 25 | labeled | 100 | 729205 | 400 | 729205.400 |
| PTFE-100/25 | 1.0 | 25 | labeled | 100 | 729247 | | |

| Type | Pore size [µm] | Membrane diameter [mm] | Color code Top | Color code Bottom | Standard pack Filters/Pack | Standard pack REF | BIGbox Filters/Pack | BIGbox REF |
|---|---|---|---|---|---|---|---|---|
| **CHROMAFIL®** | | | | | | | | |
| O-20/3 | 0.20 | 3 | colorless | colorless | 100 | 729014 | | |
| O-45/3 | 0.45 | 3 | colorless | colorless | 100 | 729015 | | |
| O-20/15 MS | 0.20 | 15 | yellow | colorless | 100 | 729008 | | |
| O-45/15 MS | 0.45 | 15 | colorless | colorless | 100 | 729009 | | |
| O-20/25 | 0.20 | 25 | yellow | colorless | 100 | 729007 | 400 | 729007.400 |

MS = minispike on filter exit

## Hydrophilized polytetrafluoroethylene (H-PTFE)

### Key features

- Hydrophobic membrane with additional hydrophilic characteristic
- For polar and nonpolar solutions
- Resistant towards all kinds of solvents as well as acids and bases

### Ordering information

| Type | Pore size [µm] | Membrane diameter [mm] | | Standard pack Filters/Pack | Standard pack REF | BIGbox Filters/Pack | BIGbox REF |
|---|---|---|---|---|---|---|---|
| **CHROMAFIL® Xtra** | | | | | | | |
| H-PTFE-20/13 | 0.20 | 13 | labeled | 100 | 729256 | | |
| H-PTFE-45/13 | 0.45 | 13 | labeled | 100 | 729257 | | |
| H-PTFE-20/25 | 0.20 | 25 | labeled | 100 | 729245 | | |
| H-PTFE-45/25 | 0.45 | 25 | labeled | 100 | 729246 | 400 | 729246.400 |

## Cellulose mixed esters (MV)

### Key features

- Hydrophilic membrane with very low adsorption
- For aqueous or polar solutions

### Ordering information

| Type | Pore size [µm] | Membrane diameter [mm] | | Standard pack Filters/Pack | Standard pack REF | BIGbox Filters/Pack | BIGbox REF |
|---|---|---|---|---|---|---|---|
| **CHROMAFIL® Xtra** | | | | | | | |
| MV-20/25 | 0.20 | 25 | labeled | 100 | 729206 | | |
| MV-45/25 | 0.45 | 25 | labeled | 100 | 729204 | 400 | 729204.400 |

| Type | Pore size [µm] | Membrane diameter [mm] | Color code Top | Color code Bottom | Standard pack Filters/Pack | Standard pack REF | BIGbox Filters/Pack | BIGbox REF |
|---|---|---|---|---|---|---|---|---|
| **CHROMAFIL®** | | | | | | | | |
| A-20/25 | 0.20 | 25 | yellow | yellow | 100 | 729006 | 400 | 729006.400 |
| A-45/25 | 0.45 | 25 | colorless | yellow | 100 | 729004 | 400 | 729004.400 |

## Cellulose acetate (CA)

### Key features

- Hydrophilic membrane
- For the filtration of water-soluble oligomers and polymers, especially suited for biological macromolecules
- Very high shape stability in aqueous solutions
- Extremely low binding capacity for proteins (21 µg / 25 mm filter)
- Also available in a sterile package (S) for filtration under sterile conditions (each filter individually sealed)

### Ordering information

| Type | Pore size [µm] | Membrane diameter [mm] | | Standard pack Filters/Pack | Standard pack REF | BIGbox Filters/Pack | BIGbox REF |
|---|---|---|---|---|---|---|---|
| **CHROMAFIL® Xtra** | | | | | | | |
| CA-20/13 | 0.20 | 13 | labeled | 100 | 729254 | | |
| CA-45/13 | 0.45 | 13 | labeled | 100 | 729255 | | |
| CA-20/25 | 0.20 | 25 | labeled | 100 | 729226 | 400 | 729226.400 |
| CA-45/25 | 0.45 | 25 | labeled | 100 | 729227 | 400 | 729227.400 |

| Type | Pore size [µm] | Membrane diameter [mm] | Color code Top | Color code Bottom | Standard pack Filters/Pack | Standard pack REF | BIGbox Filters/Pack | BIGbox REF |
|---|---|---|---|---|---|---|---|---|
| **CHROMAFIL®** | | | | | | | | |
| CA-20/15 MS | 0.20 | 15 | yellow | red | 100 | 729054 | | |
| CA-45/15 MS | 0.45 | 15 | colorless | red | 100 | 729055 | | |
| CA-20/25 | 0.20 | 25 | yellow | red | 100 | 729026 | 400 | 729026.400 |
| CA-45/25 | 0.45 | 25 | colorless | red | 100 | 729027 | 400 | 729027.400 |
| Sterile filters | | | | | | | | |
| CA-20/25 (S) | 0.20 | 25 | yellow | red | 50 | 729024 | | |
| CA-45/25 (S) | 0.45 | 25 | colorless | red | 50 | 729025 | | |

MS = minispike on filter exit; S = sterile filters

# CHROMAFIL® syringe filters

## Polyamide (PA) = Nylon

### Key features

- Rather hydrophilic membrane
- For aqueous and organic–aqueous medium polar liquids

### Ordering information

| Type | Pore size [µm] | Membrane diameter [mm] | | Standard pack Filters/Pack | Standard pack REF | BIGbox Filters/Pack | BIGbox REF |
|---|---|---|---|---|---|---|---|
| **CHROMAFIL® Xtra** | | | | | | | |
| PA-20/13 | 0.20 | 13 | labeled | 100 | 729248 | | |
| PA-45/13 | 0.45 | 13 | labeled | 100 | 729249 | | |
| PA-20/25 | 0.20 | 25 | labeled | 100 | 729212 | 400 | 729212.400 |
| PA-45/25 | 0.45 | 25 | labeled | 100 | 729213 | 400 | 729213.400 |

| Type | Pore size [µm] | Membrane diameter [mm] | Color code Top | Color code Bottom | Standard pack Filters/Pack | Standard pack REF | BIGbox Filters/Pack | BIGbox REF |
|---|---|---|---|---|---|---|---|---|
| **CHROMAFIL®** | | | | | | | | |
| AO-20/3 | 0.20 | 3 | colorless | colorless | 100 | 729010 | | |
| AO-45/3 | 0.45 | 3 | colorless | colorless | 100 | 729011 | | |
| AO-20/15 MS | 0.20 | 15 | yellow | green | 100 | 729048 | | |
| AO-45/15 MS | 0.45 | 15 | colorless | green | 100 | 729049 | | |
| AO-20/25 | 0.20 | 25 | yellow | green | 100 | 729012 | 400 | 729012.400 |
| AO-45/25 | 0.45 | 25 | colorless | green | 100 | 729013 | 400 | 729013.400 |

MS = minispike on filter exit

## Polyethersulfone (PES)

### Key features

- Hydrophilic membrane
- For aqueous liquids and aqueous liquids with low organic contents
- Very low adsorption of pharmaceuticals and proteins
- Good stability against acids and bases
- Binding capacity for proteins 29 µg per 25 mm filter

### Ordering information

| Type | Pore size [µm] | Membrane diameter [mm] | | Standard pack Filters/Pack | Standard pack REF | BIGbox Filters/Pack | BIGbox REF |
|---|---|---|---|---|---|---|---|
| **CHROMAFIL® Xtra** | | | | | | | |
| PES-20/25 | 0.20 | 25 | labeled | 100 | 729240 | | |
| PES-45/25 | 0.45 | 25 | labeled | 100 | 729241 | 400 | 729241.400 |
| PES-500/25 | 5.0 | 25 | labeled | 100 | 729242 | | |

## Polyvinylidene difluoride (PVDF)

### Key features

- Hydrophilic membrane
- For 100 % aqueous samples, water-soluble oligomers and polymers like proteins
- Binding capacity for proteins 20 µg per 25 mm filter

### Ordering information

| Type | Pore size [µm] | Membrane diameter [mm] | | Standard pack Filters/Pack | Standard pack REF | BIGbox Filters/Pack | BIGbox REF |
|---|---|---|---|---|---|---|---|
| **CHROMAFIL® Xtra** | | | | | | | |
| PVDF-20/13 | 0.20 | 13 | labeled | 100 | 729243 | | |
| PVDF-45/13 | 0.45 | 13 | labeled | 100 | 729244 | | |
| PVDF-20/25 | 0.20 | 25 | labeled | 100 | 729218 | 400 | 729218.400 |
| PVDF-45/25 | 0.45 | 25 | labeled | 100 | 729219 | 400 | 729219.400 |

| Type | Pore size [µm] | Membrane diameter [mm] | Color code Top | Color code Bottom | Standard pack Filters/Pack | Standard pack REF |
|---|---|---|---|---|---|---|
| **CHROMAFIL®** | | | | | | |
| PVDF-20/15 MS | 0.20 | 15 | yellow | white | 100 | 729043 |
| PVDF-45/15 MS | 0.45 | 15 | colorless | white | 100 | 729044 |

MS = minispike on filter exit

## Glass fiber (GF)

### Key features

- Inert filter, nominal pore size 1 µm, allows higher flow rates than small pore filters
- For solutions with high loads of particulate matter or for highly viscous solutions (e.g., soil samples, fermentation broths). Glass fiber exhibits a high protein-binding capacity.
- As prefilters for other CHROMAFIL® filters, they prevent plugging of the membrane

### Ordering information

| Type | Pore size [µm] | Membrane diameter [mm] | | Standard pack Filters/Pack | Standard pack REF | BIGbox Filters/Pack | BIGbox REF |
|---|---|---|---|---|---|---|---|
| **CHROMAFIL® Xtra** | | | | | | | |
| GF-100/13 | nominal 1.0 | 13 | labeled | 100 | 729234 | | |
| GF-100/25 | nominal 1.0 | 25 | labeled | 100 | 729228 | 400 | 729228.400 |

| Type | Pore size [µm] | Membrane diameter [mm] | Color code Top | Color code Bottom | Standard pack Filters/Pack | Standard pack REF | BIGbox Filters/Pack | BIGbox REF |
|---|---|---|---|---|---|---|---|---|
| **CHROMAFIL®** | | | | | | | | |
| GF-100/15 MS | nominal 1.0 | 15 | blue | colorless | 100 | 729034 | | |
| GF-100/25 | nominal 1.0 | 25 | yellow | black | 100 | 729028 | 400 | 729028.400 |

MS = minispike on filter exit

# CHROMAFIL® syringe filters

## Special filter for ion chromatography (IC)

### Key features

- For the filtration of aqueous liquids
- For optimal results with blind values < 5 ppb we recommend to prewash the filter with deionized water

### Ordering information

| Type | Pore size [µm] | Membrane diameter [mm] | | Standard pack Filters/Pack | REF |
|---|---|---|---|---|---|
| **CHROMAFIL® Xtra** | | | | | |
| IC-45/25 | 0.45 | 25 | labeled | 100 | 729258 |

## Hints for using CHROMAFIL® syringe filters

For optimum filtration results we recommend to keep the following in mind:

- Either discard the first mL or rinse the filter unit with 1 mL of the solvent prior to filtration
- Before filling the syringe, draw about 1 mL air into the syringe in order to minimize the liquid remaining in the filter
- Start filtration with a slight pressure; this will optimize the throughput of the filter. As soon as particles accumulate on the filter, filtration will become more difficult and the pressure on the filter will increase.
- Change the filter whenever the resistance becomes too large in order to prevent rupture of the housing
- Do not apply CHROMAFIL® syringe filters on humans; they are only intended for lab use!
- Always use syringes ≥ 10 mL; smaller syringes can easily cause pressures above the 6 bar limit of the filters
- The temperature should not exceed 55 °C
- Do not re-use the filters

## Disposable syringes with Luer tip

### Key features

- Body and piston made from polypropylene (non sterile)

### Ordering information

| Volume | Pack of | REF |
|---|---|---|
| 2 mL | 100 | 729100 |
| 5 mL | 100 | 729101 |
| 10 mL | 100 | 729102 |

## Chemical compatibility of filter materials

The chemical compatibility depends on several parameters such as time, pressure, temperature and concentration. In most cases, CHROMAFIL® filters will have only short contact with a solvent. In these cases they may be used despite of limited compatibility.

For example, a PTFE filter with PP housing does not liberate any UV-detectable substances during filtration of 5 mL THF, although PP shows only limited resistance towards THF.
The following table lists the chemical compatibility of our CHROMAFIL® materials.

| Solvent | Material | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MV | CA | RC | PA | PTFE | H-PTFE | PVDF | PES | PET | GF | IC | PP |
| Acetaldehyde | – | – | + | O | + | + | + | | + | + | | O |
| Acetic acid, 100 % | – | – | – | – | + | + | + | + | + | + | | + |
| Acetone | – | – | + | + | + | + | – | – | + | + | | + |
| Acetonitrile | – | – | + | + | + | + | + | + | + | + | | + |
| Ammonia, 25 % | – | – | O | – | + | + | + | + | O | + | – | + |
| Benzene | + | + | + | + | + | + | O | + | + | + | | O |
| *n*-Butanol | + | + | + | O | + | + | + | + | + | + | | + |
| Cyclohexane | + | + | + | O | + | + | + | + | + | + | | + |
| Dichloromethane | + | – | + | – | + | + | + | – | + | + | | – |
| Diethyl ether | O | O | + | + | + | + | + | + | + | + | | O |
| Dimethylformamide | – | – | O | + | + | + | – | – | + | + | | + |
| 1,4–Dioxane | – | – | + | + | + | + | O | – | + | + | | O |
| Ethanol | – | + | + | + | + | + | + | + | + | + | | + |
| Ethyl acetate | – | – | + | + | + | + | + | + | + | + | | O |
| Ethylene glycol | O | O | + | + | + | + | + | + | + | + | | + |
| Formic acid, 100 % | + | – | O | – | + | + | + | + | O | + | | + |
| Hydrochloric acid, 30 % | – | – | – | – | + | + | + | + | – | + | – | + |
| Methanol | – | – | + | + | + | + | + | + | + | + | | + |
| Nitric acid, 65 % | – | – | – | – | O | + | O | | O | + | – | – |
| Oxalic acid, 10 % aqueous | + | – | + | – | + | + | + | | + | + | | + |
| Petroleum ether | + | + | + | + | + | + | + | + | + | + | | + |
| Phosphoric acid, 80 % | – | – | O | – | + | + | O | | + | + | – | + |
| Potassium hydroxide, 1 mol/L | – | – | O | + | + | + | O | O | O | + | + | + |
| 2–Propanol | + | + | + | + | + | + | + | + | + | + | | + |
| Sodium hydroxide, 1 mol/L | – | – | O | + | + | + | O | O | O | O | + | + |
| Tetrachloromethane | + | – | + | + | + | + | O | | + | + | | O |
| Tetrahydrofuran | – | – | + | O | + | + | + | – | + | + | | O |
| Toluene | + | – | + | + | + | + | + | + | + | + | | O |
| Trichloroethene | + | + | + | O | + | + | + | O | + | + | | O |
| Trichloromethane (chloroform) | + | – | + | – | + | + | + | – | + | + | | – |
| Urea | + | + | + | + | + | + | + | | + | + | | + |
| Water | + | + | + | + | + | + | + | + | + | + | + | + |
| Xylene | + | + | + | + | + | | O | O | + | + | | O |

Data not guaranteed.
+ resistant, – not resistant, O limited resistance

## Material

### Membranes

MV = cellulose mixed esters, CA = cellulose acetate, RC = regenerated cellulose, PA = polyamide,
PTFE = polytetrafluoroethylene, H-PTFE = hydrophilized polytetrafluoroethylene, PVDF = polyvinylidene difluoride, PES = polyethersulfone,
PET = polyester, GF = glass fiber, IC = special filter for ion chromatography

### Housing material

PP = polypropylene

## CHROMAFIL® filtration cartridges

### Key features

- Filtration cartridges for sample clarification under vacuum (e.g., using the CHROMABOND® vacuum manifold or SPE automation systems like Gilson ASPEC™, Rapidtrace®) or by gravity
- Cartridge sizes 3 mL and 6 mL
- Different membranes (PET, RC, PTFE, PVDF, GF) and pore sizes (0.2, 0.45 and 1.0 µm). Membrane materials correspond to the respective CHROMAFIL® syringe filters.

### Ordering information

| Description | Pore size [µm] | Pack of [cartridges] | Column volume | |
|---|---|---|---|---|
| | | | 3 mL | 6 mL |
| **CHROMAFIL® filtration cartridges** | | | | |
| Filtration cartridges PET (polyester) | 0.20 | 100 | 730578.320 | 730578.620 |
| Filtration cartridges PET (polyester) | 0.45 | 100 | 730578.345 | 730578.645 |
| Filtration cartridges RC (regenerated cellulose) | 0.20 | 100 | 730068.320 | 730068.620 |
| Filtration cartridges RC (regenerated cellulose) | 0.45 | 100 | 730068.345 | 730068.645 |
| Filtration cartridges PTFE (polytetrafluoroethylene) | 0.20 | 100 | 730570.320 | 730570.620 |
| Filtration cartridges PTFE (polytetrafluoroethylene) | 0.45 | 100 | 730570.345 | 730570.645 |
| Filtration cartridges PVDF (polyvinylidene difluoride) | 0.20 | 100 | 730579.320 | 730579.620 |
| Filtration cartridges PVDF (polyvinylidene difluoride) | 0.45 | 100 | 730579.345 | 730579.645 |
| Filtration cartridges GF (glass fiber) | nom. 1.0 | 100 | 730517.3100 | 730517.6100 |

## CHROMAFIL® MULTI 96 filter plates

### Key features

- 96-well polypropylene plates for the simultaneous filtration of 96 samples
- Advantages of this high-throughput system are:
  - Economical by saving time and solvent
  - The use of multi-channel pipetters facilitates liquid transfer steps
  - Readily adaptable to all common automated and robotic handling systems
  - Minimized dead volume (≤ 40 µL)
- Membrane materials correspond to the respective CHROMAFIL® syringe filters

### Ordering information

| Description | Pack of | REF |
|---|---|---|
| **CHROMAFIL® MULTI 96 Filter plates** | | |
| Filter plates with cellulose mixed ester filter elements (0.20 µm) | 1 | 738770.M |
| Filter plates with cellulose mixed ester filter elements (0.45 µm) | 1 | 738771.M |
| Filter plates with RC filter elements (regenerated cellulose 0.2 µm) | 1 | 738656.M |
| Filter plates with RC filter elements (regenerated cellulose 0.45 µm) | 1 | 738657.M |
| Filter plates with PTFE filter elements (0.2 µm) | 1 | 738660.M |
| Filter plates with PTFE filter elements (0.45 µm) | 1 | 738661.M |
| Filter plates with PTFE filter elements (1.0 µm) | 1 | 738662.M |
| Filter plates with PTFE filter elements (3.0 µm) | 1 | 738663.M |
| Filter plates with PE filter elements (20 µm) | 1 | 738655.M |
| Filter plates with PE filter elements (50 µm) | 1 | 738659.M |
| Filter plates with glass fiber filter elements (nominal 1 µm) | 1 | 738655.2M |
| Filter plates with glass fiber filter elements (nominal 3 µm) | 1 | 738658.M |
| CHROMABOND® MULTI 96 vacuum manifold for monoblocks, with reservoir tank, vacuum gauge and control valve, for filtration with 96-well filter plates | 1 | 738630.M |

MN

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### Technical data of vials

Except for the snap cap vials for storage of powdery samples and the blow-molded glass 70209.1, the vials of our program are made from 1st hydrolytic class glass. The dimensions stated in this catalog with respect to vial diameter and height are exact values. Please note that other suppliers often list rounded values (e.g., 12 x 32 mm instead of 11.6 x 32 mm), the actual dimensions are, however, identical due to the required fit in the instrument. Our data concerning the volume are defined realistically usable volumes, not calculated values. For reasons of safety we state rather low values. Here, too, deviations of data of other suppliers may occur, which either use the calculated volume (e.g., 2 mL instead of 1.5 mL) or a defined, realistically usable volume in the upper range (e.g., 1.8 mL instead of 1.5 mL). For suitability of certain vial types on instruments of the most important manufacturers please refer to the autosampler compatibility list at the end of this chapter.

### Closure selection in GC / HPLC

The choice of the best closure depends on certain features of the instrument (needle type / design, transportation mechanism of the autosampler, etc.) as well as on the requirements of the application (temperature, sensitivity of the analysis, single / multiple injections, etc.) and thus is more complicated and more individual than selection of the correct vial type.

Basically the following recommendations can be made:

- Due to the relatively thick and blunt HPLC needles, only Silicone / PTFE closures, either with or without slit, should be used in combination with them
- Screw closures N 9 are universally suitable on most autosamplers, convenient in handling and available in a broad selection of different cap colors and septum materials. They fulfill all requirements with regard to tightness and analytical purity for GC as well as for HPLC. Due to the relatively thin septa penetration is safe and easy. Crimp closures N 11 are also universally suitable with regard to autosampler compatibility, however, they are not as safe and convenient in their closing technique as the screw closures N 9.
- Snap ring closures N 11 should only be used in HPLC, as the punctual compacting pressure of the septum against the vial rim by the four pins in the cap does not achieve the same level of tightness as the evenly applied pressure through a circular thread or by crimping.
- For sensitive analyses only high purity Silicone / PTFE closures can be used; if additionally there is a need for minimal coring during penetration, a PTFE / Silicone / PTFE septum (sandwich septum) is recommendable.
- Cap colors may be used for marking (sample marking / lab marking / shift marking). However, please consider that some autosamplers work with photocells which may not be able to recognize transparent caps.
- For sample storage closed top screw closures (without center hole) should be used. Generally, these also need an elastomeric liner for sealing vials with liquid samples tightly.

- Due to their artificially reduced cap height screw caps N 9 don't have a standardized thread design. Therefore, it is recommendable only to use vials and closures from one source of supply, in order to ensure a harmonious and tight matching of both components.
- Replacement septa are partially available, however, in case of manual assembly you have the risk of contamination with skin fat / sweat and of a possible wrong side orientation. Therefore we highly recommend only to use ready assembled closures, where the liner perfectly matches the cap and has been automatically inserted under strict hygienic conditions.
- Normally ready assembled closures should be suitable for all types of needles, provided the proper type of septum has been selected. Nevertheless, there might be cases where usage of bonded closures (cap and liner form an inseparable unit) can be recommendable. Example: blunt HPLC needle, however, due to the risk of sample loss / concentration changes no septa with slit can be used. In order to avoid that the unslit septum is pushed into the vial by the needle, you use a bonded closure with unslit septum.
- The following table shows the different physical and chemical properties of the various elastomeric septa materials:

## Septa Guide

| | Temperature resistance from / to | Analytical purity | Fragmentation due to hardness and molecular structure (coring) | Hardness (needle penetration) | Resealability (in case of multiple injections) |
|---|---|---|---|---|---|
| PTFE virginal | –200 °C / 260 °C | very high | | very hard (but very thin material) | no resealability |
| Natural rubber / PTFE | –40 °C / 120 °C | low | high, big particles | very hard | high |
| Red Rubber / TEF (FEP) | –40 °C / 110 °C | medium | medium | medium hard | medium |
| Butyl | –40 °C / 120 °C | medium | medium | medium hard | medium |
| Butyl / PTFE | –40 °C / 120 °C | medium | medium | medium hard | medium |
| Silicone / PTFE | –60 °C / 200 °C | high | low to medium | soft | low to medium |
| PTFE / Silicone / PTFE | –60 °C / 200 °C | high | very low | soft | very low |

### Certificates

Upon request we can issue (batch related) certificates of conformity for all vials, inserts and closures, if this is required for your own ISO documentation.

### Samples

Sample packs of all vials and closures can be requested at any time. The sample packs contain 5 pieces of the respective product. These can be requested cost-free with the REF number of the respective product plus the addition ".MUSTER" (e.g., 1 x 70201HP.MUSTER = 1 sample pack with five vials of 70201HP).

Example for a sample pack with five vials

Example for a sample pack with five screw closures

### Packaging

Vials: normally packed with 100 pieces in a PP box, bottom part being shrink-wrapped

Closures: normally packed with 100 pieces in a resealable PE zip lock bag

Vial Kits with 100 vials and closures each (for all vials 11.6 x 32 mm)

## Literature

The following literature, which contains vials and caps, can be requested free of charge under the indicated KAT no.

Brochure vials and caps (English): KATEN200010
Link to the PDF download: *www.mn-net.com/vials*

Chromatography catalog (English): KATEN200001
Link to the PDF download: *www.mn-net.com* → Chromatography → Customer Services → Catalog download

Poster autosampler vials and caps (English): KATEN200086

Brochure crimping tools (English): KATEN200100
Link to the PDF download: *www.mn-net.com/vials* → Vial accessories

Poster "Optimal crimping" (German/English): KATDE/EN200153
Link to the PDF download: *www.mn-net.com/vials* → Vial accessories

## Website guide

| | |
|---|---|
| Up-dated product range vials and caps: | *www.mn-net.com/vials* |
| VialFinder as translation tool for cross-references: | *www.mn-net.com/vialfinder* |
| General literature on chromatography products (PDF download): | *www.mn-net.com/chroma* → Customer services → Catalog download |
| Instructions for manual crimping tools (PDF download): | *www.mn-net.com/manualcrimper* (left pane) |
| Instructions for electronic crimping tools (PDF download): | *www.mn-net.com/electroniccrimper* (left pane) |
| Current edition of the "Chroma-News" as well as their archive: | *www.mn-net.com/chroma* (right pane) |
| Decision tool for selecting the most optimal crimping tool for your own user profile (PDF download): | *www.mn-net.com/vials* → Vial accessories (containers, crimping tools) → blue marked link to PDF Download in the yellow box on top of the section |

### Translation tool for cross-references: the VialFinder at *www.mn-net.com/vialfinder*

The VialFinder is a database-driven translation tool for cross-references of instrument manufacturers and suppliers of consumables worldwide. The VialFinder immediately shows all options available from MACHEREY-NAGEL for the product of interest. The Finder shows 1:1 matches (in bold type) as well as possible alternative products (in normal type) that – in spite of technical differences to the indicated product – are suitable for the application. The corresponding link on the product description will lead you to the appropriate product page on our website that will give information on technical product features as well as possible illustrations of the product. In case you cannot find your part number via the VialFinder, please send your inquiry by e-mail to vials@mn-net.com providing us with all product information you may have. We will then check, if we can offer an equivalent product.

### Miscellaneous

Should you need more information concerning this product range, you can ask for our separate brochure "Vials and caps" (KATEN200010), which – among others – features 1:1 drawings of all glass products.

Except where explicitly mentioned, septa are assembled ready to use. Septa beneath or beside a cap are shown for illustration purposes only, and they are pictured upside down.

All drawings in this chapter are scale 1:2.

### General remarks

All information is subject to technical changes. All product data are subject to the currently valid specifications.

### Contacts

Aside from your known contacts of our sales team you can also contact product management for technical questions at: vials@mn-net.com

## Crimp neck vials and caps N 8

### Key features

- 0.2–0.8 mL usable volume
- Adapter required for use in an autosampler
- Available with flat, round or conical bottom
- Economic closure versions: three-layer septum Natural rubber / Butyl / TEF or two-layer septum Red Rubber / FEP
- For more demanding analyses: high purity Silicone / PTFE septa

## Ordering information

### Crimp neck vials N 8

70286

70282

70251

702002

(Illustrations scale 1:2)

| Type of vial | Usable volume | OD x height | Pack of | REF |
|---|---|---|---|---|
| Clear, conical | 0.2 mL | 5.5 x 31.5 mm | 100 | 70286 |
| Clear, round bottom | 0.3 mL | 5.5 x 31.5 mm | 100 | 70282 |
| Clear, flat bottom | 0.8 mL | 8.2 x 30 mm | 100 | 70251 |
| Clear, flat bottom | 0.7 mL | 7 x 40 mm | 100 | 702002 |

### Ready assembled crimp closures N 8 and plain crimp caps N 8

70283 | 70252.1 | 702025 | 70289 | 702878 | 702800

| Cap description | Septa description | Thickness | Pack of | REF |
|---|---|---|---|---|
| N 8 aluminium crimp cap, silver, center hole | PTFE virginal, white | 0.25 mm | 100 | 70283 |
| N 8 aluminium crimp cap, silver, center hole | Natural rubber / Butyl red-orange / TEF colorless | 1.0 mm | 100 | 70252.1 |
| N 8 aluminium crimp cap, silver, center hole | Red Rubber / FEP colorless | 1.0 mm | 100 | 702025 |
| N 8 aluminium crimp cap, silver, center hole | Silicone white / PTFE red | 1.0 mm | 100 | 70289 |
| N 8 aluminium crimp cap, silver, center hole | PTFE red / Silicone white / PTFE red | 1.0 mm | 100 | 702878 |
| N 8 aluminium crimp cap, silver, center hole | no liner | – | 100 | 702800 |

### Crimping tools N 8

| Description | Pack of | REF |
|---|---|---|
| Manual crimper (standard) for 8 mm aluminium crimp caps | 1 | 735126 |
| Manual decapper (standard) for 8 mm aluminium crimp caps | 1 | 735408 |
| Manual ergonomic crimper for 8 mm aluminium crimp caps | 1 | 735208 |

Manual crimper (standard)

Manual ergonomic crimper

## Screw neck vials and caps N 8

### Key features

- Are among the oldest vial types for HPLC and GC (besides crimp neck vials N 11)
- More and more replaced by screw neck vials N 9, which are easier to fill due to the wide opening compared to screw neck vials N 8 with small opening
- Due to the cap design not universally usable on all autosamplers in GC and HPLC – however, often used on instruments of VWR (Merck®) / Hitachi, Varian®, Knauer, Gilson®, Shimadzu® and others
- In combination with closed top screw closures also used for sample storage (see page 120)
- Now also available as practical Vial Kits with 100 vials and closures each

### Ordering information

### Screw neck vials N 8, small opening (8-425 thread), and compatible inserts

(Illustrations scale 1:2)

| Type of vial | Usable volume | OD x height | Pack of | REF |
|---|---|---|---|---|
| Clear, flat bottom | 1.5 mL | 11.6 x 32 mm | 100 | 70213 |
| Amber, flat bottom | 1.5 mL | 11.6 x 32 mm | 100 | 70213.2 |
| Clear, flat bottom, label and scale | 1.5 mL | 11.6 x 32 mm | 100 | 702004 |
| Amber, flat bottom, label and scale | 1.5 mL | 11.6 x 32 mm | 100 | 702893 |
| Insert for small opening vials, clear, conical, 15 mm tip | 0.1 mL | 5 x 31 mm | 100 | 702968* |
| Insert for small opening vials, clear, conical, 9 mm tip | 0.15 mL | 5 x 31 mm | 100 | 702968.1* |
| Metal spring for conical inserts 5 x 31 mm | – | – | 100 | 702974.1 |
| Insert for small opening vials, clear, with plastic spring | 0.1 mL | 5 x 29 mm | 100 | 702824 |
| Insert for small opening vials, clear, flat bottom | 0.25 mL | 5 x 31 mm | 100 | 702005 |
| Micro-vial, clear, conical | 1.1 mL | 11.6 x 32 mm | 100 | 702860 |

* Optionally you may use metal springs 702974.1 in combination with these products to push them up in the vial.

## Ordering information

### Ready assembled screw closures N 8 and plain screw caps N 8

| Cap description | Septa description | Thickness | Pack of | REF |
|---|---|---|---|---|
| N 8 PP screw cap, black, center hole | Red Rubber / FEP colorless | 1.3 mm | 100 | 702067 |
| as above, but with closed top | Red Rubber / FEP colorless | 1.3 mm | 100 | 702068 |
| N 8 PP screw cap, black, center hole | Silicone white / PTFE red | 1.3 mm | 100 | 70245 |
| as above, but with closed top | Silicone white / PTFE red | 1.3 mm | 100 | 702066 |
| N 8 PP screw cap, black, center hole | Silicone white / PTFE blue, slit | 1.0 mm | 100 | 702437 |
| N 8 PP screw cap, black, center hole | PTFE red / Silicone white / PTFE red | 1.0 mm | 100 | 702069 |
| N 8 PP screw cap, black, center hole | no liner | – | 100 | 70249 |
| as above, but with closed top | no liner | – | 100 | 70250 |

### N 8 Septa for screw caps N 8

| Material | Illustration | Thickness | Pack of | REF |
|---|---|---|---|---|
| Septum N 8, PTFE virginal, white | | 0.25 mm | 100 | 70261 |
| Septum N 8, Red Rubber / FEP colorless | | 1.3 mm | 100 | 702070 |
| Septum N 8, Silicone white / PTFE red | | 1.3 mm | 100 | 70248 |
| Septum N 8, Silicone white / PTFE blue, slit | | 1.0 mm | 100 | 702481 |

### Vial Kits screw neck N 8

Packs of 100 vials and 100 closures, each

| Closure → | 70245 | 702437 | 702067 |
|---|---|---|---|
| Vial ↓ | | | |
| 70213:<br>1.5 mL, clear, flat bottom | 702238 | 702247 | 702246 |
| 70213.2:<br>1.5 mL, amber, flat bottom | 702249 | 702251 | 702248 |

Other Vial Kits on request.

# Screw neck vials and caps N 9

## Screw neck vials and caps N 9

### Key features

- Can be used on almost all HPLC and GC autosamplers
- Large range of vials and closures
- Also available as bonded closures (advantage: thick (blunt) HPLC needles cannot push the septum into the vial)
- Also available as convenient Vial Kits with 100 vials and 100 caps and as presealed vial-closure combinations
- Now also 1.5 mL polypropylene vials N 9 for special applications (e.g., IC, CE, etc.)

## Ordering information

### Screw neck vials N 9, wide opening (short thread), and compatible inserts

| 702282 | 702293 | 702283 silanized 702078 | 702284 silanized 702079 | 702500 | 702813 silanized 702077 | 702716 | 702818 silanized 702818.1 | 702825 |
|---|---|---|---|---|---|---|---|---|

(Illustrations scale 1:2)

| Type of vial | Usable volume | OD x height | Pack of | REF |
|---|---|---|---|---|
| Clear, flat bottom | 1.5 mL | 11.6 x 32 mm | 100 | 702282 |
| Amber, flat bottom | 1.5 mL | 11.6 x 32 mm | 100 | 702293 |
| Clear, flat bottom, label and scale | 1.5 mL | 11.6 x 32 mm | 100 | 702283 |
| as above, silanized | 1.5 mL | 11.6 x 32 mm | 100 | 702078 |
| Amber, flat bottom, label and scale | 1.5 mL | 11.6 x 32 mm | 100 | 702284 |
| as above, silanized | 1.5 mL | 11.6 x 32 mm | 100 | 702079 |
| Polypropylene, transparent, with filling lines | 1.5 mL | 11.6 x 32 mm | 100 | 702500 |
| Insert for wide opening vials, clear, conical, 15 mm tip | 0.2 mL | 6 x 31 mm | 100 | 702813 |
| as above, silanized | 0.2 mL | 6 x 31 mm | 100 | 702077 |
| Insert for wide opening vials, clear, conical, 12 mm tip | 0.25 mL | 6 x 31 mm | 100 | 702716 |
| Insert for wide opening vials, clear, with plastic spring | 0.1 mL | 5.7 x 29 mm | 100 | 702818 |
| as above, silanized | 0.1 mL | 5.7 x 29 mm | 100 | 702818.1 |
| Insert for wide opening vials, clear, flat bottom | 0.3 mL | 6 x 31 mm | 100 | 702825 |

## Ordering information

### Screw neck micro-vials N 9, wide opening (short thread)

(Illustrations scale 1:2)

| Type of vial | Usable volume | OD x height | Pack of | REF |
|---|---|---|---|---|
| Micro-vial, clear, 15 µL funnel in solid glass bottom | 1.1 mL | 11.6 x 32 mm | 100 | 702006 |
| Micro-vial, clear, conical, with round pedestal glass plate | 1.1 mL | 11.6 x 32 mm | 100 | 702088 |
| Micro-vial, clear, with integrated 0.2 mL insert | 0.2 mL | 11.6 x 32 mm | 100 | 702007 |
| Micro-vial, amber, with integrated 0.2 mL insert | 0.2 mL | 11.6 x 32 mm | 100 | 702008 |
| Micro-vial, polypropylene, transparent, with integrated 0.2 mL glass insert, conical | 0.2 mL | 11.6 x 32 mm | 100 | 702135* |
| Micro-vial, polypropylene, amber, with integrated 0.2 mL glass insert, conical | 0.2 mL | 11.6 x 32 mm | 100 | 702335* |
| Micro-vial, polypropylene, transparent, with inner cone | 0.3 mL | 11.6 x 32 mm | 100 | 702009 |
| Micro-vial, polypropylene, amber, with inner cone | 0.3 mL | 11.6 x 32 mm | 100 | 702172 |
| Micro-vial, polypropylene, transparent, with round bottom insert | 0.7 mL | 11.6 x 32 mm | 100 | 702010 |

* upon request also available with an integrated silanized glass insert

### Pre-assembled vial-insert combinations with screw neck N 9

| Vial description | Insert description | Pack of | REF |
|---|---|---|---|
| Vial 702282: 1.5 mL, clear, flat bottom | with pre-assembled micro-insert 702813: 0.2 mL, conical, 15 mm tip | 100 | 702177 |
| Vial 702283: 1.5 mL, clear, flat bottom, label and scale | with pre-assembled micro-insert 702813: 0.2 mL, conical, 15 mm tip | 100 | 702178 |
| Vial 702284: 1.5 mL, amber, flat bottom, label and scale | with pre-assembled micro-insert 702813: 0.2 mL, conical, 15 mm tip | 100 | 702179 |

Further pre-assembled vial-insert combinations on request

### Bonded screw closures N 9 (septum firmly connected with the cap; cannot be removed)

| Cap description | Septa description | Thickness | Pack of | REF |
|---|---|---|---|---|
| N 9 PP bonded screw cap, blue, center hole | Red Rubber / TEF colorless | 1.0 mm | 100 | 702028 |
| N 9 PP bonded screw cap, blue, center hole | Silicone beige / PTFE white | 1.3 mm | 100 | 702026 |
| N 9 PP bonded screw cap, blue, center hole | Silicone beige / PTFE white, slit | 1.3 mm | 100 | 702027 |

# Screw neck vials and caps N 9

## Ordering information

### Ready assembled screw closures N 9

| Cap description | Septa description | Thickness | Pack of | REF |
|---|---|---|---|---|
| N 9 PP screw cap, transparent, center hole | PTFE virginal, white | 0.25 mm | 100 | 702029 |
| N 9 PP screw cap, blue, center hole | PTFE virginal, white | 0.25 mm | 100 | 702031 |
| N 9 PP screw cap blue, closed top | PTFE virginal, white | 0.25 mm | 100 | 702032 |

| Cap description | Septa description | Thickness | Pack of | REF |
|---|---|---|---|---|
| N 9 PP screw cap, transparent, center hole | Red Rubber / FEP colorless | 1.0 mm | 100 | 702030 |
| N 9 PP screw cap, blue, center hole | Red Rubber / FEP colorless | 1.0 mm | 100 | 702732 |
| N 9 PP screw cap, black, center hole | Red Rubber / FEP colorless | 1.0 mm | 100 | 702080 |
| N 9 PP screw cap, red, center hole | Red Rubber / FEP colorless | 1.0 mm | 100 | 702081 |
| N 9 PP screw cap, green, center hole | Red Rubber / FEP colorless | 1.0 mm | 100 | 702082 |
| N 9 PP screw cap, yellow, center hole | Red Rubber / FEP colorless | 1.0 mm | 100 | 702147 |
| N 9 PP screw cap blue, closed top | Red Rubber / FEP colorless | 1.0 mm | 100 | 702033 |

| Cap description | Septa description | Thickness | Pack of | REF |
|---|---|---|---|---|
| N 9 PP screw cap, transparent, center hole | Silicone white / PTFE red | 1.0 mm | 100 | 702287 |
| N 9 PP screw cap, blue, center hole | Silicone white / PTFE red | 1.0 mm | 100 | 702287.1 |
| N 9 PP screw cap, black, center hole | Silicone white / PTFE red | 1.0 mm | 100 | 702036 |
| N 9 PP screw cap, red, center hole | Silicone white / PTFE red | 1.0 mm | 100 | 702037 |
| N 9 PP screw cap, green, center hole | Silicone white / PTFE red | 1.0 mm | 100 | 702038 |
| N 9 PP screw cap, yellow, center hole | Silicone white / PTFE red | 1.0 mm | 100 | 702107 |
| N 9 magnetic screw cap, silver, center hole | Silicone white / PTFE red | 1.0 mm | 100 | 702155 |
| N 9 PP screw cap blue, closed top | Silicone white / PTFE red | 1.0 mm | 100 | 702034 |

| Cap description | Septa description | Thickness | Pack of | REF |
|---|---|---|---|---|
| N 9 PP screw cap, transparent, center hole | Silicone white / PTFE blue, slit | 1.0 mm | 100 | 702288 |
| N 9 PP screw cap, blue, center hole | Silicone white / PTFE blue, slit | 1.0 mm | 100 | 702288.1 |
| N 9 PP screw cap, black, center hole | Silicone white / PTFE blue, slit | 1.0 mm | 100 | 702039 |
| N 9 PP screw cap, red, center hole | Silicone white / PTFE blue, slit | 1.0 mm | 100 | 702040 |
| N 9 PP screw cap, green, center hole | Silicone white / PTFE blue, slit | 1.0 mm | 100 | 702083 |
| N 9 PP screw cap, yellow, center hole | Silicone white / PTFE blue, slit | 1.0 mm | 100 | 702109 |

| Cap description | Septa description | Thickness | Pack of | REF |
|---|---|---|---|---|
| N 9 PP screw cap, transparent, center hole | PTFE red / Silicone white / PTFE red | 1.0 mm | 100 | 702286 |
| N 9 PP screw cap, blue, center hole | PTFE red / Silicone white / PTFE red | 1.0 mm | 100 | 702035 |
| N 9 PP screw cap, black, center hole | PTFE red / Silicone white / PTFE red | 1.0 mm | 100 | 702158 |
| N 9 PP screw cap, red, center hole | PTFE red / Silicone white / PTFE red | 1.0 mm | 100 | 702084 |
| N 9 PP screw cap, green, center hole | PTFE red / Silicone white / PTFE red | 1.0 mm | 100 | 702085 |
| N 9 PP screw cap, yellow, center hole | PTFE red / Silicone white / PTFE red | 1.0 mm | 100 | 702159 |

| Cap description | Septa description | Thickness | Pack of | REF |
|---|---|---|---|---|
| N 9 PP screw cap, transparent, center hole | no liner | – | 100 | 702160 |
| N 9 PP screw cap, blue, center hole | no liner | – | 100 | 702161 |
| N 9 PP screw cap, black, center hole | no liner | – | 100 | 702162 |
| N 9 PP screw cap, red, center hole | no liner | – | 100 | 702163 |
| N 9 PP screw cap, green, center hole | no liner | – | 100 | 702164 |
| N 9 PP screw cap, yellow, center hole | no liner | – | 100 | 702165 |

## Ordering information

### N 9 septa for screw caps N 9

| Material | Illustration | Thickness | Pack of | REF |
|---|---|---|---|---|
| PTFE virginal, white | | 0.25 mm | 100 | 702043 |
| Red Rubber / FEP colorless | | 1.0 mm | 100 | 702041 |
| Silicone white / PTFE red | | 1.0 mm | 100 | 702042 |
| Silicone white / PTFE blue, slit | | 1.0 mm | 100 | 702148 |

### Vial Kits screw neck N 9

Packs of 100 vials and 100 closures, each

| Closure → / Vial ↓ | 702287.1 | 702288.1 | 702732 | 702026 | 702027 |
|---|---|---|---|---|---|
| 702282:<br>1.5 mL, clear, flat bottom | 702201 | 702204 | 702207 | | 702244 |
| 702283:<br>1.5 mL, clear, flat bottom, label and scale | 702202 | 702205 | 702208 | 702211 | 702213 |
| 702284:<br>1.5 mL, amber, flat bottom, label and scale | 702203 | 702206 | 702209 | 702212 | 702214 |
| 702009:<br>0.3 mL, PP, transparent, with inner cone | | 702226 | | | |

Other Vial Kits on request.

Vial Kit with screw neck vials and closures N 9

Pre-sealed vial-closure combination

## Ordering information

### Pre-sealed vial-closure combinations with screw neck N 9

| Vial description | Closure description | Pack of | REF |
|---|---|---|---|
| Pre-sealed vials 702282:<br>1.5 mL screw neck vial N 9, 11.6 x 32 mm,<br>clear, flat bottom, wide opening | pre-screwed with 702732:<br>N 9 PP screw cap, blue, center hole,<br>Red Rubber/FEP colorless, 1.0 mm | 100 | 702857 |
| Pre-sealed vials 702283:<br>1.5 mL screw neck vial N 9, 11.6 x 32 mm,<br>clear, flat bottom, wide opening, label and scale | pre-screwed with 702732:<br>N 9 PP screw cap, blue, center hole,<br>Red Rubber/FEP colorless, 1.0 mm | 100 | 702858 |
| Pre-sealed vials 702282:<br>1.5 mL screw neck vial N 9, 11.6 x 32 mm,<br>clear, flat bottom, wide opening | pre-screwed with 702287.1:<br>N 9 PP screw cap, blue, center hole,<br>Silicone white/PTFE red, 1.0 mm | 100 | 702874 |
| Pre-sealed vials 702283:<br>1.5 mL screw neck vial N 9, 11.6 x 32 mm,<br>clear, flat bottom, wide opening, label and scale | pre-screwed with 702288.1:<br>N 9 PP screw cap, blue, center hole,<br>Silicone white/PTFE blue, slit, 1.0 mm | 100 | 702863 |
| Pre-sealed vials 702284:<br>1.5 mL screw neck vial N 9, 11.6 x 32 mm,<br>amber, flat bottom, wide opening, label and scale | pre-screwed with 702288.1:<br>N 9 PP screw cap, blue, center hole,<br>Silicone white/PTFE blue, slit, 1.0 mm | 100 | 702873 |
| Pre-sealed vials 702283:<br>1.5 mL screw neck vial N 9, 11.6 x 32 mm,<br>clear, flat bottom, wide opening, label and scale | pre-screwed with 702026:<br>N 9 PP bonded screw cap, blue, center hole,<br>Silicone beige / PTFE white, 1.3 mm | 100 | 702864 |

Other pre-sealed vial-closure combinations on request.

# Screw neck vials and caps N 10

## Screw neck vials and caps N 10

### Key features

- Wide opening for easy filling
- Due to the cap height not universally suitable for all instruments
- Large range of bonded screw closures for a safe penetration (septa firmly connected with the cap; cannot be removed)
- Often used on Jasco, Shimadzu® and PerkinElmer® instruments
- On request also available as convenient Vial Kits with 100 vials and 100 caps

## Ordering information

### Screw neck vials N 10, wide opening (10-425 thread), and compatible inserts

(Illustrations scale 1:2)

| Type of vial | Usable volume | OD x height | Pack of | REF |
|---|---|---|---|---|
| Clear, flat bottom | 1.5 mL | 11.6 x 32 mm | 100 | 702011 |
| Clear, flat bottom, label and scale | 1.5 mL | 11.6 x 32 mm | 100 | 702012 |
| Amber, flat bottom, label and scale | 1.5 mL | 11.6 x 32 mm | 100 | 702013 |
| Insert for wide opening vials, clear, conical, 15 mm tip | 0.2 mL | 6 x 31 mm | 100 | 702813 |
| as above, silanized | 0.2 mL | 6 x 31 mm | 100 | 702077 |
| Insert for wide opening vials, clear, conical, 12 mm tip | 0.25 mL | 6 x 31 mm | 100 | 702716 |
| Insert for wide opening vials, clear, with plastic spring | 0.1 mL | 5.7 x 29 mm | 100 | 702818 |
| as above, silanized | 0.1 mL | 5.7 x 29 mm | 100 | 702818.1 |
| Insert for wide opening vials, clear, flat bottom | 0.3 mL | 6 x 31 mm | 100 | 702825 |

### Screw closures N 10 and plain screw caps N 10

| Cap description | Septa description | Thickness | Pack of | REF |
|---|---|---|---|---|
| N 10 PP bonded screw cap*, black, center hole | Red Rubber / TEF colorless | 1.0 mm | 100 | 702044 |
| N 10 PP bonded screw cap*, black, center hole | Silicone white / PTFE beige | 1.5 mm | 100 | 702045 |
| N 10 PP bonded screw cap*, black, center hole | Silicone white / PTFE red | 1.0 mm | 100 | 702046 |
| N 10 PP bonded screw cap*, black, center hole | Silicone white / PTFE blue, slit | 1.5 mm | 100 | 702047 |
| N 10 PP screw cap, black, center hole | PTFE red / Silicone white / PTFE red | 1.0 mm | 100 | 702048 |
| N 10 PP screw cap, black, center hole | no liner | – | 100 | 702049 |

* Septum firmly connected with the cap, cannot be removed.

## Crimp neck vials and caps N 11

### Key features

- Broad variety of standard crimp neck vials (with small or wide opening), as well as crimp neck micro-vials for smaller sample volumes
- Economic closures: Natural rubber / TEF (2 layers), Natural rubber / Butyl / TEF (3 layers) and Red Rubber / FEP (2 layers)
- For more demanding analyses: analytically pure Silicone / PTFE septa with lower fragmentation
- Magnetic closure: REF 702879 for use on CTC GC PAL
- Manual and electronic crimping tools for vials N 11 can be found on pages 113 and 134–135

### Ordering information

### Crimp neck vials N 11, small opening, and compatible inserts

70201CG 70214CG 702968 702968.1 702824 702005

(Illustrations scale 1:2)

| Type of vial | Usable volume | OD x height | Pack of | REF |
|---|---|---|---|---|
| Clear, flat bottom, small opening | 1.5 mL | 11.6 x 32 mm | 100 | 70201CG |
| Amber, flat bottom, small opening | 1.5 mL | 11.6 x 32 mm | 100 | 70214CG |
| Insert for small opening vials, clear, conical, 15 mm tip | 0.1 mL | 5 x 31 mm | 100 | 702968* |
| Insert for small opening vials, clear, conical, 9 mm tip | 0.15 mL | 5 x 31 mm | 100 | 702968.1* |
| Insert for small opening vials, clear, with plastic spring | 0.1 mL | 5 x 29 mm | 100 | 702824 |
| Insert for small opening vials, clear, flat bottom | 0.25 mL | 5 x 31 mm | 100 | 702005 |

* Optionally you may use metal springs 702974.1 in combination with these products to push them up in the vial.

## MACHEREY-NAGEL CHROMABOND® QuEChERS

### The “Quick Easy Cheap Effective Rugged Safe” method

- High throughput, because of an easy handling and time-saving procedure
- Useful for sample preparation of many pesticides (“multi method”)
- Broad range of applications for different food
- Low solvent amounts
- High reproducibility and recovery rates
- No need for chlorinated solvents

More information from page 57 onwards as well as online at *www.mn-net.com/quechers*

# Crimp neck vials and caps N 11

## Crimp neck vials N 11, wide opening, and compatible inserts

(Illustrations scale 1:2)

| Type of vial | Usable volume | OD x height | Pack of | REF |
|---|---|---|---|---|
| Clear, flat bottom, wide opening | 1.5 mL | 11.6 x 32 mm | 100 | 70201HP |
| Amber, flat bottom, wide opening | 1.5 mL | 11.6 x 32 mm | 100 | 70201HP.2 |
| Clear, flat bottom, wide opening, label and scale | 1.5 mL | 11.6 x 32 mm | 100 | 702885 |
| as above, silanized | 1.5 mL | 11.6 x 32 mm | 100 | 702075 |
| Amber, flat bottom, wide opening, label and scale | 1.5 mL | 11.6 x 32 mm | 100 | 702892 |
| as above, silanized | 1.5 mL | 11.6 x 32 mm | 100 | 702076 |
| Insert for wide opening vials, clear, conical, 15 mm tip | 0.2 mL | 6 x 31 mm | 100 | 702813 |
| as above, silanized | 0.2 mL | 6 x 31 mm | 100 | 702077 |
| Insert for wide opening vials, clear, conical, 12 mm tip | 0.25 mL | 6 x 31 mm | 100 | 702716 |
| Insert for wide opening vials, clear, with plastic spring | 0.1 mL | 5.7 x 29 mm | 100 | 702818 |
| as above, silanized | 0.1 mL | 5.7 x 29 mm | 100 | 702818.1 |
| Insert for wide opening vials, clear, flat bottom | 0.3 mL | 6 x 31 mm | 100 | 702825 |

## Optimal crimping

### For an optimal crimp result the crimping tool needs to be adjusted to:

- Type and height of the vial's crimp neck
- Thickness and hardness of the septa
- Properties of the cap (type, material)

For doing so, please refer to the instruction manual of the individual tool.

Permanent control of the crimp result and thus of the crimping tool settings is necessary.

### Incorrect crimping can be recognized by the following features:

Cap deformation

Pulled up edge of the center hole

Strong formation of wrinkles

Convex looking liner

Cap can be turned with only low expenditure of power

## Ordering information

### Crimp neck micro-vials N 11

(Illustrations scale 1:2)

| Type of vial | Usable volume | OD x height | Pack of | REF |
|---|---|---|---|---|
| Micro-vial, clear, flat bottom<br>15 µL funnel in solid glass bottom | 1.1 mL | 11.6 x 32 mm | 100 | 702888 |
| Micro-vial, clear, conical, with round pedestal glass plate | 1.1 mL | 11.6 x 32 mm | 100 | 702015 |
| Micro-vial, amber, conical, with round pedestal glass plate | 1.1 mL | 11.6 x 32 mm | 100 | 702016 |
| Micro-vial, clear, conical | 1.1 mL | 11.6 x 32 mm | 100 | 702141 |
| Micro-vial, clear, with integrated 0.2 mL insert | 0.2 mL | 11.6 x 32 mm | 100 | 702891 |
| Micro-vial, amber, with integrated 0.2 mL insert | 0.2 mL | 11.6 x 32 mm | 100 | 702014 |
| Micro-vial, polypropylene, transparent,<br>with integrated 0.2 mL glass insert, conical | 0.2 mL | 11.6 x 32 mm | 100 | 702134* |
| Micro-vial, polypropylene, amber,<br>with integrated 0.2 mL glass insert, conical | 0.2 mL | 11.6 x 32 mm | 100 | 702334* |
| Micro-vial, polypropylene, transparent, with inner cone | 0.3 mL | 11.6 x 32 mm | 100 | 702809 |
| Micro-vial, polypropylene, amber, with inner cone | 0.3 mL | 11.6 x 32 mm | 100 | 702173 |
| Micro-vial, polypropylene, transparent, with round bottom insert | 0.7 mL | 11.6 x 32 mm | 100 | 702174 |

* upon request also available with an integrated silanized glass insert

### Ready assembled aluminium crimp closures N 11

| Cap description | Septa description | Thickness | Pack of | REF |
|---|---|---|---|---|
| N 11 aluminium crimp cap, silver, center hole | Natural rubber / Butyl red-orange / TEF colorless | 1.3 mm | 100 | 70231 |
| N 11 aluminium crimp cap, silver, center hole | Natural rubber red-orange / TEF colorless | 1.0 mm | 100 | 702001 |
| N 11 aluminium crimp cap, silver, center hole | Red Rubber / FEP colorless | 1.0 mm | 100 | 702730 |
| N 11 aluminium crimp cap, green, center hole | as above | 1.0 mm | 100 | 702730.1 |
| N 11 aluminium crimp cap, red, center hole | as above | 1.0 mm | 100 | 702730.2 |
| N 11 aluminium crimp cap, blue, center hole | as above | 1.0 mm | 100 | 702730.3 |
| N 11 aluminium crimp cap, silver, center hole | Natural rubber / Butyl red-orange / TEF colorless | 1.0 mm | 100 | 70256 |
| N 11 aluminium crimp cap, green, center hole | as above | 1.0 mm | 100 | 70231.1 |
| N 11 aluminium crimp cap, red, center hole | as above | 1.0 mm | 100 | 70231.2 |
| N 11 aluminium crimp cap, blue, center hole | as above | 1.0 mm | 100 | 70231.3 |
| N 11 aluminium crimp cap, gold, center hole | as above | 1.0 mm | 100 | 70231.4 |
| N 11 aluminium crimp cap, silver, center hole | PTFE gray / Butyl beige / PTFE gray | 1.3 mm | 100 | 70239 |
| N 11 aluminium crimp cap, silver, center hole | Silicone white / PTFE red | 1.3 mm | 100 | 70288 |
| N 11 aluminium crimp cap, green, center hole | as above | 1.3 mm | 100 | 70288.1 |
| N 11 aluminium crimp cap, red, center hole | as above | 1.3 mm | 100 | 70288.2 |
| N 11 aluminium crimp cap, blue, center hole | as above | 1.3 mm | 100 | 70288.3 |
| N 11 aluminium crimp cap, silver, center hole | Silicone white / PTFE blue, cross-slit | 1.5 mm | 100 | 702823* |

| | | | |
|---|---|---|---|
| N 11 PE cap, transparent, closed top, with thin piercing area | | 100 | 702401 |

* upon request also available with a green, red or a blue crimp cap

# Crimp neck vials and caps N 11

## Ordering information

### Ready assembled crimp closures N 11

| Cap description | Septa description | Thickness | Pack of | REF |
|---|---|---|---|---|
| N 11 aluminium crimp cap, silver, center hole | PTFE red / Silicone white / PTFE red | 1.0 mm | 100 | 702995 |
| N 11 aluminium crimp cap, green, center hole | as above | 1.0 mm | 100 | 702995.1 |
| N 11 aluminium crimp cap, red, center hole | as above | 1.0 mm | 100 | 702995.2 |
| N 11 aluminium crimp cap, blue, center hole | as above | 1.0 mm | 100 | 702995.3 |
| N 11 aluminium crimp cap, silver, center hole | Viton black | 1.0 mm | 100 | 702146 |
| N 11 magnetic crimp cap, gold, center hole | Silicone white / PTFE red | 1.0 mm | 100 | 702879 |
| N 11 aluminium crimp cap, silver, center hole | PTFE virginal, white | 0.25 mm | 100 | 70284 |
| N 11 aluminium crimp cap, silver, roll grove, center hole | O-ring + aluminium septa, TPF (Total Phthalate Free) | 0.1 mm | 100 | 702175 |
| N 11 aluminium crimp cap, silver, center hole | no liner | – | 100 | 702801 |

### N 11 Septa for crimp caps N 11

| Material | Illustration | Thickness | Pack of | REF |
|---|---|---|---|---|
| PTFE virginal, white | | 0.25 mm | 100 | 70262 |
| Red Rubber / FEP colorless | | 1.0 mm | 100 | 702065 |

### Vial Kits crimp neck N 11

Packs of 100 vials and 100 closures, each

| Closure → / Vial ↓ | 70288 | 702995 | 70256 | 702001 |
|---|---|---|---|---|
| 70201HP: 1.5 mL, clear, flat bottom | 702215 | 702218 | 702222 | |
| 702885: 1.5 mL, clear, flat bottom, label and scale | 702216 | 702219 | 702223 | 702253 |
| 702892: 1.5 mL, amber, flat bottom, label and scale | 702217 | 702221 | 702224 | 702254 |

Other Vial Kits on request.

Vial Kit with crimp neck vials and closures N 11

Pre-sealed vial-closure combination

## Ordering information

### Pre-sealed vial-closure combinations with crimp neck N 11

| Vial description | Closure description | Pack of | REF |
|---|---|---|---|
| Pre-sealed vials 70201CG:<br>1.5 mL crimp neck vial N 11, 11.6 x 32 mm,<br>clear, flat bottom, small opening | crimped with 70256:<br>N 11 aluminium crimp cap, silver, center hole,<br>Natural rubber / Butyl red-orange / TEF colorless, 1.0 mm | 100 | 702881 |
| Pre-sealed vials 70201HP:<br>1.5 mL crimp neck vial N 11, 11.6 x 32 mm,<br>clear, flat bottom, wide opening | crimped with 70256:<br>N 11 aluminium crimp cap, silver, center hole,<br>Natural rubber / Butyl red-orange / TEF colorless, 1.0 mm | 100 | 702101HP |
| Pre-sealed vials 702892:<br>1.5 mL crimp neck vial N 11, 11.6 x 32 mm,<br>amber, flat bottom, wide opening,<br>label and scale | crimped with 70256:<br>N 11 aluminium crimp cap, silver, center hole,<br>Natural rubber / Butyl red-orange / TEF colorless, 1.0 mm | 100 | 702859 |
| Pre-sealed vials 70201HP:<br>1.5 mL crimp neck viale N 11, 11.6 x 32 mm,<br>clear, flat bottom, wide opening | crimped with 702995:<br>N 11 aluminium crimp cap, silver, center hole,<br>PTFE red / Silicone white / PTFE red, 1.0 mm | 100 | 702867 |

Other pre-sealed vial-closure combinations on request.

## Ordering information

### Crimping tools N 11

| Description | | Pack of | REF |
|---|---|---|---|
| Manual crimper (standard), height adjustable,<br>for 11 mm aluminium crimp caps | | 1 | 735111 |
| Manual decapper (standard)<br>for 11 mm aluminium crimp caps | | 1 | 735911 |
| Manual decapper (plier style)<br>for 11 mm and 20 mm aluminium crimp caps | | 1 | 735911.20 |
| Manual ergonomic crimper<br>for 11 mm aluminium crimp caps | | 1 | 735211 |
| Manual ergonomic decapper<br>for 11 mm aluminium crimp caps | | 1 | 735311 |
| Electronic crimper for 11 mm aluminium crimp caps (battery-powered) | | 1 | 735511 |
| Electronic decapper for 11 mm aluminium crimp caps (battery-powered) | | 1 | 735611 |
| Electronic high power crimping tool with power supply | | 1 | 735700 |
| Crimping head for 11 mm crimp caps (aluminium, magnetic) | | 1 | 735711 |
| Decapping head for 11 mm crimp caps (aluminium, magnetic) | | 1 | 735811 |
| Stand for electronic crimping tools | | 1 | 735501 |
| Replacement battery 6.6 V, 8.6 Wh for 735511, 735611 | | 1 | 735500 |

## Snap ring vials and caps N 11

### Key features

- Quick, convenient sealing method which, however, should only be used in HPLC
- Can be used on all common HPLC autosamplers
- Alternatively crimp closures N 11 can be used (see preceding pages).
- 0.3 and 0.7 mL PP snap ring vials for special applications, e.g., for ion chromatography
- Most common closure: with cross-slit Silicone / PTFE septum, which supports easy penetration with the relatively thick, blunt HPLC needle
- Besides hard caps in transparent and blue also more easy to handle soft caps in light blue are available

### Ordering information

### Snap ring vials N 11, wide opening, and compatible inserts

(Illustrations scale 1:2)

| Type of vial | Usable volume | OD x height | Pack of | REF |
|---|---|---|---|---|
| Clear, flat bottom | 1.5 mL | 11.6 x 32 mm | 100 | 702714 |
| Clear, flat bottom, label and scale | 1.5 mL | 11.6 x 32 mm | 100 | 702713 |
| Amber, flat bottom, label and scale | 1.5 mL | 11.6 x 32 mm | 100 | 702712 |
| Insert for wide opening vials, clear, conical, 15 mm tip | 0.2 mL | 6 x 31 mm | 100 | 702813 |
| as above, silanized | 0.2 mL | 6 x 31 mm | 100 | 702077 |
| Insert for wide opening vials, clear, conical, 12 mm tip | 0.25 mL | 6 x 31 mm | 100 | 702716 |
| Insert for wide opening vials, clear, with plastic spring | 0.1 mL | 5.7 x 29 mm | 100 | 702818 |
| as above, silanized | 0.1 mL | 5.7 x 29 mm | 100 | 702818.1 |
| Insert for wide opening vials, clear, flat bottom | 0.3 mL | 6 x 31 mm | 100 | 702825 |
| Micro-vial, clear, with integrated 0.2 mL insert | 0.2 mL | 11.6 x 32 mm | 100 | 702709 |
| Micro-vial, polypropylene, transparent, with integrated 0.2 mL glass-insert, conical | 0.2 mL | 11.6 x 32 mm | 100 | 702134* |
| Micro-vial, polypropylene, amber, with integrated 0.2 mL glass-insert, conical | 0.2 mL | 11.6 x 32 mm | 100 | 702334* |
| Micro-vial, polypropylene, transparent, with inner cone | 0.3 mL | 11.6 x 32 mm | 100 | 702809 |
| Micro-vial, polypropylene, amber, with inner cone | 0.3 mL | 11.6 x 32 mm | 100 | 702173 |
| Micro-vial, polypropylene, transparent, with round bottom insert | 0.7 mL | 11.6 x 32 mm | 100 | 702174 |

* upon request also available with an integrated silanized glass insert

## Pre-assembled vial-insert combinations with snap ring N 11

| Vial description | Insert description | Pack of | REF |
|---|---|---|---|
| Vial 702714:<br>1.5 mL, clear, flat bottom | with pre-assembled micro-insert 702813:<br>0.2 mL, conical, 15 mm tip | 100 | 702170 |
| Vial 702713:<br>1.5 mL, clear, flat bottom, label and scale | with pre-assembled micro-insert 702813:<br>0.2 mL, conical, 15 mm tip | 100 | 702176 |

Further pre-assembled vial-insert combinations on request.

## Ordering information

## Ready assembled snap ring closures N 11

| Cap description | Septa description | Thickness | Pack of | REF |
|---|---|---|---|---|
| Hard caps, blue or transparent | | | | |
| N 11 PE snap ring cap, transparent, center hole | Red Rubber / FEP colorless | 1.0 mm | 100 | 702731 |
| N 11 PE snap ring cap, blue, center hole | Red Rubber / FEP colorless | 1.0 mm | 100 | 702063 |
| N 11 PE snap ring cap, transparent, center hole | Silicone white / PTFE red | 1.0 mm | 100 | 702710 |
| N 11 PE snap ring cap, blue, center hole | Silicone white / PTFE red | 1.0 mm | 100 | 702710.1 |
| N 11 PE snap ring cap, transparent, center hole | Silicone white / PTFE blue, cross-slit | 1.0 mm | 100 | 702064 |
| N 11 PE snap ring cap, blue, center hole | Silicone white / PTFE blue, cross-slit | 1.0 mm | 100 | 702717.2 |
| N 11 PE snap ring cap, transparent, center hole | PTFE red / Silicone white / PTFE red | 1.0 mm | 100 | 702718 |
| N 11 PE snap ring cap, blue, center hole | PTFE red / Silicone white / PTFE red | 1.0 mm | 100 | 702718.1 |
| Soft caps, light blue | | | | |
| N 11 PE snap ring cap, soft, light blue, center hole | Red Rubber / FEP colorless | 1.0 mm | 100 | 702063.2080 |
| N 11 PE snap ring cap, soft, light blue, center hole | Silicone white / PTFE red | 1.0 mm | 100 | 702710.2080 |
| N 11 PE snap ring cap, soft, light blue, center hole | Silicone white / PTFE blue, cross-slit | 1.0 mm | 100 | 702717.2080 |
| N 11 PE snap ring cap, soft, light blue, center hole | PTFE red / Silicone white / PTFE red | 1.0 mm | 100 | 702718.2080 |
| N 11 PE cap, transparent, closed top, with thin piercing area | | | 100 | 702401 |

## Vial Kits snap ring N 11

Packs of 100 vials and 100 closures, each

| Closure → / Vial ↓ | 702710 | 702064 | 702731 | 702718 |
|---|---|---|---|---|
| 702714:<br>1.5 mL, clear, flat bottom | 702225 | 702228 | 702232 | 702235 |
| 702713:<br>1.5 mL, clear, flat bottom,<br>label and scale | 702719 | 702229 | 702233 | 702236 |
| 702712:<br>1.5 mL, amber, flat bottom,<br>label and scale | 702227 | 702231 | 702234 | 702237 |

Other Vial Kits on request.

# Snap ring vials and caps N 11

## Ordering information

### Vial rack for screw neck vials N 8, N 9, N 10 and crimp neck as well as snap ring vials N 11

| Description | Pack of | REF |
|---|---|---|
| 50 position polypropylene vial rack blue, for all vials 11.6 x 32 mm with flat bottom<br>Dimensions: 190 x 100 x 22 mm, stackable | 1 | 702502 |

## Ordering information

### Container for screw neck vials N 8, N 9, N 10 and crimp neck as well as snap ring vials N 11

| Description | Pack of | REF |
|---|---|---|
| 81 position container blue, with firmly integrated divider for vials 11.6 x 32 mm,<br>outer length 130 mm, outer width 130 mm, outer height 45 mm, coded, with transparent lid (suitable for freezers) | 1 | 702514 |

## Storage of samples in the fridge or in the freezer

### Useful tips for sample handling

Generally sample vials should be stored in a vial container when being placed in the fridge or in the freezer, in order to avoid any condensations on the cap/septa surface that may go along with contaminations in the penetration area of the septa in the center hole. When filling the vial you have to consider the expansion rate of your sample to prevent breakage of the vial. Furthermore it is important to defreeze the sample at a later point in time very slowly (no sudden defreezing with hot water for example). With screw closures you may have to check, if restoring forces have been activated during the defreezing process and if you may have to tighten the screw closure. The choice of the correct closure (septum) depends on the storage temperature.

# Special vials for special applications

## Silanized glass vials / Plastic vials / Plastic vials with glass insert

- Silanized glass vials
  Silanized glass vials have a deactivated inner glass surface, in order to reduce adsorption of polar substances. Therefore they are often used for the analysis of proteins, phenols and amino acids, which would – without any silanization of the glass surface – react with the OH-groups of the glass and thus would stick to the normally polar glass surface. It is also recommendable to use silanized vials respectively inserts for pH-sensitive and aqueous samples.
- Plastic vials
  For some applications glass vials are not suitable due their composition and their chemical properties. Amongst these are heavy metal analysis, water and protein analysis, atomic absorption, capillary electrophoresis (CE) and ion chromatography (IC). For all these cases high purity polyproylene vials with 0.3 mL, 0.7 mL and 1.5 ml in transparent and amber are available.
- Plastic vials with glass insert
  In comparison to the glass-in-glass products, glass-in-plastic systems are very robust, as the glass insert is well protected by the polypropylene outer shell. The tip of the micro-insert is centered by 100 per cent in an outlet at the bottom. The inserts sit firmly in the protective PP round bottom shell and thus can easily be filled. Another advantage of these systems is their excellent tightness, as the glass insert always constantly exceeds the rim of the plastic outer vial by 0.1 mm granting a firm sealing of the sample in the insert. Upon request also a silanized insert can be integrated into the plastic shell. The high transparent polypropylene enables a good view on the filling level.

# Crimp neck vials and caps N 13

## Crimp neck vials and caps N 13

### Key features

- Usage of these vials and closures is more in the packaging area
- Height adjustable crimpers for aluminium crimp caps as well as for Flip Top / Flip Off crimp caps
- Butyl / PTFE septa with only centrical PTFE lamination, typically called Pharma-Fix septa, stand out due to their excellent sealing on the glass rims.

## Ordering information

### Crimp neck vials N 13

70203

(Illustrations scale 1:2)

| Type of vial | Usable volume | OD x height | Pack of | REF |
|---|---|---|---|---|
| Clear, flat bottom | 2 mL | 13.75 x 35 mm | 100 | 70203 |

### Ready assembled crimp closures N 13 and plain crimp caps N 13

70257

70232

702802

702803

| Cap description | Septa description | Thickness | Pack of | REF |
|---|---|---|---|---|
| N 13 aluminium crimp cap, silver, center hole | Butyl dark gray / PTFE gray* | 2 mm | 100 | 70257 |
| N 13 aluminium center tear off cap, gold | Butyl dark gray / PTFE gray* | 2 mm | 100 | 70232 |
| N 13 aluminium crimp cap, silver, center hole | no liner | – | 100 | 702802 |
| N 13 aluminium center tear off cap, gold | no liner | – | 100 | 702803 |

* only centrically laminated, typically called Pharma-Fix

### Crimping tools N 13

| Description | Pack of | REF |
|---|---|---|
| Manual crimper (standard), height adjustable, for 13 mm aluminium crimp caps | 1 | 735113 |
| Manual crimper (standard), height adjustable, for 13 mm Flip Top / Flip Off caps | 1 | 735133 |
| Manual decapper (standard) for 13 mm aluminium crimp caps | 1 | 735913 |

### Container for crimp and screw neck vials N 13

| Description | Pack of | REF |
|---|---|---|
| 49 position container blue, with firmly integrated devider, for crimp and screw neck vials N 13, outer length 130 mm, outer width 130 mm, outer height 50 mm, with transparent lid (suitable for freezers) | 1 | 702515 |

### Vial rack for crimp and screw neck vials N 13

| Description | Pack of | REF |
|---|---|---|
| 50 position polypropylene vial rack blue, for all vials with a diameter of 15 mm max. and flat bottom<br>Dimensions: 240 x 120 x 28 mm, stackable | 1 | 702504 |

Container for crimp and screw neck vials N 13

Vial rack for crimp and screw neck vials N 13

## Screw neck vials and caps N 13

### Key features

- Generally used for large sample volumes in HPLC
- In combination with closed top screw closures suitable for sample storage (see pages 120–122)
- Compatible insert requires metal spring for centrical alignment
- Range of ready assembled closures and plain caps with center hole or with closed top as well as separate septa (PTFE virginal, Red Rubber / FEP and Silicone / PTFE) are available.

### Ordering information

#### Screw neck vials N 13 (13-425 thread) and compatible insert

702962

702973

702972

702974

(Illustrations scale 1:2)

| Type of vial | Usable volume | OD x height | Pack of | REF |
|---|---|---|---|---|
| Clear, flat bottom | 4 mL | 14.75 x 45 mm | 100 | 702962 |
| Amber, flat bottom | 4 mL | 14.75 x 45 mm | 100 | 702973 |
| Insert, clear, conical, metal spring required | 0.3 mL | 6 x 40 mm | 100 | 702972 |
| Metal spring for 702972 | – | – | 100 | 702974 |

#### Ready assembled screw closures and plain screw caps N 13

702103

702050

702051

702926

702052

702963
–

702966
–

| Cap description | Septa description | Thickness | Pack of | REF |
|---|---|---|---|---|
| N 13 screw cap (13-425), green, closed top | F217 white / PTFE beige (firmly fixed) | 1.5 mm | 100 | 702103 |
| N 13 PP screw cap, black, center hole | Red Rubber / FEP colorless | 1.5 mm | 100 | 702050 |
| as above, but with closed top | Red Rubber / FEP colorless | 1.5 mm | 100 | 702051 |
| N 13 PP screw cap, black, center hole | Silicone white / PTFE red | 1.3 mm | 100 | 702926 |
| as above, but with closed top | Silicone white / PTFE red | 1.3 mm | 100 | 702052 |
| N 13 PP screw cap, black, center hole | no liner | – | 100 | 702963 |
| as above, but with closed top | no liner | – | 100 | 702966 |

#### N 12 septa for screw caps N 13

| Material | Illustration | Thickness | Pack of | REF |
|---|---|---|---|---|
| PTFE virginal, white | | 0.25 mm | 100 | 70260 |
| Red Rubber / FEP colorless | | 1.5 mm | 100 | 702053 |
| Silicone white / PTFE red | | 1.3 mm | 100 | 702292 |

# Special vials and caps

## Screw neck vials for storage of liquid samples

### Key features

- Usable volumes of 1.5 up to 24 mL
- Available neck sizes N 8, N 9, N 13, N 15, N 18 and N 20
- Corresponding closed top screw closures with different septa materials

### Ordering information

70213

70213.2

702004

702893

702068

702066

### Screw neck vials N 8, small opening (8-425 thread)

(Illustrations scale 1:2)

| Type of vial | Usable volume | OD x height | Pack of | REF |
|---|---|---|---|---|
| Clear, flat bottom | 1.5 mL | 11.6 x 32 mm | 100 | 70213 |
| Amber, flat bottom | 1.5 mL | 11.6 x 32 mm | 100 | 70213.2 |
| Clear, flat bottom, label and scale | 1.5 mL | 11.6 x 32 mm | 100 | 702004 |
| Amber, flat bottom, label and scale | 1.5 mL | 11.6 x 32 mm | 100 | 702893 |

### Closed top screw closures N 8

| Cap description | Septa description | Thickness | Pack of | REF |
|---|---|---|---|---|
| N 8 PP screw cap, black, closed top | Red Rubber / FEP colorless | 1.3 mm | 100 | 702068 |
| N 8 PP screw cap, black, closed top | Silicone white / PTFE red | 1.3 mm | 100 | 702066 |

### Ordering information

702282

702293

702283

702284

702032

702033

702034

### Screw neck vials N 9, wide opening (short thread)

(Illustrations scale 1:2)

| Type of vial | Usable volume | OD x height | Pack of | REF |
|---|---|---|---|---|
| Clear, flat bottom | 1.5 mL | 11.6 x 32 mm | 100 | 702282 |
| Amber, flat bottom | 1.5 mL | 11.6 x 32 mm | 100 | 702293 |
| Clear, flat bottom, label and scale | 1.5 mL | 11.6 x 32 mm | 100 | 702283 |
| as above, silanized | 1.5 mL | 11.6 x 32 mm | 100 | 702078 |
| Amber, flat bottom, label and scale | 1.5 mL | 11.6 x 32 mm | 100 | 702284 |
| as above, silanized | 1.5 mL | 11.6 x 32 mm | 100 | 702079 |

### Closed top screw closures N 9

| Cap description | Septa description | Thickness | Pack of | REF |
|---|---|---|---|---|
| N 9 PP screw cap blue, closed top | PTFE virginal, white | 0.25 mm | 100 | 702032 |
| N 9 PP screw cap blue, closed top | Red Rubber / FEP colorless | 1.0 mm | 100 | 702033 |
| N 9 PP screw cap blue, closed top | Silicone white / PTFE red | 1.0 mm | 100 | 702034 |

## Ordering information

702962

702973

702103

702051

702052

### Screw neck vials N 13 (13-425 thread)

(Illustrations scale 1:2)

| Type of vial | Usable volume | OD x height | Pack of | REF |
|---|---|---|---|---|
| Clear, flat bottom | 4 mL | 14.75 x 45 mm | 100 | 702962 |
| Amber, flat bottom | 4 mL | 14.75 x 45 mm | 100 | 702973 |

### Closed top screw closures N 13

| Cap description | Septa description | Thickness | Pack of | REF |
|---|---|---|---|---|
| N 13 screw cap (13-425), green, closed top | F217 white / PTFE beige (firmly fixed) | 1.5 mm | 100 | 702103 |
| N 13 PP screw cap, black, closed top | Red Rubber / FEP colorless | 1.5 mm | 100 | 702051 |
| N 13 PP screw cap, black, closed top | Silicone white / PTFE red | 1.3 mm | 100 | 702052 |

## Ordering information

702096 / 702311

70285 / 702097

702104

702180

### Screw neck vials N 15 (15-425 thread)

(Illustrations scale 1:2)

| Type of vial | Usable volume | OD x height | Pack of | REF |
|---|---|---|---|---|
| Screw neck vial N 15 (15-425 thread), clear, flat bottom | 8 mL | 16.6 x 61 mm | 100 | 702096 |
| Screw neck vial N 15 (15-425 thread), amber, flat bottom | 8 mL | 16.6 x 61 mm | 100 | 702311 |
| Screw neck vial N 15 (15-425 thread), clear, flat bottom | 12 mL | 18.5 x 66 mm | 100 | 70285 |
| Screw neck vial N 15 (15-425 thread), amber, flat bottom | 12 mL | 18.5 x 66 mm | 100 | 702097 |

### Screw closures N 15

| Cap description | Septa description | Thickness | Pack of | REF |
|---|---|---|---|---|
| N 15 screw cap (15-425), green, closed top | F217 white / PTFE beige (firmly fixed) | 1.5 mm | 100 | 702104 |
| N 15 PP bonded screw cap (15-425), black, center hole | Silicone white / PTFE beige | 1.5 mm | 100 | 702180 |

## Ordering information

702098

702105

### Screw neck vial N 18 (18-400 thread)

(Illustrations scale 1:2)

| Type of vial | Usable volume | OD x height | Pack of | REF |
|---|---|---|---|---|
| Screw neck vial N 18 (18-400 thread), clear, flat bottom | 16 mL | 20.6 x 71 mm | 100 | 702098 |

### Screw closures N 18

| Cap description | Septa description | Thickness | Pack of | REF |
|---|---|---|---|---|
| N 18 screw cap (18-400), green, closed top | F217 white / PTFE beige (firmly fixed) | 1.5 mm | 100 | 702105 |

## Ordering information

702099

702106

702181

### Screw neck vials N 20 (20-400 thread)

(Illustrations scale 1:2)

| Type of vial | Usable volume | OD x height | Pack of | REF |
|---|---|---|---|---|
| Screw neck vial N 20 (20-400 thread), clear, flat bottom | 24 mL | 22.7 x 86 mm | 100 | 702099 |

### Screw closures N 20

| Cap description | Septa description | Thickness | Pack of | REF |
|---|---|---|---|---|
| N 20 screw cap (20-400), green, closed top | F217 white / PTFE beige (firmly fixed) | 1.5 mm | 100 | 702106 |
| N 20 PP bonded screw cap (20-400), white, center hole | Silicone white / PTFE beige | 1.5 mm | 100 | 702181 |

For screw neck vials with even larger volumes please see page 131.

## Snap cap vials for storage of powdery samples

### Key features

- Available sizes N 18 and N 22
- Usable volumes from 5 up to 25 mL
- Glass of 3rd hydrolytic class

### Ordering information

70271

70272

70274

### Snap cap vials N 18

| Type of vial | Usable volume | (Illustrations scale 1:2) OD x height | Pack of | REF |
|---|---|---|---|---|
| N 18, clear, flat bottom | 5 mL | 20 x 40 mm | 100 | 70271 |
| N 18, clear, flat bottom | 10 mL | 22 x 50 mm | 100 | 70272 |

### PE snap caps N 18

| Description | Pack of | REF |
|---|---|---|
| N 18 PE snap cap, transparent, for 70271 and 70272 | 100 | 70274 |

### Ordering information

702019

70273

70275

### Snap cap vials N 22

| Type of vial | Usable volume | (Illustrations scale 1:2) OD x height | Pack of | REF |
|---|---|---|---|---|
| N 22, clear, flat bottom | 15 mL | 26 x 48 mm | 100 | 702019 |
| N 22, clear, flat bottom | 25 mL | 26 x 65 mm | 100 | 70273 |

### PE snap caps N 22

| Description | Pack of | REF |
|---|---|---|
| N 22 PE snap cap, transparent, for 702019 and 70273 | 100 | 70275 |

## Shell vials N 8 and N 12

### Key features

- Economic combination of vials and closures for uncritical HPLC applications
- PE stoppers with a diaphragm for safe penetration of the needle
- Often used on Waters® and Shimadzu® instruments

### Ordering information

70202.1

702017

702807

### Shell vials N 8 with PE plug

| Type of vial | Usable volume | (Illustrations scale 1:2) OD x height | Pack of | REF |
|---|---|---|---|---|
| N 8, clear, flat bottom | 1 mL | 8.2 x 40 mm | 100 | 70202.1 |
| N 8, amber, flat bottom | 1 mL | 8.2 x 40 mm | 100 | 702017 |

### PE plug N 8

| Description | Pack of | REF |
|---|---|---|
| N 8 PE plug, transparent, for 70202.1 and 702017 | 100 | 702807 |

### Ordering information

702018

702054

### Shell vials N 12 with PE plug

| Type of vial | Usable volume | (Illustrations scale 1:2) OD x height | Pack of | REF |
|---|---|---|---|---|
| N 12, clear, flat bottom | 2 mL | 11.6 x 31.5 mm | 100 | 702018 |

### PE plug N 12

| Description | Pack of | REF |
|---|---|---|
| N 12 PE plug, transparent, for 702018 | 100 | 702054 |

## Screw neck vials and magnetic screw caps N 18

### Key features

- Headspace vials for convenient, safe and consistent handling
- High tightness and better reproducibility of the sealing process (as compared to crimping)
- Thinner septum (1.5 mm instead of 3 mm septum thickness in crimp caps), thus safe penetration of the needle and less fragmentation (especially important for SPME applications)
- Improved run in autosamplers with magnets (CTC Combi PAL and equivalent instruments), since a flat surface for the magnet is ensured, thus avoiding that the filled vial can drop from the magnet

## Ordering information

702866 702826 702826.2

702827 702055 702136 702072

### Headspace screw neck vials N 18

| Type of vial | Usable volume | (Illustrations scale 1:2) OD x height | Pack of | REF |
|---|---|---|---|---|
| Clear, rounded bottom | 10 mL | 22.5 x 46.0 mm | 100 | 702866 |
| Clear, rounded bottom | 20 mL | 22.5 x 75.5 mm | 100 | 702826 |
| Amber, rounded bottom | 20 mL | 22.5 x 75.5 mm | 100 | 702826.2 |

### Ready assembled, magnetic screw closures N 18

| Cap description | Septa description | Thickness | Pack of | REF |
|---|---|---|---|---|
| N 18 magnetic screw cap, silver, center hole | Silicone blue transparent / PTFE white | 1.5 mm | 100 | 702827 |
| N 18 magnetic screw cap, silver, center hole | Silicone white / PTFE blue | 1.5 mm | 100 | 702055 |
| N 18 magnetic screw cap, silver, center hole | Silicone white / PTFE blue, slit | 1.5 mm | 100 | 702136 |
| N 18 magnetic screw cap, silver, center hole | Red Rubber / TEF colorless | 1.5 mm | 100 | 702072 |

### N 17 septa for magnetic screw caps N 18

| Material | Illustration | Thickness | Pack of | REF |
|---|---|---|---|---|
| Silicone blue transparent / PTFE white | | 1.5 mm | 100 | 702981 |
| Silicone white / PTFE blue | | 1.5 mm | 100 | 702110 |

### Container for screw neck vials N 18 and crimp neck vials N 20

| Description | Pack of | REF |
|---|---|---|
| 25 position container blue, with removable divider, for headspace screw neck vials N 18 and crimp neck vials N 20; outer length 130 mm, outer width 130 mm, outer height 80 mm, with transparent lid (suitable for freezers) | 1 | 702516 |

# Crimp neck vials and caps N 20

## Crimp neck vials and caps N 20

### Key features

- Large range of Headspace crimp neck vials with different volumes and diameters
- Flat DIN crimp neck with stable bearing surface for the septum (especially suited for high vial pressures) as well as beveled HS crimp neck for instruments of certain manufacturers (PerkinElmer®).
- Assignment to respective instrument manufacturers in parentheses
- Different types of crimp closures depending on instrument and application
- Please consider our various crimping tools on pages 134-135.

## Ordering information

### Crimp neck vials N 20 (volume 5–10 mL)

(Illustrations scale 1:2)

| Type of vial | Usable volume | OD x height | Pack of | REF |
|---|---|---|---|---|
| Clear, flat bottom, flat DIN crimp neck (Varian®) | 5 mL | 20.5 x 38.0 mm | 100 | 70204.36 |
| Amber, flat bottom, flat DIN crimp neck (Varian®) | 5 mL | 20.5 x 38.0 mm | 100 | 70215.36 |
| Clear, rounded bottom, beveled HS crimp neck (PerkinElmer®) | 6 mL | 22.0 x 38.25 mm | 100 | 702917 |
| Clear, flat bottom, beveled HS crimp neck (Metrohm®, Karl-Fischer titration) | 5 mL | 21.7 x 38.25 mm | 100 | 702020 |
| Clear, flat bottom, flat DIN crimp neck (Varian®) | 10 mL | 20.5 x 54.5 mm | 100 | 70205.36 |
| Amber, flat bottom, flat DIN crimp neck (Varian®) | 10 mL | 20.5 x 54.5 mm | 100 | 70216.36 |
| Clear, flat bottom, flat DIN crimp neck (Dani, Agilent®) | 10 mL | 22.5 x 46.0 mm | 100 | 702918 |
| Clear, rounded bottom, flat DIN crimp neck (CTC) | 10 mL | 22.5 x 46.0 mm | 100 | 702924 |

### Container for screw neck vials N 18 and crimp neck vials N 20

| Description | Pack of | REF |
|---|---|---|
| 25 position container blue, with removable divider, for headspace screw neck vials N 18 and crimp neck vials N 20; outer length 130 mm, outer width 130 mm, outer height 80 mm, with transparent lid (suitable for freezers) | 1 | 702516 |

## Ordering information

### Crimp neck vials N 20 (volume 20 mL)

(Illustrations scale 1:2)

| Type of vial | Usable volume | OD x height | Pack of | REF |
|---|---|---|---|---|
| Clear, flat bottom, flat DIN crimp neck | 20 mL | 23.25 x 75.5 mm | 100 | 70206.36 |
| Amber, flat bottom, flat DIN crimp neck | 20 mL | 23.25 x 75.5 mm | 100 | 70217.36 |
| Clear, rounded bottom, beveled HS crimp neck (PerkinElmer®) | 20 mL | 23.0 x 75.5 mm | 100 | 70254 |
| Amber, rounded bottom, beveled HS crimp neck (PerkinElmer®) | 20 mL | 23.0 x 75.5 mm | 100 | 702541 |
| Clear, rounded bottom, beveled HS crimp neck, label (PerkinElmer®) | 20 mL | 23.0 x 75.5 mm | 100 | 702540 |
| Clear, flat bottom, flat DIN crimp neck (Dani, Agilent®) | 20 mL | 22.5 x 75.5 mm | 100 | 702261 |
| Clear, rounded bottom, flat DIN crimp neck (CTC) | 20 mL | 22.5 x 75.5 mm | 100 | 702263 |
| Amber, rounded bottom, flat DIN crimp neck (CTC) | 20 mL | 22.5 x 75.5 mm | 100 | 702263.2 |
| Clear, rounded bottom, beveled HS crimp neck, graduation at 15 mL | 20 mL | 22.0 x 75.0 mm | 100 | 702086 |

# Crimp neck vials and caps N 20

## Ordering information

### Crimp neck vials N 20 (volume > 20 mL)

70210.36 | 70208.36 | 702100 | 70209.1

(Illustrations scale 1:2)

| Type of vial | Usable volume | OD x height | Pack of | REF |
|---|---|---|---|---|
| Clear, flat bottom, flat DIN crimp neck | 25 mL | 30 x 65 mm | 100 | 70210.36 |
| Clear, flat bottom, flat DIN crimp neck | 50 mL | 31 x 101 mm | 100 | 70208.36 |
| Amber, flat bottom, flat DIN crimp neck | 50 mL | 31 x 101 mm | 100 | 702100 |
| Clear, flat bottom, flat DIN crimp neck (3rd hydrolytic class) | 100 mL | 51.6 x 94.5 mm | 60 | 70209.1 |

## Ordering information

### Crimping tools N 20

| Description | | Pack of | REF |
|---|---|---|---|
| Manual crimper (standard), height adjustable, for 20 mm aluminium crimp caps | | 1 | 735120 |
| Manual crimper (standard), height adjustable, for 20 mm Flip Top / Flip Off caps | | 1 | 735132 |
| Manual decapper (standard) for 20 mm aluminium crimp caps | | 1 | 735920 |
| Manual decapper (plier style, dual) for 11 mm and 20 mm aluminium crimp caps | | 1 | 735911.20 |
| Manual ergonomic crimper for 20 mm aluminium crimp caps | | 1 | 735220 |
| Manual ergonomic decapper for 20 mm aluminium crimp caps | | 1 | 735320 |
| Electronic crimper for 20 mm aluminium crimp caps (battery-powered) | | 1 | 735520 |
| Electronic decapper for 20 mm aluminium crimp caps (battery-powered) | | 1 | 735620 |
| Electronic high power crimping tool with power supply | | 1 | 735700 |
| Crimping head for 20 mm crimp caps (aluminium, magnetic, bi-metal) | | 1 | 735720 |
| Decapping head for 20 mm crimp caps (aluminium, magnetic, bi-metal) | | 1 | 735820 |
| Stand for electronic crimping tools | | 1 | 735501 |
| Replacement battery 6.6 V, 8.6 Wh for 735520, 735620 | | 1 | 735500 |

## Ordering information

### Ready assembled crimp closures N 20

Center hole caps

with assembled septum →

702773 702775 70234.9 70234 702056 70237 702093 702094 702091 702145 no liner 702804

70234.10

| Cap description | Septa description | Thickness | Pack of | REF |
|---|---|---|---|---|
| N 20 aluminium crimp cap, silver, center hole | Butyl red / PTFE gray | 3 mm | 100 | 702773 |
| N 20 aluminium crimp cap, silver, center hole | Butyl light gray / PTFE dark gray | 3 mm | 100 | 702775 |
| N 20 aluminium crimp cap, silver, center hole | Molded septum Butyl / PTFE gray | 3 mm | 100 | 70234.9 |
| N 20 aluminium crimp cap, silver, center hole | Butyl dark gray / PTFE gray* | 3 mm | 100 | 70234 |
| N 20 aluminium crimp cap, silver, center hole | Butyl dark gray / PTFE gray*, high purity | 3 mm | 100 | 70234.10 |
| N 20 aluminium crimp cap, gold, center hole  | Butyl dark gray / PTFE gray* | 3 mm | 100 | 702056 |
| N 20 aluminium crimp cap, silver, center hole | Butyl stopper gray, unassembled (separate parts) | – | 100 each | 70237 |
| N 20 aluminium crimp cap, silver, center hole | Silicone blue transp. / PTFE colorless | 3 mm | 100 | 702093 |
| N 20 aluminium crimp cap, silver, center hole | Silicone white / PTFE beige | 3 mm | 100 | 702094 |
| N 20 aluminium crimp cap, silver, center hole | Silicone white / PTFE red (economy line) | 3 mm | 100 | 702091 |
| N 20 aluminium crimp cap, silver, center hole | Silicone white / FEP-/Aluminium foil silver | 3.2 mm | 100 | 702145 |
| N 20 aluminium crimp cap, silver, center hole | no liner | – | 100 | 702804 |
| N 20 aluminium crimp cap, gold, center hole | no liner | – | 100 | 702112 |

Pressure release caps

with assembled septum →

702836 702829 70234.8 702071 702927 702835 no liner 702799

| Cap description | Septa description | Thickness | Pack of | REF |
|---|---|---|---|---|
| N 20 aluminium pressure release cap, silver, center hole | Butyl red / PTFE gray | 3 mm | 100 | 702836 |
| N 20 aluminium pressure release cap, silver, center hole | Butyl light gray / PTFE dark gray | 3 mm | 100 | 702829 |
| N 20 aluminium pressure release cap, silver, center hole | Molded septum Butyl / PTFE gray | 3 mm | 100 | 70234.8 |
| N 20 aluminium pressure release cap, silver, center hole | Butyl dark gray / PTFE gray* | 3 mm | 100 | 702071 |
| N 20 aluminium pressure release cap, silver, center hole | Silicone blue transp. / PTFE colorless | 3 mm | 100 | 702927 |
| N 20 aluminium pressure release cap, silver, center hole | Silicone white / PTFE beige | 3 mm | 100 | 702835 |
| N 20 aluminium pressure release cap, silver, center hole | no liner | – | 100 | 702799 |

Bi-metal crimp caps

with assembled septum →

702838 702834 702837 no liner 702833

| Cap description | Septa description | Thickness | Pack of | REF |
|---|---|---|---|---|
| N 20 Bi-metal crimp cap, blue / silver, center hole | Butyl light gray / PTFE dark gray | 3 mm | 100 | 702838 |
| N 20 Bi-metal crimp cap, blue / silver, center hole | Silicone blue transp. / PTFE colorless | 3 mm | 100 | 702834 |
| N 20 Bi-metal crimp cap, blue / silver, center hole | Silicone white / PTFE beige | 3 mm | 100 | 702837 |
| N 20 Bi-metal crimp cap, blue / silver, center hole | no liner | – | 100 | 702833 |

Magnetic crimp caps

with assembled septum →

702774 702928 702928.9 702929 no liner 702808

| Cap description | Septa description | Thickness | Pack of | REF |
|---|---|---|---|---|
| N 20 magnetic crimp cap, silver, 8 mm center hole | Butyl red / PTFE gray | 3 mm | 100 | 702774 |
| N 20 magnetic crimp cap, silver, 8 mm center hole | Butyl light gray / PTFE dark gray | 3 mm | 100 | 702928 |
| N 20 magnetic crimp cap, silver, 8 mm center hole | Butyl dark gray / PTFE gray* | 3 mm | 100 | 702928.9 |
| N 20 magnetic crimp cap, silver, 8 mm center hole | Silicone blue transp. / PTFE colorless | 3 mm | 100 | 702929 |
| N 20 magnetic crimp cap, silver, 8 mm center hole | no liner | – | 100 | 702808 |

* only centrically laminated with PTFE, typically called Pharma-Fix

# Crimp neck vials and caps N 20

## Ordering information

### Ready assembled crimp closures N 20

Center tear off caps

70233

70236

no liner 70236.1

| Cap description | Septa description | Thickness | Pack of | REF |
|---|---|---|---|---|
| N 20 aluminium center tear off cap, gold | Butyl dark gray / PTFE gray* | 3 mm | 100 | 70233 |
| N 20 aluminium center tear off cap, silver | Butyl stopper gray, unassembled (separate parts) | – | 100 each | 70236 |
| N 20 aluminium center tear off cap, silver | no liner | – | 100 | 70236.1 |

Complete tear off caps

70235

70238

no liner 702805

| Cap description | Septa description | Thickness | Pack of | REF |
|---|---|---|---|---|
| N 20 aluminium complete tear off cap, silver | Butyl dark gray / PTFE gray* | 3 mm | 100 | 70235 |
| N 20 aluminium complete tear off cap, silver | Butyl stopper gray, unassembled (separate parts) | – | 100 each | 70238 |
| N 20 aluminium complete tear off cap, silver | no liner | – | 100 | 702805 |

### N 20 septa for crimp caps N 20

| Material | Illustration | Thickness | Pack of | REF |
|---|---|---|---|---|
| Butyl red / PTFE gray | | 3 mm | 100 | 70277 |
| Butyl light gray / PTFE dark gray | | 3 mm | 100 | 702057 |
| Molded septum Butyl / PTFE gray | | 3 mm | 100 | 702101 |
| Butyl dark gray / PTFE gray* | | 3 mm | 100 | 702D20TB |
| Silicone blue transparent / PTFE colorless | | 3 mm | 100 | 702780 |
| Silicone white / PTFE beige | | 3 mm | 100 | 70278 |
| Silicone white / Aluminium foil silver | | 3 mm | 100 | 70279 |

* only centrically laminated, typically called Pharma-Fix

### Stoppers N 20

| Material | Illustration | Pack of | REF |
|---|---|---|---|
| Butyl gray | | 100 | 702931 |
| Bromobutyl red | | 100 | 702931.1 |

## Ordering information

### PE caps N 20

height 8.4 mm

70266

702128

height 9.1 mm

70267

702129

| Description | Pack of | REF |
|---|---|---|
| N 20 PE cap, transparent, for beveled HS crimp neck N 20, 4.3 mm center hole (no liner) | 100 | 70266 |
| as above, but with septum Butyl beige / PTFE gray, unassembled, 1.3 mm | 100 | 70242 |
| as above, but with assembled septum natural rubber red-orange / TEF colorless, 1.3 mm | 100 | 702128 |
| N 20 PE cap, transparent, for flat DIN crimp neck N 20, 4.3 mm center hole (no liner) | 100 | 70267 |
| as above, but with septum Butyl beige / PTFE gray, unassembled, 1.3 mm | 100 | 70240 |
| as above, but with assembled septum natural rubber red-orange / TEF colorless, 1.3 mm | 100 | 702129 |

### N 19 septa for PE caps N 20

| Description | Illustration | Thickness | Pack of | REF |
|---|---|---|---|---|
| Butyl beige / PTFE gray | | 1.3 mm | 100 | 70269 |
| Natural rubber red-orange / TEF colorless | | 1.3 mm | 100 | 702904 |
| Silicone blue transparent / PTFE white | | 1.3 mm | 100 | 702144 |

## Screw neck vials and caps N 24 (EPA)

### Key features

- Recommended for VOC and TOC analyses
- Closed top screw closures for sample storage
- Most frequently used: 40 mL clear glass
- Often called EPA vials, since they are defined in the regulations of the US Environmental Protection Agency
- Due to their size mainly used as bonded closure for a firm fit of the septum
- Recommended for environmental analysis: screw closure with center hole and Silicone / PTFE septum
- Universal screw closure 702168 with removable protection lid for sample storage and analysis

### Ordering information

#### Screw neck vials N 24 (EPA)

702021 / 702022

702132 / 702133

702023 / 702024

702074 / 702131

(Illustrations scale 1:2)

| Type of vial | Usable volume | OD x height | Pack of | REF |
|---|---|---|---|---|
| Clear, flat bottom | 20 mL | 27.5 x 57.0 mm | 100 | 702021 |
| Amber, flat bottom | 20 mL | 27.5 x 57.0 mm | 100 | 702022 |
| Clear, flat bottom | 30 mL | 27.5 x 72.5 mm | 100 | 702132 |
| Amber, flat bottom | 30 mL | 27.5 x 72.5 mm | 100 | 702133 |
| Clear, flat bottom | 40 mL | 27.5 x 95.0 mm | 100 | 702023 |
| Amber, flat bottom | 40 mL | 27.5 x 95.0 mm | 100 | 702024 |
| Clear, flat bottom | 60 mL | 27.5 x 140 mm | 100 | 702074 |
| Amber, flat bottom | 60 mL | 27.5 x 140 mm | 100 | 702131 |

#### Container for screw neck vials N 24

| Description | Pack of | REF |
|---|---|---|
| 16 position container blue, with removable divider, for screw neck vials N 24 (20 mL, 30 mL, 40 mL); outer length 130 mm, outer width 130 mm, outer height 102 mm, with transparent lid (suitable for freezers) | 1 | 702517 |

# Screw neck vials and caps N 24

## Ordering information

### Screw closures N 24 and plain screw caps N 24

702058 702059 702073

702168

702130 702102

702060 702061
– –

| Cap description | Septa description | Thickness | Pack of | REF |
|---|---|---|---|---|
| N 24 PP bonded* screw cap, white, center hole | Silicone white / PTFE beige | 3.2 mm | 100 | 702058 |
| as above, but with closed top | Silicone white / PTFE beige | 3.2 mm | 100 | 702059 |
| N 24 PP bonded* screw cap, white, center hole | Red Rubber / TEF colorless | 2.5 mm | 100 | 702073 |
| N 24 PP bonded* screw cap, white, center hole, with removable protection lid | Silicone natural / PTFE colorless | 3.2 mm | 100 | 702168 |
| N 24 PP screw cap, white, center hole | Butyl red / PTFE gray | 2.4 mm | 100 | 702130 |
| as above, but with closed top | Butyl red / PTFE gray | 2.4 mm | 100 | 702102 |
| N 24 PP screw cap, white, center hole | no liner | | 100 | 702060 |
| as above, but with closed top | no liner | | 100 | 702061 |

* septum firmly connected with the cap, cannot be removed

### Septa N 22 for screw caps N 24

| Material | Illustration | Thickness | Pack of | REF |
|---|---|---|---|---|
| Silicone natural / PTFE colorless | | 3.2 mm | 100 | 702062 |
| Butyl red / PTFE gray | | 2.4 mm | 100 | 702791 |

## Ordering information

### Pre-sealed vial-closure combinations with screw neck N 24

| Vial description | Closure description | Pack of | REF |
|---|---|---|---|
| Pre-sealed vials 702021:<br>20 mL screw neck vial N 24, 27.5 x 57 mm, clear, flat bottom | pre-screwed with 702073:<br>N 24 PP bonded screw cap, white, center hole, Red rubber / TEF colorless, 45° shore A, 2.5 mm | 100 | 702865 |
| Pre-sealed vials 702023:<br>40 mL screw neck vial N 24, 27.5 x 95 mm, clear, flat bottom | pre-screwed with 702058:<br>N 24 PP bonded screw cap, white, center hole, Silicone white / PTFE beige, 45° shore A, 3.2 mm | 100 | 702877 |

Other pre-sealed vial-closure combinations on request.

## Universal screw closure N 24

### All-in-one closure for sample storage and analysis, REF 702168

- Fits on all screw neck vials N 24 (EPA)
- Removable protection lid covers the penetration area and thus keeps the septa dust and contamination free
- Bonded Silicone / PTFE septa for safe penetration (septa is firmly connected to the screw cap)
- Ultrapure, soft Silicone / PTFE septa material prevents ghost peaks in the analysis
- Protection lid can repeatedly be removed and put on again

## Containers

### Key features

- Allow a secure transportation of sample vials
- Safe standing position in dividers designed for the respective diameter
- Ideal for space-saving storage in fridges, since the transparent lid prevents condensations on the closures and thus avoids a possible contamination in the cooling unit
- Available for all 1.5 mL vials (standard volume), for crimp and screw neck vials N 13 and for headspace vials with screw neck N 18 or crimp neck N 20, respectively as well as for EPA screw neck vials N 24

### Ordering information

#### Containers

| Description | Pack of | REF |
|---|---|---|
| 81 position container blue, with integrated divider for all vials 11.6 x 32 mm outer length 130 mm, outer width 130 mm, outer height 45 mm, coded, with transparent lid (suitable for freezers) | 1 | 702514 |
| 49 position container blue, with integrated divider for crimp and screw neck vials N 13; outer length 130 mm, outer width 130 mm, outer height 50 mm, with transparent lid (suitable for freezers) | 1 | 702515 |
| 25 position container blue, with removable divider for headspace screw neck vials N 18 and crimp neck vials N 20; outer length 130 mm, outer width 130 mm, outer height 80 mm, with transparent lid (suitable for freezers) | 1 | 702516 |
| 16 position container blue, with removable divider for screw neck vials N 24 (20 mL, 30 mL, 40 mL); outer length 130 mm, outer width 130 mm, outer height 102 mm, with transparent lid (suitable for freezers) | 1 | 702517 |

### Ordering information

#### Vial racks

| Description | Pack of | REF |
|---|---|---|
| 50 position polypropylene vial rack blue, for all vials 11.6 x 32 mm with flat bottom Dimensions: 190 x 100 x 22 mm, stackable | 1 | 702502 |
| 50 position polypropylene vial rack blue, for all vials with a diameter of 15 mm max. and flat bottom Dimensions: 240 x 120 x 28 mm, stackable | 1 | 702504 |

## Manual crimping tools

### Advanced ergonomic version

Crimper available for 8 mm, 11 mm and 20 mm crimp caps

- More lightweighted than complete steel crimpers
- Ergonomically designed handles
- Adjustment by a knob on the crimping head that is easily accessible and visible
- Activated by bottom handle motion only which allows a steadier and safer hold of the tool during crimping
- Due to design and alignment of the crimping head better vertical clearance over the vial

Advanced ergonomic decappers allow safe removal of caps; no adjustment required (for 11 and 20 mm crimp caps available)

### Standard version

Crimper available for 8, 11, 13 and 20 mm crimp caps

- Adjustable crimping height via hexagon key, which allows to move the inner part of the crimping head up and down (not possible for manual crimpers N 8)
- Crimping pressure adjustable via screw in the handle
- Manual crimpers for N 13 and N 20 Flip Top / Flip Off caps (pharmaceutical closures) available
- Long life time and convenient handling

Manual decappers (standard version) allow safe removal of caps; no adjustment required

### Ordering information

| Description | Pack of | REF |
|---|---|---|
| **Manual crimpers (ergonomic)** | | |
| (crimping pressure adjustable by knob on the crimping head) | | |
| Manual ergonomic crimper for 8 mm aluminium crimp caps | 1 | 735208 |
| Manual ergonomic crimper for 11 mm aluminium crimp caps | 1 | 735211 |
| Manual ergonomic crimper for 20 mm aluminium crimp caps | 1 | 735220 |
| **Manual decappers (ergonomic)** | | |
| Manual ergonomic decapper for 11 mm aluminium crimp caps | 1 | 735311 |
| Manual ergonomic decapper for 20 mm aluminium crimp caps | 1 | 735320 |
| **Manual crimpers (standard)** | | |
| Crimping height: adjustable by a hexagon key in the crimping head<br>Crimping pressure: adjustable by a screw in the handle | | |
| Manual crimper for 8 mm aluminium crimp caps | 1 | 735126 |
| Manual crimper, height adjustable, for 11 mm aluminium crimp caps | 1 | 735111 |
| Manual crimper, height adjustable, for 13 mm aluminium crimp caps | 1 | 735113 |
| Manual crimper, height adjustable, for 13 mm Flip Top / Flip Off crimp caps | 1 | 735133 |
| Manual crimper, height adjustable, for 20 mm aluminium crimp caps | 1 | 735120 |
| Manual crimper, height adjustable, for 20 mm Flip Top / Flip Off crimp caps | 1 | 735132 |
| **Manual decappers (standard)** | | |
| Manual decapper for 8 mm aluminium crimp caps | 1 | 735408 |
| Manual decapper for 11 mm aluminium crimp caps | 1 | 735911 |
| Manual decapper for 13 mm aluminium crimp caps | 1 | 735913 |
| Manual decapper for 20 mm aluminium crimp caps | 1 | 735920 |
| **Manual decapper (plier style) for two cap sizes** | | |
| Manual decapper, for 11 mm and 20 mm crimp caps | 1 | 735911.20 |

## Electronic crimping tools

### Battery-powered electronic crimping tools

Available for 11 mm and 20 mm aluminium crimp caps (not suitable for 20 mm magnetic / bi-metal crimp caps). Mobile tools for consistent and reproducible crimping results

- Crimping pressure adjustable by pushing +/– buttons of the control unit on top of the tool
- Long lasting lithium ion cell batteries (full battery charge for several hundred vials, life time of battery > 1500 charges)
- CE certificate of conformity along with one year warranty
- One tool each necessary for crimping and for decapping
- For more convenient handling a stand is optionally available

### Electronic high power crimping tool

Available for 11 mm and 20 mm crimp caps (also suitable for magnetic / bi-metal crimp caps). Due to a more powerful motor also suitable for magnetic and bi-metal crimp caps

- Fixed power supply
- Exchangeable crimping / decapping heads
- Digital LED display of crimp settings; different jaw settings can be stored in separate programs
- CE certificate of conformity along with one year warranty
- For more convenient handling a stand is optionally available

### Ordering information

| Description | Pack of | REF |
|---|---|---|
| **Electronic crimpers (battery-powered)** | | |
| Electronic crimper for 11 mm aluminium crimp caps | 1 | 735511 |
| Electronic crimper for 20 mm aluminium crimp caps (not suitable for magnetic / bi-metal crimp caps) | 1 | 735520 |
| **Electronic decappers (battery-powered)** | | |
| Electronic decapper for 11 mm aluminium crimp caps | 1 | 735611 |
| Electronic decapper for 20 mm aluminium crimp caps (not suitable for magnetic / bi-metal crimp caps) | 1 | 735620 |
| **Accessories for battery-powered electronic crimping / decapping tools** | | |
| Replacement battery 6.6 Volt, 8.6 Wh | 1 | 735500 |
| Stand for electronic crimping tools | 1 | 735501 |
| **Electronic high power crimping tool** | | |
| Electronic high power crimping tool with power supply (please order exchangeable crimping / decapping heads separately) | 1 | 735700 |
| **Accessories for 735700** | | |
| Crimping head for 11 mm crimp caps (for electronic high power crimping tool 735700) | 1 | 735711 |
| Crimping head for 20 mm crimp caps (for electronic high power crimping tool 735700) | 1 | 735720 |
| Decapping head for 11 mm crimp caps (for electronic high power crimping tool 735700) | 1 | 735811 |
| Decapping head for 20 mm crimp caps (for electronic high power crimping tool 735700) | 1 | 735820 |
| Stand for electronic crimping tools | 1 | 735501 |

## Autosampler compatibility charts

The autosampler compatibility charts generally show the most typical vials and closures for use on the instruments of a given manufacturer. In addition to the products listed in those charts, our catalog may contain other technically and functionally suitable products for use on a given autosampler which are not marketed actively as accessories by the respective manufacturer. We look forward to recommend any suitable product.

Compatibility charts have been compiled for the following instrument manufacturers: Agilent®, CTC, Dionex®, Knauer, PerkinElmer®, Shimadzu®, Thermo Scientific®, Varian® (Agilent®), VWR® (Merck®/Hitachi®), Waters®. Where applicable, each chart is divided into fields of use (GC, HPLC, Headspace).

We generally recommend that you ask for cost-free samples for testing purposes, as even technically comparable products may differ in their optical appearance.

We kindly ask for your understanding that we do not take over any guarantee for the correctness and completeness of the data indicated here.

### Agilent®

| Application / Type of vial | Most popular MN products for use on Agilent® instruments | | | Page |
|---|---|---|---|---|
| | Vials: | Inserts: | Closures: | |
| GC | | | | |
| N 8 crimp (micro sampling) | 70282, 70286 | | 70289, 702878 | 101 |
| N 9 screw (standard sample) | 702282, 702293, 702283, 702078, 702284, 702079, 702006, 702088, 702007, 702008, 702135, 702335, 702009, 702172, 702010, 702500 | 702716, 702813, 702077, 702818, 702818.1, 702825 | 702732, 702080, 702082, 702081, 702287.1, 702037, 702038, 702035, 702084, 702085, 702026<br><br>702155 (for GC PAL) | 104 |
| N 11 crimp (standard sample) | 70201HP, 70201HP.2, 702885, 702075, 702892, 702076, 702888, 702015, 702016, 702891, 702014, 702134, 702334 | 702716, 702813, 702077, 702818, 702818.1, 702825 | 70256, 702730, 702001, 70231.3, 70231.1, 70231.2, 70288, 702995, 702146<br><br>702879 (for GC PAL) | 109 |
| HPLC | | | | |
| N 9 screw (standard sample) | as indicated under GC, additionally closures with slit septum: 702288.1, 702083, 702040, 702027, however, not closure 702155 | | | 104 |
| N 11 crimp (standard sample) | as indicated under GC, however, not closures 702146 and 702879 | | | 109 |
| N 11 snap ring (standard sample) | 702714, 702713, 702712, 702709, 702134, 702334, 702809, 702173, 702174 | 702716, 702813, 702077, 702818, 702818.1, 702825 | 702063, 702063.2080, 702710.1, 702710.2080, 702731, 702064, 702718 | 114 |
| Headspace | | | | |
| N 18 screw (Combi PAL + G 1888A) | 702866, 702826, 702826.2 | | 702055 | 125 |
| N 20 crimp | 702918, 702261<br><br>for Combi PAL:<br>702924, 702263, 702263.2 | | 70234, 70234.10, 702071, 702094, 702835, 70237<br><br>702929 (for Combi PAL) | 126 |

## CTC

| Application / Type of vial | Most popular MN products for use on CTC instruments | | | Page |
|---|---|---|---|---|
| | Vials: | Inserts: | Closures: | |
| **GC** | | | | |
| N 8 crimp (micro sampling) | 70282, 70286 | | 70289, 702878 | 101 |
| N 9 screw (standard sample) | 702282, 702293, 702283, 702284, 702078, 702079, 702006, 702007, 702008, 702135, 702335 | 702716, 702813, 702077, 702818, 702818.1, 702825 | 702287, 702287.1, 702036, 702037, 702038, 702107, 702026, 702286, 702035, 702158, 702084, 702085, 702159<br>702155 (for GC PAL) | 104 |
| N 11 crimp (standard sample) | 70201HP, 70201HP.2, 702885, 702892, 702075, 702076, 702888, 702891, 702014, 702134, 702334 | 702716, 702813, 702077, 702818, 702818.1, 702825 | 70288, 702995<br>702879 (for GC PAL) | 109 |
| **HPLC** | | | | |
| N 9 screw (standard sample) | as indicated under GC, additionally closures with slit septum: 702288, 702288.1, 702027, 702039, 702040, 702083, 702109, however, not closure 702155 | | | 104 |
| N 11 crimp (standard sample) | as indicated under GC, additionally closure 702823 with slit septum, however, not closure 702879 | | | 109 |
| N 11 snap ring (standard sample) | 702714, 702713, 702712, 702709, 702134, 702334, 702809, 702173, 702174 | 702716, 702813, 702077, 702818, 702818.1, 702825 | 702710.1, 702717.2, 702718.1, 702710, 702064, 702718 | 114 |
| **Headspace** | | | | |
| N 18 screw (Combi PAL) | 702866, 702826, 702826.2 | | 702827, 702055 | 125 |
| N 20 crimp | 702924, 702263, 702263.2 | | 702929, 702834<br>closure for washer bottle 702924: 70267 + 702144 | 126 |

## Dionex® (Thermo Scientific®)

| Application / Type of vial | Most popular MN products for use on Dionex® instruments | | | Page |
|---|---|---|---|---|
| | Vials: | Inserts: | Closures: | |
| **HPLC** | | | | |
| N 8 crimp (micro sampling) | 70282, 70286 | | 702025, 70289 | 101 |
| N 8 screw (standard sample) | 70213, 70213.2, 702004, 702893, 702860 | 702968, 702968.1, 702824, 702005 | 70245, 702437 | 102 |
| N 9 screw (standard sample) | 702282, 702293, 702283, 702284, 702078, 702079, 702007, 702008, 702135, 702335, 702006, 702009, 702172, 702010, 702500 | 702813, 702077, 702818, 702818.1, 702825 | 702287.1, 702287, 702036, 702037, 702038, 702107, 702288.1, 702288, 702039, 702040, 702083, 702109, 702026, 702027 | 104 |
| N 11 crimp (standard sample) | 70201HP, 70201HP.2, 702885, 702892, 702075, 702076, 702888, 702891, 702014, 702134, 702334 | 702813, 702077, 702818, 702818.1, 702825 | 70288, 702823, 70256 | 109 |
| N 11 snap ring (standard sample) | 702714, 702713, 702712, 702709, 702134, 702334, 702809, 702173, 702174 | 702813, 702077, 702818, 702818.1, 702825 | 702710.1, 702710, 702710.2080, 702717.2, 702064, 702717.2080 | 114 |
| N 13 screw (large sample volumes) | 702962, 702973 | 702972 + spring 702974 | 702926 | 119 |

# Autosampler compatibility

## Knauer

| Application / Type of vial | Most popular MN products for use on Knauer instruments | | | Page |
|---|---|---|---|---|
| | Vials: | Inserts: | Closures: | |
| HPLC (Knauer S3950, Knauer UHPLC Version AS-1, Knauer Optimas) | | | | |
| N 8 screw (standard sample) | 70213, 70213.2, 702004, 702893 | 702968, 702968.1, 702824, 702005 | 702067, 70245 | 102 |
| N 9 screw (standard sample) | 702282, 702293, 702283, 702284, 702078, 702079, 702006, 702007, 702008, 702135, 702335, 702088, 702009, 702172, 702010, 702500 | 702813, 702077, 702716, 702818, 702818.1, 702825 | 702732, 702030, 702080, 702081, 702082, 702147, 702287.1, 702287, 702036, 702037, 702038, 702107, 702028, 702026 | 104 |
| N 18 screw (large sample volumes) | 702866 | | 702072, 702055, 702827 | 125 |
| N 20 crimp (large sample volumes) | 702918 | | 702094, 702129 | 126 |

## PerkinElmer®

| Application / Type of vial | Most popular MN products for use on PerkinElmer® instruments | | | Page |
|---|---|---|---|---|
| | Vials: | Inserts: | Closures: | |
| GC | | | | |
| N 8 crimp (micro sampling) | 70251 | | 70252.1, 702025 | 101 |
| N 11 crimp (standard sample) | 70201CG*, 70214CG* 70201HP**, 70201HP.2**, 702885**, 702892**, 702075**, 702076**, 702891, 702014, 702134, 702334 | 702824*, 702005* 702818**, 702818.1**, 702825** | 702730, 70256, 70231.1, 70231.2, 70231.3, 70288, 702995 | 109 |
| * small opening; ** wide opening | | | | |
| HPLC | | | | |
| N 8 crimp (micro sampling) | 70286 | | 70252.1, 702025 | 101 |
| N 8 screw (standard sample) | 70213, 70213.2, 702004, 702892 | 702824, 702005 | 702067 = 70249 + 702070, 70245 | 102 |
| N 9 screw (standard sample) | 702282, 702293, 702283, 702284, 702078, 702079, 702009, 702172, 702010, 702500, 702007, 702008, 702135, 702335 | 702818, 702818.1, 702825 | 702288.1, 702027, 702287.1, 702026, 702732, 702028 | 104 |
| N 10 screw (standard sample) | 702012, 702013 | 702818, 702818.1, 702825 | 702047, 702044, 702045, 702046 | 108 |
| N 11 crimp (standard sample) | as indicated under GC | | | 109 |
| N 11 snap ring (standard sample) | 702714, 702713, 702712, 702709, 702134, 702334 | 702818, 702818.1, 702825 | 702064, 702710, 702718 | 114 |
| Headspace | | | | |
| N 18 screw (CTC Combi PAL + TurboMatrix™ HS 16 + 40) | 702866, 702826, 702826.2 | | 702055, 702827, 702072 | 125 |
| N 20 crimp (CTC Combi PAL) | 702924, 702263, 702263.2 | | 702929, 702834, 702774, 702928.9, 702928 | 126 |
| N 20 crimp (TurboMatrix™ HS 16, 40 + 110) | 702917**, 70254, 702540, 702541 | | 702836, 702773, 702829, 70234.8, 702775, 70234.9, 702835, 702927, 702094, 702093, 702145, 70234, 70234.10, 702931 + 702804, 70237 | 126 |
| ** not suited for TurboMatrix™ 110 | | | | |

## Shimadzu®

| Application / Type of vial | Most popular MN products for use on Shimadzu® instruments | | | Page |
|---|---|---|---|---|
| | Vials: | Inserts: | Closures: | |
| GC | | | | |
| N 8 crimp (micro sampling) | 70282, 70286 | | 70289, 702878 | 101 |
| N 9 screw (standard sample) | 702282, 702293, 702283, 702284, 702078, 702079, 702006, 702007, 702008, 702135, 702335 | 702716, 702813, 702077, 702825, 702818, 702818.1 | 702081, 702036, 702037, 702038, 702107, 702287.1, 702026<br>702155 (for AOC 5000) | 104 |
| N 10 screw (standard sample) | 702011, 702012, 702013 | as indicated under N 9 screw | 702045, 702046, 702048 | 108 |
| N 11 crimp (standard sample) | 70201HP, 70201HP.2, 702885, 702892, 702075, 702076, 702888, 702891, 702014, 702134, 702334, 702141 | 702716, 702813, 702077, 702825, 702818, 702818.1 | 70288, 702995<br>702879 (for AOC 5000) | 109 |
| N 13 screw (large sample volumes) | 702962, 702973 | 702972 + spring 702974 | 702926, 702963 + 702292 | 119 |
| HPLC | | | | |
| N 8 crimp (micro sampling) | 70282, 70286 | | 70289, 702878 | 101 |
| N 9 screw (standard sample) | 702282, 702293, 702283, 702284, 702078, 702079, 702006, 702007, 702008, 702135, 702335 | 702716, 702813, 702077, 702825, 702818, 702818.1 | 702287.1, 702036, 702037, 702038, 702107, 702026, 702039, 702040, 702083, 702288.1, 702109, 702027 | 104 |
| N 10 screw (standard sample) | 702011, 702012, 702013 | as indicated under N 9 screw | 702045, 702046, 702047 | 108 |
| N 11 crimp (standard sample) | as indicated under N 11 crimp GC | as indicated under N 11 crimp | 70288, 702823 | 109 |
| N 11 snap ring (standard sample) | 702714, 702713, 702712, 702709, 702134, 702334 | as indicated under N 9 screw | 702710.1, 702710, 702717.2, 702064 | 114 |
| N 8, N 12 shell vials (standard sample) | | | vials + stoppers:<br>70202.1 + 702807,<br>702017 + 702807,<br>702018 + 702054 | 124 |
| Headspace | | | | |
| N 18 screw (AOC 5000) | 702866, 702826, 702826.2 | | 702055, 702827 | 125 |
| N 20 crimp (AOC 5000) | 702924, 702263, 702263.2 | | 702929, 702928, 702834<br>for washer bottle 702924:<br>70267 + 702144 | 126 |

# Autosampler compatibility

## Thermo Scientific®

| Application / Type of vial | Most popular MN products for use on Thermo Scientific® instruments<br>Vials: | Inserts: | Closures: | Page |
|---|---|---|---|---|
| GC | | | | |
| N 8 crimp (micro sampling) | 70282, 70286, 70251 | | 70289, 702025 | 101 |
| N 8 screw (standard sample) | 70213, 70213.2, 702004, 702893 | 702968, 702968.1, 702824, 702005 | 702067, 70245, 702069 | 102 |
| N 9 screw (standard sample) | 702282, 702293, 702283, 702284, 702078, 702079, 702006, 702007, 702008, 702135, 702335 | 702716, 702813, 702077, 702818, 702818.1, 702825 | 702732, 702081, 702084, 702287.1, 702037, 702026<br>702155 (for GC PAL) | 104 |
| N 11 crimp (standard sample) | 70201HP, 70201HP.2, 702885, 702892, 702075, 702076, 702888, 702891, 702014, 702134, 702334 | 702716, 702813, 702077, 702818, 702818.1, 702825 | 70256, 702730, 70288<br>702879 (for GC PAL) | 109 |
| HPLC | | | | |
| N 8 crimp (micro sampling) | 70282, 70286 | | 70289, 702025 | 101 |
| N 8 screw (standard sample) | as indicated under GC | | | 102 |
| N 9 screw (standard sample) | as indicated under GC, but additionally closures 702040 and 702027, however, not closure 702155 | | | 104 |
| N 11 crimp (standard sample) | as indicated under GC, however, not closure 702879 | | | 109 |
| N 11 snap ring (standard sample) | 702714, 702713, 702712, 702709, 702134, 702334, 702809, 702173, 702174 | 702716, 702813, 702077, 702818, 702818.1, 702825 | 702063.2080, 702063, 702710.2080, 702710.1, 702717.2080, 702710.2080 | 114 |
| Headspace | | | | |
| N 18 screw (Combi PAL) | 702866, 702826, 702826.2 | | 702055, 702827 | 125 |
| N 20 crimp (Combi PAL) | 702924, 702263, 702263.2 | | 702929, 702834 | 126 |
| N 20 crimp (HS850/HS200) | 702924, 702263, 702263.2 | | 702775, 70234.9, 702773, 702931 + 702804 = 70237, 702093 | 126 |

## Varian® (now Agilent®)

| Application / Type of vial | Most popular MN products for use on Varian® instruments<br>Vials: | Inserts: | Closures: | Page |
|---|---|---|---|---|
| GC | | | | |
| N 8 crimp (micro sampling) | 70282, 70286 | | 70289, 702878 | 101 |
| N 8 screw (standard sample) | 70213, 70213.2, 702004, 702893 | 702968.1, 702824, 702005 | 702067, 70245, 702069 | 102 |
| N 9 screw (standard sample) | 702282, 702293, 702283, 702284, 702078, 702006, 702079, 702008, 702007, 702135, 702335 | 702813, 702077, 702818, 702818.1, 702825 | 702732, 702287.1, 702037, 702084<br>702155 (for GC PAL) | 104 |
| N 11 crimp (standard sample) | 70201HP, 70201HP.2, 702885, 702892, 702075, 702076, 702888, 702891, 702014, 702134, 702334 | 702813, 702077, 702818, 702818.1, 702825 | 70256, 702730, 70288, 702995<br>702879 (for GC PAL) | 109 |
| HPLC | | | | |
| N 8 crimp (micro sampling) | as indicated under GC | | | 101 |
| N 8 screw (standard sample) | as indicated under GC, but additionally closure 702437 | | | 102 |
| N 9 screw (standard sample) | as indicated under GC, but additionally PP vials 702009, 702172, 702010, 702500 as well as closures 702040 and 702288.1 | | | 104 |
| N 11 crimp (standard sample) | as indicated under GC, but additionally closures 70231.4 and 70231.2 | | | 109 |
| N 11 snap ring (standard sample) | 702714, 702713, 702712, 702709, 702134, 702334, 702809, 702173, 702174 | 702813, 702077, 702818, 702818.1, 702825 | 702731, 702063, 702710, 702710.1, 702064, 702717.2, 702718, 702718.1 | 114 |
| Headspace | | | | |
| N 18 screw (Combi PAL) | 702866, 702826, 702826.2 | | 702827, 702072, 702055 | 125 |
| N 20 crimp (Combi PAL) | 702924, 702263, 702263.2 | | 702929, 702834 | 126 |
| N 20 crimp (CP-9020/9025, CP-9060, Genesis) | 702924, 702918, 702261 | | 70234, 70234.10, 702775, 702094, 702931 + 702804 = 70237 | 126 |

## VWR® (Merck® / Hitachi®)

| Application / Type of vial | Most popular MN products for use on VWR® instruments | | | Page |
|---|---|---|---|---|
| | Vials: | Inserts: | Closures: | |
| HPLC | | | | |
| N 8 crimp (micro sampling) | 70282, 70286 | | 70289, 702878 | 101 |
| N 8 screw (standard sample) | 70213, 70213.2, 702004, 702893, 702860 | 702968, 702968.1, 702824, 702005 | 70245, 702437, 702067 | 102 |
| N 9 screw (standard sample) | 702282, 702293, 702283, 702078, 702284, 702079, 702007, 702008, 702135, 702335, 702006, 702009, 702172, 702010, 702500 | 702813, 702077, 702818, 702818.1, 702716, 702825 | 702287.1, 702287, 702036, 702037, 702038, 702107, 702288.1, 702288, 702039, 702040, 702083, 702109, 702026, 702027 | 104 |
| N 11 crimp (standard sample) | 70201HP, 70201HP.2, 702885, 702075, 702892, 702076, 702888, 702891, 702014, 702134, 702334 | 702813, 702077, 702818, 702818.1, 702716, 702825 | 70288, 702823 | 109 |
| N 11 snap ring (standard sample) | 702714, 702713, 702712, 702709, 702134, 702334, 702809, 702173, 702174 | 702813, 702077, 702818, 702818.1, 702716, 702825 | 702710.1, 702710, 702717.2, 702064, 702718.1, 702718, 702063, 702731 | 114 |
| N 13 screw (large sample volumes) | 702962, 702973 | 702972 + spring 702974 | 702926, 702963 + 70260 | 119 |

## Waters®

| Application / Type of vial | Most popular MN products for use on Waters® instruments | | | Page |
|---|---|---|---|---|
| | Vials: | Inserts: | Closures: | |
| HPLC | | | | |
| N 9 screw (standard sample) | 702282, 702293, 702283, 702284, 702078, 702079, 702007, 702008, 702135, 702335, 702006, 702009, 702172, 702010, 702500 | 702818, 702818.1 | 702026, 702027, 702287.1, 702287, 702036, 702037, 702038, 702288.1, 702288, 702039, 702040, 702083 | 104 |
| N 10 screw (standard sample) | 702011, 702012, 702013 | 702818, 702818.1 | 702045, 702046, 702047 | 108 |
| N 11 crimp (standard sample) | 70201HP, 70201HP.2, 702885, 702892, 702075, 702076 | 702818, 702818.1 | 70288, 702995 | 109 |
| N 11 snap ring (standard sample) | 702714, 702713, 702712, 702709, 702134, 702334, 702809, 702173, 702174 | 702818, 702818.1 | 702710.1, 702717.2 | 114 |
| N 8 shell vials (standard sample) | | | vials + closures: 70202.1 + 702807, 702017 + 702807 | 124 |
| N 13 screw (large sample volumes) | 702962, 702973 | 702972 + spring 702974 | 702926, 702963 + 70260 | 119 |

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Packings for preparative applications:
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# Basics

High performance liquid chromatography (HPLC) is part of liquid chromatographic separating processes of substance mixtures and their analysis. At the beginning the technique was also called high pressure liquid chromatography due to the high back pressure of the column. HPLC offers qualitative (identification of substances) and quantitative (concentration determination) analysis by comparison with standard substances. The term HPLC was introduced in the 1970s, for the delineation of the high-performance method to the in the 1930s developed column liquid chromatography (column chromatography). At the beginning of the 21st century the HPLC was complemented by the even more efficient UHPLC (ultra high performance liquid chromatography). Hereby even higher pressures (> 400 bar) result in shorter analysis time and enhanced efficiency enabling a higher sample throughput with smaller sample volumes.

## Application

HPLC / UHPLC is used additionally to gas chromatography (GC) for separation and determination of complex substance mixtures composed of low-volatile, polar and ionic, high-molecular or thermal instable substances. Therefore a sufficient solubility of the sample in a solvent or a solvent mixture is required. HPLC / UHPLC is used for purity control of chemicals and industrial products, determination of active agents for drug development, production and testing, environmental analytics, quality and purity control of foods, analysis of ingredients in cosmetics as well as for the isolation of biopolymers.

## Basic principle

In liquid column chromatography a mobile phase (eluent) flows through a particle filled tube (separation column, stationary phase). In classic column chromatography this tube is a glass column with an inner diameter of several centimeters and a length up to 450 mm or even bigger. The filling material typically consists of coarse-grained particles like silica gel 60. The eluent is transported through the separation column either by hydrostatic pressure or a low-pressure pump with 1.5-2 bar.

In contrast HPLC columns consist of stainless steel with an inner diameter of 2-4.6 mm and a length of 20-300 mm. The column packing, mostly modified porous silica, has generally a particle size of 3, 5, 7 or 10 µm and a pore size of 50, 100, 120 (for low-molecular analytes) or 300-4000 Å (for high-molecular analytes). In UHPLC shorter columns in the range of 20-150 mm length with highly efficient particles of 1.8 µm size (sub-2 µm) are utilized. A guard column of a few millimeters length can be utilized and installed with a specific Column Protection System to increase the column lifetime. HPLC / UHPLC uses a high-pressure pump to transport the eluent from a storage vessel into the system with a column back pressure of up to 600 / 1200 bar.

## Instrument

HPLC as well as UHPLC instruments have different building blocks. The storage vessel (eluent reservoir, 1) usually contains a deaerator unit (3) for the solvents. Followed by a gradient valve (4) with mixing chamber (5) in flow direction, which allows the usage of isocratic as well as gradient methods. A high-pressure pump (6) transports the sample into the system. The sample is injected via an injection valve (7). Usually this is operated automatically with a syringe by an autosampler. With the eluent flow the sample is transported to the guard and the separating column (8). For better reproducibility of the separation tempering with a column oven (2) should be performed. The separated substances are determined with a detector (9). In the resulting chromatogram each detector signal of a substance (peak), is related to the retention time of the column. With the data evaluation (10) these peaks can be identified and their concentration can be determined.

## Separation mechanism

While flowing through the column each component of the solved mixture interacts differently with the stationary phase. According to the characteristics of the substance (hydrophobic, polar, ionic, aromatic, sterically hindered etc.) the strength of the interactions vary and thus the compounds are retained by the stationary phase in different ways. Essentially a distinction is drawn between normal phase (NP), reversed phase (RP) and ion exchange chromatography. Depending on the structure of the stationary phase diverse interactions e.g., van der Waals forces or π-π-stacking can occur and different polar mobile phases are required. For polar stationary normal phases (e.g., SiOH, CN, OH, $NH_2$) non-polar eluents like *n*-heptane, hexane, dichloromethane or 2-propanol are applicable. While for reversed phases (e.g., $C_{18}$, $C_8$, $C_4$, $C_2$, $C_6H_5$) typically polar RP eluents (e.g., acetonitrile or methanol with ultrapure water or buffer) and for ion exchange (e.g., SA, SB) aqueous buffers (e.g., phosphate, acetate, citric buffer) come to use.

## Selectivity

The characteristic separation behavior of phases under certain conditions is also called selectivity. This is dependent on different parameters like structure and modifications of the base silica gel, nature of the chemical binding or the type of endcapping.

In recent decades several methods have been developed to compare and distinguish the selectivity of various silica gels and their modifications. In this connection defined substances or substance classes are analyzed and the chromatographic parameters are graphically presented. A frequently applied model in specialist literature is e.g., the TANAKA plot, which allows a quick comparison of different HPLC phases. [4]

Parameter of the Tanaka diagram:
Capacity = k' (pentylbenzene)
Hydrophobicity = α (pentylbenzene, butylbenzene)
Steric selectivity = α (triphenyl, *o*-terphenyl)
Hydrogen bonding capacity (capacity of silanol) = α (caffeine, phenol)
Ion exchange capacity at pH 2.7 = α (benzylamine, phenol)
Ion exchange capacity at pH 7.6 = α (benzylamine, phenol)

The comparison of NUCLEOSHELL® RP 18 and NUCLEOSHELL RP® 18plus for example shows a lower ion exchange capacity at pH 7.6 for the monomeric NUCLEOSHELL® RP 18plus. The radar chart also reflects a more pronounced steric selectivity of NUCLEOSHELL® RP 18 due to a higher density of modifications with $C_{18}$ chains.

## Characteristic parameters

The success of a chromatographic separation depends apart from the stationary and mobile phase also on other characteristics like the quality of the separating column or the linear flow rate. The following schematic chromatogram illustrates the most important parameters which characterize a separation.

Schematic chromatogram

| | |
|---|---|
| **Peak width:** | |
| $w_{1/2}$ | peak width at half height |
| w | peak width of the peak (intersection point of the inflectional tangents with the zero line) |
| **Peak symmetry:** | |
| A | peak front to peak maximum at 10 % of peak height |
| B | peak maximum to peak end at 10 % of peak height |
| **Retention time::** | |
| $t_0$ | dead time of a column = retention time of a non-retarded substance |
| $t_{R1}$, $t_{R2}$ | retention times of components 1 and 2 |
| $t'_{R1}$, $t'_{R2}$ | net retention times of components 1 and 2 |

In a chromatographic system the substances differ from each other in their retention time in or on the stationary phase. The time, which is needed by a sample component to migrate from column inlet (sample injection) to the column end (detector) is the retention time $t_{R1}$ or $t_{R2}$. The dead time $t_0$ is the time required by an inert compound to migrate from column inlet to column end without any retardation by the stationary phase. Consequently, the dead time is identical with the retention time of the sample component remaining in the stationary phase. The difference of total retention time and dead time yields the net retention time $t'_{R1}$ or $t'_{R2}$, which is the time a sample component remains in the stationary phase.

$$t'_{R1} = t_{R1} - t_0 \quad \text{bzw.} \quad t'_{R2} = t_{R2} - t_0$$

To compare chromatograms that are recorded with columns of different lengths and internal diameters, as well as different flow rates, the retention time is converted into a dimensionless capacity factor k'.

$$k'_1 = \frac{t_{R1} - t_0}{t_0} \quad \text{bzw.} \quad k'_2 = \frac{t_{R2} - t_0}{t_0}$$

The relative retention α, also known as the separation factor, describes the ability of a chromatographic system (stationary and mobile phase) to distinguish between two compounds. This is calculated from the rate of the capacity factors of the substances, where the figure in the denominator is the reference compound.

$$\alpha = \frac{k'_2}{k'_1}$$

The resolution R is a measure for the efficiency of the column to separate two substances. Besides the retention time $t_R$ the peak width at half height $w_{1/2}$ is also included.

$$R = 1.18 \cdot \frac{t_{R2} - t_{R1}}{(w_{1/2})_2 + (w_{1/2})_1}$$

For practical reasons the peak symmetry is calculated at 10 % of peak height. Ideally symmetry should be 1, i.e. A = B. Values > 1 indicate peak tailing, while values < 1 indicate peak fronting.

$$\text{Peak symmetry} = \frac{B}{A}$$

Instead of the mobile phase volumetric flow rate [mL/min], which is controlled at the HPLC instrument, it is advantageous to use the linear velocity u [cm/sec]. The linear velocity is independent of the column cross section and proportional to the pressure drop in the column. The linear velocity can be calculated by means of the dead time, where L is the column length in cm and $t_0$ the dead time in sec.

$$u = \frac{L}{t_0}$$

The quality of a column packing is determined through the number of theoretical plates N. High N values indicate a high capability to separate complex sample mixtures.

$$N = 5.54 \cdot \left(\frac{t_{R1}}{w_{1/2}}\right)^2$$

The value of the height equivalent to a theoretical plate HEPT is a criterion for the quality of a column. HEPT, is the length, in which the chromatographic equilibrium between mobile and stationary phase has been adjusted once. Its value depends on the particle size, the flow velocity, the mobile phase viscosity and especially on the packing quality. Small HEPT values, meaning a large number of theoretical plates N, facilitate the column to separate complex sample mixtures.

$$H = \frac{L}{N}$$

The Van Deemter equation shows the dependence of the HEPT on the velocity u.

$$H = A + \frac{B}{u} + C \cdot u$$

A term = eddy-diffusion, B term = longitudinal diffusion coefficient, C term = mass transfer coefficient, H = HEPT = height equivalent to a theoretical plate

The A term, also called eddy-diffusion, is a function of the particle size, the B term a function of the diffusion coefficient of the substance in the mobile phase and the C term the retardation of a substance by the interface between stationary and mobile phase. In the point of intersection of $h_{min}$ and $u_{opt}$ the optimal separation efficiency for a column with high peak symmetry for the separated substances is obtained.

## Column quality

Each HPLC / UHPLC column of MACHEREY-NAGEL is individually tested according to the most important characteristic parameters in quality control and the results are documented in a certificate of analysis.

Detailed information of the particular properties of the high-purity silica phases NUCLEODUR®, of the established standard silica NUCLEOSIL® and the modern Core-Shell material NUCLEOSHELL® as well as phases for special separations and the equivalent HPLC- and UHPLC-columns can be found on the following pages.

## Strict quality specifications for outstanding reliability

- Highest production standard
  our facilities are EN ISO 9001:2008 certified
- Perfect reproducibility from batch to batch and within each lot
- Each column is individually tested and supplied with test chromatogram and test conditions.

Test mixture* for reversed phase columns in acetonitrile, pack of 1 mL
REF 722394

MACHEREY-NAGEL
MN
EN ISO 9001:2008
CERTIFIED

Furthermore custom-packed columns with different column types, dimensions and particle sizes are available on request.

* This product (REF 722394) contains harmful substances which must be specially labeled as hazardous. For detailed information please see SDS.

## USP specification of MN HPLC phases

| Code | Specification | MN HPLC Phases | Page |
|---|---|---|---|
| USP L1 | octadecyl silane chemically bonded to porous silica particles 1.5 to 10 µm diameter, or monolithic silica gel | NUCLEODUR® $C_{18}$ ec | 181 |
| | | NUCLEODUR® $C_{18}$ Gravity | 158 |
| | | NUCLEODUR® $C_{18}$ Gravity-SB | 162 |
| | | NUCLEODUR® $C_{18}$ HTec | 178 |
| | | NUCLEODUR® $C_{18}$ Isis | 164 |
| | | NUCLEODUR® $C_{18}$ PAH | 227 |
| | | NUCLEODUR® $C_{18}$ Pyramid | 166 |
| | | NUCLEODUR® PolarTec | 168 |
| | | NUCLEODUR® Sphinx RP | 176 |
| | | NUCLEOSHELL® RP 18 | 200 |
| | | NUCLEOSHELL® RP 18plus | 202 |
| | | NUCLEOSIL® $C_{18}$ | 214 |
| | | NUCLEOSIL® $C_{18}$ AB | 214 |
| | | NUCLEOSIL® $C_{18}$ HD | 214 |
| | | NUCLEOSIL® $C_{18}$ MPN | 243 |
| | | NUCLEOSIL® $C_{18}$ PAH | 229 |
| | | NUCLEOSIL® $C_{18}$ PPN | 244 |
| USP L3 | porous silica particles, 1.5 to 10 µm diameter, or monolithic silica gel | NUCLEODUR® SiOH | 190 |
| | | NUCLEOSIL® SiOH | 224 |
| USP L7 | octyl silane chemically bonded to totally porous silica particles, 1.8 to 10 µm diameter | NUCLEODUR® $C_8$ ec | 181 |
| | | NUCLEODUR® $C_8$ Gravity | 158 |
| | | NUCLEOSIL® $C_8$ | 217 |
| | | NUCLEOSIL® $C_8$ HD | 217 |
| USP L8 | an essentially monomolecular layer of aminopropyl silane chemically bonded to totally porous silica gel support, 1.5 to 10 µm diameter | NUCLEODUR® $NH_2$ / $NH_2$-RP | 188 |
| | | NUCLEOSIL® Carbohydrate | 246 |
| | | NUCLEOSIL® $NH_2$ / $NH_2$-RP | 221 |
| USP L9 | irregular or spherical, totally porous silica gel having a chemically bonded, strongly acidic cation-exchange coating, 3 to 10 µm diameter | NUCLEOSIL® SA | 223 |
| USP L10 | nitrile groups chemically bonded to porous silica particles, 1.5 to 10 µm diameter | NUCLEODUR® CN / CN-RP | 186 |
| | | NUCLEOSIL® CN / CN-RP | 222 |

## USP specification of MN HPLC phases

| Code | Specification | MN HPLC Phases | Page |
|---|---|---|---|
| USP L11 | phenyl groups chemically bonded to porous silica particles, 1.5 to 10 µm diameter | NUCLEODUR® Phenyl-Hexyl | 170 |
| | | NUCLEODUR® $\pi^2$ | 172 |
| | | NUCLEOSHELL® Phenyl-Hexyl | 204 |
| | | NUCLEODUR® Sphinx RP | 176 |
| | | NUCLEOSIL® $C_6H_5$ | 220 |
| USP L14 | silica gel having a chemically bonded, strongly basic quaternary ammonium anion-exchange coating, 5 to 10 µm diameter | NUCLEOSIL® SB | 223 |
| USP L16 | dimethylsilane chemically bonded to porous silica particles, 5 to 10 µm diameter | NUCLEOSIL® $C_2$ | 219 |
| USP L17 | strong cation-exchange resin consisting of sulfonated cross-linked PS/DVB copolymer in the H form, 6 to 12 µm diameter | NUCLEOGEL® ION 300 OA | 248 |
| | | NUCLEOGEL® SUGAR 810 H | 247 |
| USP L19 | strong cation-exchange resin consisting of sulfonated cross-linked PS/DVB copolymer in the Ca form, 5 to 15 µm particle size | NUCLEOGEL® SUGAR 810 Ca | 247 |
| | | NUCLEOGEL® SUGAR Ca | 248 |
| USP L20 | dihydroxypropane groups chemically bonded to porous silica particles, 5 to 10 µm diameter | NUCLEOSIL® OH (Diol) | 220 |
| USP L21 | a rigid, spherical styrene-divinylbenzene copolymer, 5 to 10 µm diameter | NUCLEOGEL® RP | 245 |
| USP L22 | a cation-exchange resin made of porous polystyrene gel with sulfonic acid groups, about 10 µm in size | NUCLEOGEL® SCX | 240 |
| USP L23 | an anion-exchange resin made of porous polymethacrylate or polyacrylate gel with quaternary ammonium groups, about 10 µm in size | NUCLEOGEL® SAX | 240 |
| USP L26 | butyl silane chemically bonded to totally porous silica particles, 5 to 10 µm diameter | NUCLEODUR® $C_4$ ec | 241 |
| | | NUCLEOSIL® $C_4$ | 219 |
| | | NUCLEOSIL® $C_4$ MPN | 243 |
| USP L32 | a chiral ligand-exchange resin packing · L-proline copper complex covalently bonded to irregular shaped silica particles, 5 to 10 µm diameter | NUCLEOSIL® CHIRAL-1 | 235 |
| USP L34 | strong cation-exchange resin consisting of sulfonated cross-linked PS-DVB copolymer in the Pb form, 5 to 7 µm particle size | NUCLEOGEL® SUGAR Pb | 248 |
| USP L36 | a 3,5-dinitrobenzoyl derivative of L-phenylglycine covalently bonded to 5 µm aminopropyl silica | NUCLEOSIL® CHIRAL-3 | 236 |
| USP L40 | cellulose tris-(3,5-dimethylphenylcarbamate) coated porous silica particles, 5 to 20 µm diameter | NUCLEOCEL *DELTA* | 233 |
| USP L43 | pentafluorophenyl groups chemically bonded to silica particles by a propyl spacer, 1.5 to 10 µm diameter | NUCLEODUR® PFP | 174 |
| | | NUCLEOSHELL® PFP | 206 |
| USP L45 | beta-cyclodextrin bonded to porous silica particles, R,S-hydroxypropyl ether derivative, 3 to 10 µm diameter | NUCLEODEX β-OH, β-PM | 231 |
| USP L58 | strong cation-exchange resin consisting of sulfonated cross-linked PS/DVB copolymer in the Na form, 6 to 30 µm diameter | NUCLEOGEL® SUGAR Na | 248 |
| USP L60 | spherical porous silica gel, particle size of 10 µm diameter or smaller, the surface of which has been covalently modified with alkyl amide groups and endcapped | NUCLEODUR® PolarTec | 168 |
| | | NUCLEOSIL® $C_{18}$ Nautilus | 214 |
| USP L75 | A chiral-recognition protein, bovine serum albumin (BSA), chemically bonded to silica particles, about 7 µm in diameter, with a pore size of 300 Angstrom | RESOLVOSIL BSA-7 | 234 |

# NUCLEODUR® high purity silica for HPLC

NUCLEODUR® is a fully synthetical type B silica (silica of 3rd generation) offering highly advanced physical properties like totally spherical particle shape, outstanding surface microstructure, high pressure stability and low metal content.

NUCLEODUR® as a state-of-the-art silica is the ideal base material for modern HPLC phases. It is the result of MACHEREY-NAGEL's pioneering research in chromatography for more than 40 years.

In RP liquid chromatography the efficiency of the packing is strongly affected by the quality of the base silica itself. Shortcomings in the surface geometry of the particles or metal contaminants are the main reasons for inadequate coverage with the covalently bonded alkylsilanes in the subsequent derivatization steps. It is well known, that poor surface coverage and, in consequence, high activity of residual free silanols often results in peak tailing or adsorption, particularly with basic compounds.

## Particle shape and surface symmetry

NUCLEODUR® silicas are synthesized in a unique and carefully controlled manufacturing process which provides silica particles, which are totally spherical. The picture shows the outstanding smoothness of the NUCLEODUR® surface.

## Purity

As already mentioned above, a highly pure silica is required for achieving symmetric peak shapes and maximum resolution. Inclusions of, e.g., iron or alkaline earth metal ions on the silica surface are largely responsible for the unwanted interactions with ionizable analytes, e.g., amines or phenolic compounds.

NUCLEODUR® is virtually free of metal impurities and low acidic surface silanols. Elemental analysis data of NUCLEODUR® 5 µm measured by AAS are listed below.

**Elementary analysis (metal ions) of NUCLEODUR® 100-5**

| | | |
|---|---|---|
| Aluminum | < 5 | ppm |
| Iron | < 5 | ppm |
| Sodium | < 5 | ppm |
| Calcium | < 10 | ppm |
| Titanium | < 1 | ppm |
| Zirconium | < 1 | ppm |
| Arsenic | < 0.5 | ppm |
| Mercury | < 0.05 | ppm |

## Pressure stability

The totally spherical and 100 % synthetic silica gel exhibits an outstanding mechanical stability, even at high pressures and elevated eluent flow rates. In addition, after several cycles of repeated packing, no significant drop in pressure can be observed. The latter is of prime importance for preparative and process-scale applications.

NUCLEODUR® silica is available with two pore sizes – 110 Å pore size as standard material and as 300 Å widepore material for the separation of biomolecules, like peptides and proteins.

**Physical data of NUCLEODUR®**

| | Standard | Widepore |
|---|---|---|
| Pore size | 110 | 300 Å |
| Surface area (BET) | 340 $m^2/g$ | 100 $m^2/g$ |
| Pore volume | 0.9 mL/g | 0.9 mL/g |
| Density | 0.47 g/mL | 0.47 g/mL |

### NUCLEODUR® modifications

Several different surface modifications based on NUCLEODUR® silica have been developed over the last years providing a full range of specified HPLC phases and an ideal tool for every separation.

For a summary of important properties of our NUCLEODUR® phases please see page 152.

## 1.8 µm particles for increased separation efficiency

### Key feature

- Decrease of analysis time (ultra fast HPLC)
- Shorter columns with high separation efficiency and significant improvement of resolution and detection sensitivity
- Suitable for LC/MS due to low bleeding characteristics

### Fractionation

- NUCLEODUR® 1.8 µm particles are fractionated to limit the increase in back pressure.

### Availability

- The following NUCLEODUR® phases are available in 1.8 µm:
  $C_{18}$ Gravity, $C_8$ Gravity, $C_{18}$ Gravity-SB, $C_{18}$ Isis, $C_{18}$ Pyramid, PolarTec, Phenyl-Hexyl, PFP, Sphinx RP, $C_{18}$ HTec and HILIC

## Advantages of 1.8 µm particle size

Miniaturization started in the early stage of HPLC with the reduction of particle size from 10 µm via 7 µm to standard 5 µm – still the most used particle diameter in analytical HPLC – to 3 µm spherical particles. With the introduction of 1.8 µm NUCLEODUR® particles researchers have turned over a new leaf in HPLC column technology, featuring extraordinary improvements in terms of plate numbers, column efficiency and resolution compared with 3 µm particles.

### Increased separation efficiency by higher number of theoretical plates (N):

- 50 x 4.6 mm NUCLEODUR® $C_{18}$ Gravity
- 3 µm: N ≥ 100 000 plates/m (h-value≤ 10)
- 1.8 µm: N ≥ 166 667 plates/m (h-value≤ 6)

Increase of the plate number by ~ 67 % offers the possibility of using shorter columns with equal plate number resulting in a decrease of analysis time.

### Significant improvement in resolution

$$R_s = \frac{\sqrt{N}}{4}\left(\frac{\alpha - 1}{\alpha}\right)\left(\frac{k_i'}{k_i' + 1}\right)$$

$R_s$ = resolution, α = selectivity (separation factor), $k_i'$ = retention
N = plate number with $N \propto 1/d_P$, $d_P$ = particle diameter

**Resolution as a function of particle size**

Column: 50 x 4 mm NUCLEODUR® $C_{18}$ Gravity
A) 3 µm, B) 1.8 µm
Eluent: acetonitrile – water (80:20, v/v)
Flow rate: 2 mL/min
Detection: UV, 254 nm

Peaks:
1. Naphthalene
2. Ethylbenzene

Use of 1.8 µm instead of 3 µm particles leads to an increase of resolution by a factor of 1.29 (29 %) since the resolution is inversely proportional to the square root of the particle size.

### Column back pressure

Due to the smaller particles the back pressure will increase according to

$$\Delta_P = \frac{\Phi \cdot L_C \cdot \eta \cdot u}{d_P^2}$$

$\Delta_P$ = pressure drop, Φ = flow resistance (nondimensional), LC = column length, η = viscosity, u = linear velocity, $d_P$ = particle diameter

The high sphericity of the NUCLEODUR® particles and the very narrow particle size distribution allow to keep the back pressure on a moderate level.

**Comparison of back pressures**

Eluent 100 % methanol, flow rate 1.5 mL/min
temperature 22 °C, column dimensions 50 x 4.6 mm

| | NUCLEODUR® $C_{18}$ Gravity | Competitor |
|---|---|---|
| 3 µm | 70 bar | – |
| 1.8 µm | 130 bar | 170 bar |

### Higher flow rates and shorter run times

The optimal flow rate for 1.8 µm particles is higher than for 3 and 5 µm particles (see figure – the flow rate should be at the van Deemter minimum).

Van Deemter curves

Column 50 x 4.6 mm, acetonitrile – water (50:50, v/v), analyte toluene

### Technical requirements

To gain best results with 1.8 µm particles certain technical demands must be met including pumps for flow rates of 2–3 mL with pressures of 250–1000 bar, minimized dead volume, and fast data recording.

# NUCLEODUR® phase overview

## Overview of NUCLEODUR® HPLC phases

| Phase | Specification | Page | Characteristic* | Stability | Structure |
|---|---|---|---|---|---|
| $C_{18}$ Gravity | octadecyl, high density coating, multi-endcapping<br>18 % C · USP L1 | 158 | A ●●●●●<br>B ◖<br>C ●●◖ | pH 1–11,<br>suitable for LC/MS | NUCLEODUR® $(Si\text{-}O_2)_n$ |
| $C_{18}$ Gravity-SB | octadecyl (monomeric), extensive endcapping<br>13 % C · USP L1 | 162 | A ●●●●<br>B ●●◖<br>C - | pH 1–9,<br>suitable for LC/MS | NUCLEODUR® $(Si\text{-}O_2)_n$ |
| $C_8$ Gravity | octyl, high density coating, multi-endcapping<br>11 % C · USP L7 | 158 | A ●●◖<br>B ●<br>C ●◖ | pH 1–11,<br>suitable for LC/MS | NUCLEODUR® $(Si\text{-}O_2)_n$ |
| $C_{18}$ Isis | octadecyl phase with specially crosslinked surface modification endcapping<br>20 % C · USP L1 | 164 | A ●●●●◖<br>B ●●<br>C ●●●●● | pH 1–10,<br>suitable for LC/MS | NUCLEODUR® $(Si\text{-}O_2)_n$ |
| $C_{18}$ Pyramid | octadecyl with polar endcapping<br>14 % C · USP L1 | 166 | A ●●●●<br>B ●●◖<br>C ●● | stable in 100 % aqueous eluent,<br>pH 1–9,<br>suitable for LC/MS | NUCLEODUR® $(Si\text{-}O_2)_n$ |
| PolarTec | octadecyl with embedded polar group<br>17 % C · USP L1 and L60 | 168 | A ●●●●<br>B ●●◖<br>C ●●●● | stable in 100 % aqueous eluent,<br>pH 1–9,<br>suitable for LC/MS | NUCLEODUR® $(Si\text{-}O_2)_n$ |
| Phenyl-Hexyl | phenylhexyl, multi-endcapping<br>10 % C · USP L11 | 170 | A ●●<br>B ●●●<br>C ● | pH 1–10,<br>suitable for LC/MS | NUCLEODUR® $(Si\text{-}O_2)_n$ |
| $\pi^2$ | biphenylpropyl, multi-endcapping<br>17 % C · USP L11 | 172 | A ●●<br>B ●●●●<br>C ●●● | pH 1.5–10 | NUCLEODUR® $(Si\text{-}O_2)_n$ |

* A = ● hydrophobic selectivity, B = ● polar / ionic selectivity, C = ● steric selectivity

# NUCLEODUR® phase overview

| Application | Similar phases** | Interactions · retention mechanism | |
|---|---|---|---|
| in general compounds with ionizable functional groups such as basic pharmaceuticals and pesticides | NUCLEOSIL® $C_{18}$ HD<br>Xterra® RP18 / MS C18; Luna® C18(2), Gemini®, Synergi® Max RP; Zorbax® Extend-C18; Inertsil® ODS III; Purospher® STAR RP-18; Hypersil™ BDS | hydrophobic<br>(van der Waals interactions) | |
| overall sophisticated analytical separations, especially for polar compounds, e.g., antibiotics, water-soluble vitamins, organic acids | – | hydrophobic<br>(van der Waals interactions)<br>with additional polar interactions | |
| like $C_{18}$ Gravity, however, generally shorter retention times for nonpolar compounds | NUCLEOSIL® $C_8$ HD<br>Xterra® RP8 / MS C8; Luna® C8; Zorbax® Eclipse XDB-C8 | hydrophobic<br>(van der Waals interactions) | |
| high steric selectivity, thus suited for separation of positional and structural isomers, planar / nonplanar molecules | NUCLEOSIL® $C_{18}$ AB<br>Inertsil® ODS-P; Pro C18 RS | steric and hydrophobic | |
| basic pharmaceuticals, very polar compounds, organic acids | Aqua, Synergi® Hydro-RP;<br>AQ; Atlantis® dC18; Polaris® C18-A | hydrophobic and polar<br>(H bonds) | |
| basic pharmaceuticals, organic acids, pesticides, amino acids, water-soluble vitamins | NUCLEOSIL® $C_{18}$ Nautilus<br>ProntoSIL® C18 AQ, Zorbax® Bonus-RP, Polaris® Amide-C18; Ascentis® RP Amide, SymmetryShield™ RP18; SUPELCOSIL™ LC-ABZ+; HyPURITY™ ADVANCE; ACCLAIM Polar AD.II | hydrophobic and polar<br>(H bonds) | |
| aromatic and unsaturated compounds, polar compounds like pharmaceuticals, antibiotics | Luna® Phenyl-Hexyl;<br>Zorbax® Eclipse Plus Phenyl-Hexyl;<br>Kromasil® Phenyl-Hexyl | π-π and hydrophobic | |
| aromatic and unsaturated compounds, polar compounds like pharmaceuticals, antibiotics | Pinnacle® DB Biphenyl;<br>Ultra Biphenyl | π-π and hydrophobic | |

** phases which provide a similar selectivity based on chemical and physical properties

# NUCLEODUR® phase overview

## Overview of NUCLEODUR® HPLC phases

| Phase | Specification | Page | Characteristic* | Stability | Structure |
|---|---|---|---|---|---|
| PFP | pentafluorophenylpropyl, multi-endcapping<br>8 % C · USP L43 | 174 | A ●●<br>B ●●●●<br>C ●●●● | pH 1–9,<br>suitable for LC/MS | NUCLEODUR® $(Si\text{-}O_2)_n$ |
| Sphinx RP | bifunctional, balanced ratio of propylphenyl and octadecyl, endcapping<br>15 % C · USP L1 and L11 | 176 | A ●●●<br>B ●●◖<br>C ● | pH 1–10,<br>suitable for LC/MS | NUCLEODUR® $(Si\text{-}O_2)_n$ |
| $C_{18}$ HTec | octadecyl, high density coating, high capacity, multi-endcapping<br>18 % C · USP L1 | 178 | A ●●●●●<br>B ◖<br>C ●●◖ | pH 1–11,<br>suitable for LC/MS | NUCLEODUR® $(Si\text{-}O_2)_n$ |
| $C_{18}$ ec | octadecyl, medium density, endcapping<br>available in 110 Å and 300 Å pore size<br>17.5 % / 4 % C · USP L1 | 181 | A ●●●●<br>B ●<br>C ●●●◖ | pH 1–9 | NUCLEODUR® $(Si\text{-}O_2)_n$ |
| $C_8$ ec | octyl, medium density, endcapping<br>10.5 % C · USP L7 | 181 | A ●●<br>B ●◖<br>C ●●◖ | pH 1–9 | NUCLEODUR® $(Si\text{-}O_2)_n$ |
| $C_4$ ec | butyl, medium density, endcapping, 300 Å pore size<br>2.5 % C · USP L26 | 181 | A ●<br>B ●●<br>C ●◖ | pH 1–9 | NUCLEODUR® $(Si\text{-}O_2)_n$ |
| HILIC | zwitterionic ammonium – sulfonic acid phase<br>7 % C | 184 | A ●<br>B ●●●●●<br>C - | pH 2–8.5 | NUCLEODUR® $(Si\text{-}O_2)_n$ |
| CN / CN-RP | cyano (nitrile) for NP and RP separations<br>7 % C · USP L10 | 186 | A ●<br>B ●●●●<br>C - | pH 1–8,<br>stable towards highly aqueous mobile phases | NUCLEODUR® $(Si\text{-}O_2)_n$ |

* A = ● hydrophobic selectivity, B = ● polar / ionic selectivity, C = ● steric selectivity

# NUCLEODUR® phase overview

| Application | Similar phases** | Interactions · retention mechanism | |
|---|---|---|---|
| aromatic and unsaturated compounds, halogen compounds, phenols, isomers, polar pharmaceuticals, antibiotics | ACQUITY® CSH Fluoro-Phenyl; Hypersil™ GOLD PFP; Luna® PFP(2); Discovery® HS F5; Allure® PFP Propyl; Ultra II PFP Propyl | polar (H bond), dipole-dipole, π-π and hydrophobic | |
| compounds with aromatic and multiple bond systems | no similar phases | π-π and hydrophobic | |
| robust and well base deactivated $C_{18}$ phase; all separation tasks with preparative potential | Xterra® RP18 / MS C18 / SunFire™ C18; Luna® C18(2), Gemini®, Synergi® Max RP; Zorbax® Extend-C18; Inertsil® ODS III; Purospher® STAR RP-18; Hypersil® BDS | hydrophobic (van der Waals interactions) | |
| robust $C_{18}$ phase for routine analyses | NUCLEOSIL® $C_{18}$ Spherisorb® ODS II; Symmetry® C18; Hypersil® ODS; Inertsil® ODS II; Kromasil® C18; LiChrospher® RP-18 | hydrophobic (van der Waals interactions) some residual silanol interactions | |
| robust $C_8$ phase for routine analyses | NUCLEOSIL® $C_8$ ec / $C_8$ Spherisorb® C8; Symmetry® C8; Hypersil® MOS; Kromasil® C8; LiChrospher® RP-8 | hydrophobic (van der Waals interactions) some residual silanol interactions | |
| biological macromolecules like proteins or peptides | Jupiter® C4; ACE® C4 | hydrophobic (van der Waals interactions) some residual silanol interactions | |
| hydrophilic compounds such as polar organic acids and bases, polar natural compounds | Sequant™ ZIC®-HILIC; Obelisc™ | ionic / hydrophilic and electrostatic | |
| polar organic compounds (basic drugs), molecules containing π-electron systems | NUCLEOSIL® CN / CN-RP | π-π and polar (H bond), hydrophobic | |

** phases which provide a similar selectivity based on chemical and physical properties

# NUCLEODUR® phase overview

## Overview of NUCLEODUR® HPLC phases

| Phase | Specification | Page | Characteristic* | Stability | Structure |
|---|---|---|---|---|---|
| $NH_2$ / $NH_2$-RP | aminopropyl for NP and RP separations<br>2.5 % C · USP L8 | 188 | A ●<br>B ●●●●<br>C - | pH 2–8,<br>stable towards highly aqueous mobile phases | NUCLEODUR® $(Si\text{-}O_2)_n$ |
| SiOH | unmodified high purity silica · USP L3 | 190 | A -<br>B -<br>C - | pH 2–8 | NUCLEODUR® $(Si\text{-}O_2)_n$ |

* A = ● hydrophobic selectivity, B = ● polar / ionic selectivity, C = ● steric selectivity

| Application | Similar phases** | Interactions · retention mechanism | |
|---|---|---|---|
| sugars, sugar alcohols and other hydroxy compounds, DNA bases, polar compounds in general | NUCLEOSIL® $NH_2$ / $NH_2$-RP | polar / ionic and hydrophobic | |
| polar compounds in general | NUCLEOSIL® SiOH | polar / ionic | |

** phases which provide a similar selectivity based on chemical and physical properties

## NUCLEODUR® $C_{18}$ Gravity · $C_8$ Gravity nonpolar high density phase · USP L1 ($C_{18}$) · USP L7 ($C_8$)

### Key feature

- Suitable for LC/MS and HPLC at pH extremes (pH 1–11)
- Superior base deactivation
- Ideal for method development

### Technical data

- Available as octadecyl ($C_{18}$) and octyl ($C_8$), multi-endcapped
- Pore size 110 Å; particle sizes 1.8 µm, 3 µm and 5 µm for $C_{18}$, 1.8 and 5 µm for $C_8$; 7, 10, 12 and 16 µm particles for preparative purposes on request
- Carbon content 18 % for $C_{18}$, 11 % for $C_8$

### Recommended application

- Overall sophisticated analytical separations
- Compound classes separated include pharmaceuticals, e.g., analgesics, anti-inflammatory drugs, antidepressants; herbicides; phytopharmaceuticals; immunosuppressants

## Base deactivation

NUCLEODUR® $C_{18}$ Gravity and NUCLEODUR® $C_8$ Gravity are based on the ultrapure NUCLEODUR® silica. Derivatization generates a homogeneous surface with a high density of bonded silanes (~18 % C for $C_{18}$, ~11 % C for $C_8$). Thorough endcapping suppresses any unwanted polar interactions between the silica surface and the sample, which makes "Gravity" particularly suitable for the separation of basic and other ionizable analytes. Even strongly basic pharmaceuticals like amitriptyline are eluted without tailing under isocratic conditions. For a discussion of the different retention behavior of $C_{18}$ phases compared to $C_8$ phases see page 182.

## Enhanced pH stability

One major disadvantage of silica stationary phases is limited stability at strongly acidic or basic pH. Cleavage of the siloxane bonding by hydrolysis, or dissolution of the silica will rapidly lead to a considerable loss in column performance. Conventional RP phases are usually not recommended to be run with mobile phases at pH > 8 or pH < 2 for extended periods of time. The special surface bonding technology and the low concentration of trace elements of NUCLEODUR® $C_{18}$ and $C_8$ Gravity allow for use at an expanded pH range from pH 1 to 11.

### Benefits of enhanced pH stability

An expanded pH range is often required in method development. Many nitrogen containing compounds like basic drugs are protonated at acidic or neutral pH and exhibit poor retention on a standard $C_{18}$ phase. The retention behavior can be improved by working at a higher pH, where the analyte is no longer protonated, but formally neutrally charged, as a rule between pH 9–10. For acidic analytes it is exactly in inverse proportion, maximum retention can be attained at low pH.

### Surface silanols at different pH values

The figure above shows the extent of protonation of surface silanols and of two exemplary analytes at acidic and alkaline pH. The following graph explains the general correlation between retention and pH.

### Correlation between retention and pH for basic and acidic compounds

An example how selectivity can be controlled by pH is the separation of the acid ketoprofen, the base lidocaine and benzamide. Under acidic conditions the protonated lidocaine is eluted very fast due to lack of sufficiently strong hydrophobic interactions between analyte and $C_{18}$ chains, while the formally neutral ketoprofen is eluted after about 3 min. However, at pH 10 a reversal of the elution order, with a visibly longer retention time for the basic lidocaine, is observed.

**Influence of the pH value on selectivity**

MN Appl. No. 120860

| | |
|---|---|
| Column: | 125 x 4 mm NUCLEODUR® $C_{18}$ Gravity, 5 µm |
| Eluent: | A) acetonitrile – 10 mmol/L ammonium formate, pH 3.0 (50:50, v/v); B) acetonitrile – 10 mmol/L ammonium bicarbonate, pH 10.0 (50:50, v/v) |
| Flow rate: | 1.0 mL/min |
| Temperature: | 30 °C |
| Detection: | UV, 230 nm |
| Injection: | 2 µL |

Peaks:
1. Lidocaine
2. Benzamide
3. Ketoprofen

As mentioned above, pH stability of the stationary phase can be helpful for improving selectivity in method development. The following figure shows the separation of 4 basic drugs under acidic and basic conditions.

At pH 2.5 the protonated analytes exhibit poor retention (early elution) and in addition an inadequate resolution for papaverine and noscapine, whilst the formally non ionized molecules can be baseline separated due to the better retention pattern at alkaline pH.

**Separation of basic alkaloids**

MN Appl. No. 118010

| | |
|---|---|
| Column: | 125 x 4 mm NUCLEODUR® $C_{18}$ Gravity, 5 µm |
| Eluent: | A) acetonitrile<br>B) 20 mmol/L $(NH_4)_2HPO_4$, pH 2.5 / 10.0<br>10 % A (1 min) → 75 % A in 10 min |
| Flow rate: | 1.0 mL/min; Temperature 25 °C |
| Detection: | UV, 254 nm; Injection 2 µL |

Peaks:
1. Lidocaine
2. Papaverine
3. Noscapine
4. Diphenhydramine

The following chromatogram demonstrates the stability of NUCLEODUR® $C_{18}$ Gravity under alkaline conditions. The ultrapure Gravity with its unique high density surface bonding technology withstands strong alkaline mobile phase conditions.

### Stability of NUCLEODUR® $C_{18}$ Gravity at pH 11

MN Appl. No. 120850

| | |
|---|---|
| Column: | 50 x 4.6 mm NUCLEODUR® $C_{18}$ Gravity, 5 µm |
| Eluent: | methanol – water – ammonia (20:80:0.5, v/v/v), pH 11 |
| Flow rate: | 1.3 mL/min |
| Temperature: | 30 °C |
| Detection: | UV, 254 nm |
| Injection: | 2.0 µL |

Peaks:
1. Theophylline
2. Caffeine

Even after 300 injections no loss of column efficiency – identified, e.g., by peak broadening or decrease in retention times – could be observed.

Under alkaline conditions dissolution of the silica support is possible, resulting in dead volume and thus peak broadening. It is worth mentioning, that this phenomenon also depends on type and concentration of buffers, as well as on the temperature. It is well known that the use of phosphate buffers, particularly at elevated temperatures, can reduce column lifetime even at moderate pH. If possible, phosphate buffers should be replaced by less harmful alternatives.

The following chromatograms show the excellent column stability of NUCLEODUR® $C_{18}$ Gravity in acidic conditions. Retention times of all three compounds in the column performance test remain consistent and virtually unchanged, even after the column is run with 5000 mL eluent. Due to the extremely stable surface modification, no cleavage of the Si-O-Si bonding occurs, column deterioration is therefore successfully prevented.

### Stability of NUCLEODUR® $C_{18}$ Gravity at pH 1.5

MN Appl. No. 120840

| | |
|---|---|
| Column: | 125 x 4 mm NUCLEODUR® $C_{18}$ Gravity, 5 µm |
| Eluent: | acetonitrile – 1 % TFA in water (50:50, v/v), pH 1.5 |
| Flow rate: | 1.0 mL/min |
| Temperature: | 30 °C |
| Detection: | UV, 230 nm |
| Injection: | 5 µL |

Peaks: 1. Pyridine, 2. Toluene, 3. Ethylbenzene

## Ordering information

Eluent in column acetonitrile – water

| | ID | Length → 30 mm | 50 mm | 75 mm | 100 mm | 125 mm | 150 mm | 250 mm |
|---|---|---|---|---|---|---|---|---|
| **NUCLEODUR® $C_{18}$ Gravity, 1.8 µm** octadecyl phase, particle size 1.8 µm, 18 % C · UHPLC | | | | | | | | |
| Analytical EC columns | | | | | | | | |
| | 2 mm | 760078.20 | 760079.20 | 760071.20 | 760076.20 | | 760075.20 | |
| | 3 mm | 760078.30 | 760079.30 | | 760076.30 | | | |
| | 4 mm | 760078.40 | 760079.40 | | 760076.40 | | | |
| | 4.6 mm | 760078.46 | 760079.46 | | 760076.46 | | | |
| EC guard columns* | | | 4 x 2 mm: 761901.20 | | 4 x 3 mm: 761901.30 | | | |
| **NUCLEODUR® $C_{18}$ Gravity, 3 µm** octadecyl phase, particle size 3 µm, 18 % C | | | | | | | | |
| Analytical EC columns | | | | | | | | |
| | 2 mm | | 760080.20 | | 760084.20 | 760081.20 | 760083.20 | 760082.20 |
| | 3 mm | | 760080.30 | | 760084.30 | 760081.30 | 760083.30 | 760082.30 |
| | 4 mm | | 760080.40 | | 760084.40 | 760081.40 | 760083.40 | 760082.40 |
| | 4.6 mm | | 760080.46 | 760086.46 | 760084.46 | 760081.46 | 760083.46 | 760082.46 |
| EC guard columns* | | | 4 x 2 mm: 761902.20 | | 4 x 3 mm: 761902.30 | | | |

## Ordering information

Eluent in column acetonitrile – water

| | ID | Length → 30 mm | 50 mm | 75 mm | 100 mm | 125 mm | 150 mm | 250 mm |
|---|---|---|---|---|---|---|---|---|
| **NUCLEODUR® $C_{18}$ Gravity, 5 µm** octadecyl phase, particle size 5 µm, 18 % C | | | | | | | | |
| Analytical EC columns | | | | | | | | |
| | 2 mm | | 760102.20 | | 760104.20 | 760100.20 | 760103.20 | 760101.20 |
| | 3 mm | | 760102.30 | | 760104.30 | 760100.30 | 760103.30 | 760101.30 |
| | 4 mm | | 760102.40 | | 760104.40 | 760100.40 | 760103.40 | 760101.40 |
| | 4.6 mm | | 760102.46 | 760106.46 | 760104.46 | 760100.46 | 760103.46 | 760101.46 |
| EC guard columns* | | | 4 x 2 mm: 761903.20 | | 4 x 3 mm: 761903.30 | | | |
| Preparative VarioPrep columns | | | | | | | | |
| | 10 mm | | 762103.100 | | | 762109.100 | | 762113.100 |
| | 21 mm | | 762103.210 | | | 762109.210 | | 762113.210 |
| | 32 mm | | | | | | | 762113.320 |
| | 40 mm | | | | | | 762100.400 | 762113.400 |
| VP guard columns *** | | | 10 x 8 mm: 762160.80 | | 10 x 16 mm: 762160.160 | | 15 x 32 mm: 762163.320 | |
| **NUCLEODUR® $C_{18}$ Gravity, 10 µm** octadecyl phase, particle size 10 µm, 18 % C | | | | | | | | |
| Preparative VarioPrep columns | | | | | | | | |
| | 21 mm | | | | | | | 762250.210 |
| | 40 mm | | | | | | | 762250.400 |
| VP guard columns ** | | | | | 10 x 16 mm: 762160.160 | | 15 x 32 mm: 762163.320 | |

## Ordering information

Eluent in column acetonitrile – water

| | ID | Length → 30 mm | 50 mm | 75 mm | 100 mm | 125 mm | 150 mm | 250 mm |
|---|---|---|---|---|---|---|---|---|
| **NUCLEODUR® $C_8$ Gravity, 1.8 µm** octyl phase, particle size 1.8 µm, 11 % C · UHPLC | | | | | | | | |
| Analytical EC columns | | | | | | | | |
| | 2 mm | 760756.20 | 760755.20 | 760760.20 | 760757.20 | | 760759.20 | |
| | 3 mm | 760756.30 | 760755.30 | | 760757.30 | | | |
| | 4 mm | 760756.40 | 760755.40 | | 760757.40 | | | |
| | 4.6 mm | 760756.46 | 760755.46 | | 760757.46 | | | |
| EC guard columns* | | | 4 x 2 mm: 761905.20 | | 4 x 3 mm: 761905.30 | | | |
| **NUCLEODUR® $C_8$ Gravity, 5 µm** octyl phase, particle size 5 µm, 11 % C | | | | | | | | |
| Analytical EC columns | | | | | | | | |
| | 2 mm | | 760750.20 | | 760754.20 | 760751.20 | 760752.20 | 760753.20 |
| | 3 mm | | 760750.30 | | 760754.30 | 760751.30 | 760752.30 | 760753.30 |
| | 4 mm | | 760750.40 | | 760754.40 | 760751.40 | 760752.40 | 760753.40 |
| | 4.6 mm | | 760750.46 | 760749.46 | 760754.46 | 760751.46 | 760752.46 | 760753.46 |
| EC guard columns* | | | 4 x 2 mm: 761907.20 | | 4 x 3 mm: 761907.30 | | | |
| Preparative VarioPrep columns | | | | | | | | |
| | 10 mm | | 762081.100 | | | 762071.100 | | 762070.100 |
| | 21 mm | | 762081.210 | | | 762071.210 | 762082.210 | 762070.210 |
| VP guard columns ** | | | 10 x 8 mm: 762097.80 | | 10 x 16 mm: 762097.160 | | | |
| EC and VarioPrep columns in packs of 1, guard columns see below. | | | | | | | | |

## Guard column systems

| Guard columns for EC columns with ID | | 2 mm | 3 mm | 4 mm | 4.6 mm | Guard column holder |
|---|---|---|---|---|---|---|
| * Column Protection System (pack of) | EC | 4/2 (3) | 4/3 (3) | 4/3 (3) | 4/3 (3) | 718966 |
| **Guard columns for VarioPrep columns with ID** | | **8, 10 mm** | **16, 21 mm** | **32, 40 mm** | **≥ 50 mm** | |
| ** VP guard columns (pack of) | VP | 10/8 (2) | 10/16 (2) | 15/32 (1) | 15/50 (1) | |
| VP guard column holder | | 718251 | 718256 | 718253 | 718255 | |

For details of our column systems see page 250.

## NUCLEODUR® $C_{18}$ Gravity-SB hydrophobic phase with polar selectivity · USP L1

### Key feature

- Hydrophobic $C_{18}$ phase with distinct polar selectivity, ideal for method development, better retention of early eluting substances
- Excellent performance under highly aqueous conditions
- Suitable for LC/MS due to low bleeding characteristics

### Technical data

- Monomeric octadecyl modification, extensive endcapping
- Pore size 110 Å; available particle sizes 1.8 µm, 3 µm and 5 µm; carbon content 13 %; pH stability 1–9

### Recommended application

- Overall sophisticated analytical separations, especially for polar compounds, e.g., antibiotics, water-soluble vitamins, organic acids

NUCLEODUR® $C_{18}$ Gravity-SB excels with a relatively high hydrophobicity – similar to $C_{18}$ Gravity – while simultaneously showing distinctive polar selectivity, without having polar embedded groups or polar endcapping. As a result the column displays better retention of early eluting analytes and high performance under strongly aqueous conditions. Additionally the column is suitable for LC/MS due to low bleeding characteristics. These features are achieved through side chains (isobutyl) of the monomeric $C_{18}$ phase.

In the TANAKA plot the NUCLEODUR® Gravity-SB shows similar hydrophobicity than the Gravity, however with a reduced capacity. The ion exchange capacity under basic conditions (pH 7.6) is high, which favors good retention of early eluting, polar substances.

Due to the broad selectivity and stability the base deactivated NUCLEODUR® $C_{18}$ Gravity-SB is versatile applicable, especially for polar analytes like nucleobases or pesticides the column shows good separation efficiency.

Pesticide mix (Ehrenstorfer, 17 components)

MN Appl. No. 127330

| | |
|---|---|
| Column: | EC 250/4.6 NUCLEODUR® $C_{18}$ Gravity-SB, 3 µm |
| Eluent: | A) acetonitrile |
| | B) 5 mmol/L $NH_4Ac$; |
| | 10–37.5 % A in 50 min, 37.5–75 % A in 25 min |
| Flow rate: | 1.1 mL/min |
| Temperature: | 35 °C |
| Detection: | UV, 230 nm |
| Injection: | 3 µL |

Peaks:

| | | |
|---|---|---|
| 1. Desethylatrazine | 7. Chlortoluron | 13. Metazachlor |
| 2. Metoxuron | 8. Atrazine | 14. Sebuthylazin |
| 3. Hexazinone | 9. Monolinuron | 15. Terbuthylazine |
| 4. Simazine | 10. Isoproturon | 16. Linuron |
| 5. Cyanazine | 11. Diuron | 17. Metolachlor |
| 6. Methabenzthiazuron | 12. Metobromuron | |

Good separation of the critical pair hexazinone/simazine

Comparing of selectivity for nucleobases

MN Appl. No. 127270

Columns: EC 150/4.6 mm
NUCLEODUR® $C_{18}$ Gravity-SB, 5 µm
NUCLEODUR® $C_{18}$ Gravity, 5 µm
NUCLEODUR® $C_{18}$ Pyramid, 5 µm

Eluent: 25 mmol/L $KH_2PO_4$, pH 3 – methanol (95:5, v/v)

Flow rate: 1.0 mL/min, Temperature: 20 °C

Detection: UV, 220 nm, Injection: 2.5 µL (1 mg/mL)

Peaks:
1. Cytosine
2. Adenine
3. Uracil
4. Guanine
5. Thymine

Better resolution of early eluting analyte

## Ordering information

Eluent in column acetonitrile – water

| | ID | Length → 30 mm | 50 mm | 75 mm | 100 mm | 125 mm | 150 mm | 250 mm |
|---|---|---|---|---|---|---|---|---|
| **NUCLEODUR® $C_{18}$ Gravity-SB, 1.8 µm** particle size 1.8 µm · UHPLC | | | | | | | | |
| Analytical EC columns | | | | | | | | |
| | 2 mm | 760591.20 | 760593.20 | 760595.20 | 760596.20 | | 760598.20 | |
| | 3 mm | 760591.30 | 760593.30 | | 760596.30 | | | |
| | 4 mm | 760591.40 | 760593.40 | | 760596.40 | | | |
| | 4.6 mm | 760591.46 | 760593.46 | | 760596.46 | | | |
| EC guard columns* | | | 4 x 2 mm: 761990.20 | | 4 x 3 mm: 761990.30 | | | |
| **NUCLEODUR® $C_{18}$ Gravity-SB, 3 µm** particle size 3 µm | | | | | | | | |
| Analytical EC columns | | | | | | | | |
| | 2 mm | | 760603.20 | | 760606.20 | 760607.20 | 760608.20 | 760609.20 |
| | 3 mm | | 760603.30 | | 760606.30 | 760607.30 | 760608.30 | 760609.30 |
| | 4 mm | | 760603.40 | | 760606.40 | 760607.40 | 760608.40 | 760609.40 |
| | 4.6 mm | | 760603.46 | 760605.46 | 760606.46 | 760607.46 | 760608.46 | 760609.46 |
| EC guard columns* | | | 4 x 2 mm: 761991.20 | | 4 x 3 mm: 761991.30 | | | |
| **NUCLEODUR® $C_{18}$ Gravity-SB, 5 µm** particle size 5 µm | | | | | | | | |
| Analytical EC columns | | | | | | | | |
| | 2 mm | | 760613.20 | | 760616.20 | 760617.20 | 760618.20 | 760619.20 |
| | 3 mm | | 760613.30 | | 760616.30 | 760617.30 | 760618.30 | 760619.30 |
| | 4 mm | | 760613.40 | | 760616.40 | 760617.40 | 760618.40 | 760619.40 |
| | 4.6 mm | | 760613.46 | 760615.46 | 760616.46 | 760617.46 | 760618.46 | 760619.46 |
| EC guard columns* | | | 4 x 2 mm: 761992.20 | | 4 x 3 mm: 761992.30 | | | |
| Preparative VarioPrep columns | | | | | | | | |
| | 10 mm | | 762350.100 | | | 762351.100 | | 762353.100 |
| | 21 mm | | 762350.210 | | | 762351.210 | | 762353.210 |
| | 32 mm | | | | | | | 762353.320 |
| | 40 mm | | | | | | 762352.400 | 762353.400 |
| VP guard columns ** | | | 10 x 8 mm: 762354.80 | | 10 x 16 mm: 762354.160 | | 15 x 32 mm: 762355.320 | |
| EC and VarioPrep columns in packs of 1, guard columns see below. | | | | | | | | |

## Guard column systems

| Guard columns for EC columns with ID | | 2 mm | 3 mm | 4 mm | 4.6 mm | Guard column holder |
|---|---|---|---|---|---|---|
| * Column Protection System (pack of) | EC | 4/2 (3) | 4/3 (3) | 4/3 (3) | 4/3 (3) | 718966 |
| **Guard columns for VarioPrep columns with ID** | | **8, 10 mm** | **16, 21 mm** | **32, 40 mm** | **≥ 50 mm** | |
| ** VP guard columns (pack of) | VP | 10/8 (2) | 10/16 (2) | 15/32 (1) | 15/50 (1) | |
| VP guard column holder | | 718251 | 718256 | 718253 | 718255 | |

For details of our column systems see page 250.

## NUCLEODUR® $C_{18}$ Isis phase with high steric selectivity · USP L1

**Key feature**
- Exceptional steric selectivity
- Outstanding surface deactivation
- Suitable for LC/MS and HPLC at pH 1–10

**Technical data**
- $C_{18}$ phase with special polymeric, crosslinked surface modification; pore size 110 Å; particle sizes 1.8 µm, 3 µm and 5 µm; carbon content 20 %

**Recommended application**
- Steroids, (*o*,*p*,*m*-)substituted aromatics, fat-soluble vitamins

### Surface modification

By use of specific $C_{18}$ silanes and polymeric bonding technologies a dense shield of alkyl chains protects the subjacent silica matrix. Elemental analysis of NUCLEODUR® $C_{18}$ Isis shows a carbon load of 20 %. The target crosslinking of the $C_{18}$ chains on the surface enables the separation of compounds with similar molecular structure but different stereochemical properties. The technical term for this feature is steric selectivity.

### Slot Model

Sander and Wise [5] proposed a model for the retention of aromatic compounds based on molecular shape, which is referred to as "Slot Model". This model pictures the bonded $C_{18}$ phase on the silica surface with slots which the analytes have to penetrate during retention. Planar molecules are able to penetrate these slots deeper than non-planar molecules of similar molecular weight and length-to-width ratio. Thus triphenylene (lower structure) is longer retained than o-terphenyl (upper structure).

### Steric selectivity

The following chromatograms reveal the improved resolution for positional isomers in a test mixture of aromatic compounds on NUCLEODUR® $C_{18}$ Isis (green) in direct comparison with monomerically coated (blue) and polar endcapped (orange) $C_{18}$ columns.

**Steric selectivity of NUCLEODUR® $C_{18}$ Isis**

| | |
|---|---|
| Columns: | 125 x 4 mm<br>NUCLEODUR® $C_{18}$ Isis<br>monomerically coated $C_{18}$ phase<br>polar endcapped phase $C_{18}$ phase |
| Eluent: | methanol – water (90:10, v/v) |
| Flow rate: | 1 mL/min, temperature: 35 °C |
| Detection: | UV, 254 nm |
| Injection: | 5 µL |

Peaks:
1. *o*-Terphenyl
2. *m*-Terphenyl
3. *p*-Terphenyl
4. Triphenylen

The separation of o-terphenyl and triphenylene is a good example to evaluate the selectivity of a RP column in terms of the shape of two molecules. The phenyl rings of o-terphenyl are twisted out of plane while triphenylene has a planar geometry. The separation factor α is a measure for the steric selectivity. As is shown below the α value is considerable larger on NUCLEODUR® $C_{18}$ Isis compared to a conventional $C_{18}$ column.

**Steric selectivity of NUCLEODUR® $C_{18}$ Isis**

| | |
|---|---|
| Columns: | 125 x 4 mm |
| Eluent: | methanol – water (80:20, v/v) |
| Flow rate: | 1 mL/min |
| Temperature: | 40 °C |
| Detection: | UV, 254 nm |
| Injection: | 1 µL |

Peaks:
1. *o*-Terphenyl
2. Triphenylene

The surface bonding technology also provides improved stability features for the NUCLEODUR® $C_{18}$ Isis phase.

## Surface deactivation

The chromatography of basic analytes requires a high density of surface-bonded $C_{18}$ silanes combined with a thorough endcapping procedure to keep silanol activity at a minimum. This ensures tailing-free elution of even strongly basic amino-containing compounds (see application 121210 at *www.mn-net.com/apps*).

## Ordering information

Eluent in column acetonitrile – water

| | ID | Length → 30 mm | 50 mm | 75 mm | 100 mm | 125 mm | 150 mm | 250 mm |
|---|---|---|---|---|---|---|---|---|
| **NUCLEODUR® $C_{18}$ Isis, 1.8 µm** particle size 1.8 µm · UHPLC | | | | | | | | |
| Analytical EC columns | | | | | | | | |
| | 2 mm | 760406.20 | 760405.20 | 760396.20 | 760407.20 | | 760409.20 | |
| | 3 mm | 760406.30 | 760405.30 | | 760407.30 | | | |
| | 4 mm | 760406.40 | 760405.40 | | 760407.40 | | | |
| | 4.6 mm | 760406.46 | 760405.46 | | 760407.46 | | | |
| EC guard columns* | | | 4 x 2 mm: 761910.20 | | 4 x 3 mm: 761910.30 | | | |
| **NUCLEODUR® $C_{18}$ Isis, 3 µm** particle size 3 µm | | | | | | | | |
| Analytical EC columns | | | | | | | | |
| | 2 mm | | 760400.20 | | 760401.20 | 760402.20 | 760403.20 | 760404.20 |
| | 3 mm | | 760400.30 | | 760401.30 | 760402.30 | 760403.30 | 760404.30 |
| | 4 mm | | 760400.40 | | 760401.40 | 760402.40 | 760403.40 | 760404.40 |
| | 4.6 mm | | 760400.46 | 760397.46 | 760401.46 | 760402.46 | 760403.46 | 760404.46 |
| EC guard columns* | | | 4 x 2 mm: 761911.20 | | 4 x 3 mm: 761911.30 | | | |
| **NUCLEODUR® $C_{18}$ Isis, 5 µm** particle size 5 µm | | | | | | | | |
| Analytical EC columns | | | | | | | | |
| | 2 mm | | 760410.20 | | 760415.20 | 760412.20 | 760413.20 | 760414.20 |
| | 3 mm | | 760410.30 | | 760415.30 | 760412.30 | 760413.30 | 760414.30 |
| | 4 mm | | 760410.40 | | 760415.40 | 760412.40 | 760413.40 | 760414.40 |
| | 4.6 mm | | 760410.46 | 760416.46 | 760415.46 | 760412.46 | 760413.46 | 760414.46 |
| EC guard columns* | | | 4 x 2 mm: 761912.20 | | 4 x 3 mm: 761912.30 | | | |
| Preparative VarioPrep columns | | | | | | | | |
| | 10 mm | | 762404.100 | | | 762405.100 | | 762403.100 |
| | 21 mm | | 762404.210 | | | 762405.210 | | 762403.210 |
| | 32 mm | | | | | | | 762403.320 |
| | 40 mm | | | | | | 762406.400 | 762403.400 |
| VP guard columns ** | | | 10 x 8 mm: 762420.80 | | 10 x 16 mm: 762420.160 | | 15 x 32 mm: 762422.320 | |
| EC and VarioPrep columns in packs of 1, guard columns see below. | | | | | | | | |

## Guard column systems

| Guard columns for EC columns with ID | | 2 mm | 3 mm | 4 mm | 4.6 mm | Guard column holder |
|---|---|---|---|---|---|---|
| * Column Protection System (pack of) | EC | 4/2 (3) | 4/3 (3) | 4/3 (3) | 4/3 (3) | 718966 |
| **Guard columns for VarioPrep columns with ID** | | **8, 10 mm** | **16, 21 mm** | **32, 40 mm** | **≥ 50 mm** | |
| ** VP guard columns (pack of) | VP | 10/8 (2) | 10/16 (2) | 15/32 (1) | 15/50 (1) | |
| VP guard column holder | | 718251 | 718256 | 718253 | 718255 | |

For details of our column systems see page 250.

## NUCLEODUR® $C_{18}$ Pyramid phase for highly aqueous eluents · USP L1

### Key feature

- Stable in 100 % aqueous mobile phase systems
- Interesting polar selectivity features
- Excellent base deactivation; suitable for LC/MS due to low bleeding characteristics

### Technical data

- Special phase with polar endcapping; pore size 110 Å; particle sizes 1.8 µm, 3 µm and 5 µm (7 and 10 µm particles for preparative purposes on request); carbon content 14 %; pH stability 1–9

### Recommended application

- Analgesics, penicillin antibiotics, nucleic acid bases, water-soluble vitamins, complexing agents, organic acids

## RP-HPLC with highly aqueous mobile phases

The efforts to neutralize unwanted silanol activity often results in well base-deactivated RP phases with high carbon load, but a limited scope of selectivity beyond non-polar interactions. Polar compounds like carboxylic acids or drug metabolites show only weak retention on densely bonded RP columns due to distinct hydrophobic properties but low polar interactions. Very polar analytes require highly aqueous mobile phases for solubility and retention. Conventional reversed phase columns often display stability problems in eluent systems with high percentage of water (> 95 %) as evidenced by a sudden decrease of retention time and overall poor reproducibility. This phenomenon is described as phase collapse caused by the mobile phase expelled from the pores due to the fact, that hydrophobic RP phases are incompletely wetted with the mobile phase [6].

Different approaches can be used to increase column stability with highly aqueous mobile phase systems. The most promising concepts are incorporating a polar group in the hydrophobic alkyl chain, or using hydrophilic endcapping procedures to improve the wettability of the reversed phase modification. NUCLEODUR® PolarTec may be taken as an example for the embedded polar group strategy, in which a $C_{18}$ silane with a polar function is successfully linked to the silica surface.

## Stability features

NUCLEODUR® $C_{18}$ Pyramid is a silica phase with hydrophilic endcapping, designed especially for use in eluent systems of up to 100 % water. The upper figure shows the retention behavior of tartaric, acetic and maleic acid under purely aqueous conditions on NUCLEODUR® $C_{18}$ Pyramid in comparison with a conventionally bonded $C_{18}$ phase.

It can be shown that the retention times for NUCLEODUR® $C_{18}$ Pyramid remain nearly unchanged between initial injection and restart after the flow has been stopped for 12 h, whilst the performance of the conventional RP column already collapsed totally after 5 min.

**Stability test**

MN Appl. No. 120870

| | |
|---|---|
| Both columns: | 125 x 4 mm |
| Eluent: | 50 mmol/L $KH_2PO_4$, pH 2.5 |
| Flow rate: | 0.7 mL/min |
| Temperature: | 25 °C |
| Detection: | UV, 210 nm |
| Injection: | 1 µL |

Peaks:
1. Tartaric acid
2. Acetic acid
3. Maleic acid

### Retention characteristics

**Separation of very polar compounds**

MN Appl. No. 119170

| | |
|---|---|
| Column: | 125 x 4 mm NUCLEODUR® $C_{18}$ Pyramid, 5 µm |
| Eluent: | 0.2 % $H_3PO_4$ |
| Flow rate: | 1.0 mL/min |
| Temperature: | 22 °C |
| Detection: | UV, 202 nm |
| Injection: | 2 µL |

Peaks:
1. Formic acid
2. Acetic acid

The polar surface exhibits retention characteristics different from conventional $C_{18}$ phases. Application 119170 shows the improved retention behavior of the very polar short chain organic acids, which are insufficiently retained on RP columns with predominantly hydrophobic surface properties. In addition to the exceptional polar selectivity NUCLEODUR® $C_{18}$ Pyramid also provides adequate hydrophobic retention (see application No. 19190 at *www.mn-net.com*). The perceptible increase in polarity has no impact on the retention behavior of ionizable analytes. Even with the strongly basic compounds of the tricyclic antidepressant drug test mixture, no unwanted interactions or a so-called lack in base deactivation are observed (see application 119200 at *www.mn-net.com/apps*).

## Ordering information

Eluent in column acetonitrile – water

| | ID | Length → 30 mm | 50 mm | 75 mm | 100 mm | 125 mm | 150 mm | 250 mm |
|---|---|---|---|---|---|---|---|---|
| **NUCLEODUR® $C_{18}$ Pyramid, 1.8 µm** particle size 1.8 µm · UHPLC | | | | | | | | |
| Analytical EC columns | | | | | | | | |
| | 2 mm | 760271.20 | 760272.20 | 760275.20 | 760273.20 | | 760274.20 | |
| | 3 mm | 760271.30 | 760272.30 | | 760273.30 | | | |
| | 4 mm | 760271.40 | 760272.40 | | 760273.40 | | | |
| | 4.6 mm | 760271.46 | 760272.46 | | 760273.46 | | | |
| EC guard columns* | | | 4 x 2 mm: 761915.20 | | 4 x 3 mm: 761915.30 | | | |
| **NUCLEODUR® $C_{18}$ Pyramid, 3 µm** particle size 3 µm | | | | | | | | |
| Analytical EC columns | | | | | | | | |
| | 2 mm | | 760263.20 | | 760264.20 | 760260.20 | 760261.20 | 760262.20 |
| | 3 mm | | 760263.30 | | 760264.30 | 760260.30 | 760261.30 | 760262.30 |
| | 4 mm | | 760263.40 | | 760264.40 | 760260.40 | 760261.40 | 760262.40 |
| | 4.6 mm | | 760263.46 | 760259.46 | 760264.46 | 760260.46 | 760261.46 | 760262.46 |
| EC guard columns* | | | 4 x 2 mm: 761916.20 | | 4 x 3 mm: 761916.30 | | | |
| **NUCLEODUR® $C_{18}$ Pyramid, 5 µm** particle size 5 µm | | | | | | | | |
| Analytical EC columns | | | | | | | | |
| | 2 mm | | 760200.20 | | 760204.20 | 760201.20 | 760203.20 | 760202.20 |
| | 3 mm | | 760200.30 | | 760204.30 | 760201.30 | 760203.30 | 760202.30 |
| | 4 mm | | 760200.40 | | 760204.40 | 760201.40 | 760203.40 | 760202.40 |
| | 4.6 mm | | 760200.46 | 760205.46 | 760204.46 | 760201.46 | 760203.46 | 760202.46 |
| EC guard columns* | | | 4 x 2 mm: 761917.20 | | 4 x 3 mm: 761917.30 | | | |
| Preparative VarioPrep columns | | | | | | | | |
| | 10 mm | | 762271.100 | | | 762273.100 | | 762272.100 |
| | 21 mm | | 762271.210 | | | 762273.210 | | 762272.210 |
| | 32 mm | | | | | | | 762272.320 |
| | 40 mm | | | | | | 762269.400 | 762272.400 |
| VP guard columns ** | | | 10 x 8 mm: 762291.80 | | 10 x 16 mm: 762291.160 | | 15 x 32 mm: 762293.320 | |
| EC and VarioPrep columns in packs of 1, guard columns see below. | | | | | | | | |

## Guard column systems

| Guard columns for EC columns with ID | | 2 mm | 3 mm | 4 mm | 4.6 mm | Guard column holder |
|---|---|---|---|---|---|---|
| * Column Protection System (pack of) | EC | 4/2 (3) | 4/3 (3) | 4/3 (3) | 4/3 (3) | 718966 |
| **Guard columns for VarioPrep columns with ID** | | **8, 10 mm** | **16, 21 mm** | **32, 40 mm** | **≥ 50 mm** | |
| ** VP guard columns (pack of) | VP | 10/8 (2) | 10/16 (2) | 15/32 (1) | 15/50 (1) | |
| VP guard column holder | | 718251 | 718256 | 718253 | 718255 | |

For details of our column systems see page 250.

## NUCLEODUR® PolarTec RP phase with embedded polar group · USP L1 and L60

### Key feature
- Excellent base deactivation
- Suitable for LC/MS and 100 % aqueous eluents
- Pronounced steric selectivity

### Technical data
- Phase with embedded polar group; pore size 110 Å; particle sizes 1.8 µm, 3 µm and 5 µm; carbon content 17 %; pH stability 1–9

### Recommended application
- Exceptional selectivity for phenols and nitrogen containing compounds, polar compounds like basic pharmaceuticals, organic acids, pesticides, amino acids, water-soluble vitamins, etc.

## RP-HPLC under 100 % aqueous conditions

The dominant form of interactions of conventional $C_{18}$ phases are nonpolar London dispersion forces. Besides nonpolar interactions phases with embedded polar groups possess the ability to show polar interactions (dipole-dipole, hydrogen bonds, π-π, etc.). These interactions enhance retention and selectivity for polar compounds like carboxylic acids, phenols and nitrogen containing compounds.

**Separation of histidines**

MN Appl. No. 125140

| | |
|---|---|
| Column: | 150 x 3 mm NUCLEODUR® PolarTec, 3 µm |
| Eluent: | 1.0 mmol/L perfluoropentanoic acid in water – 0.5 mmol/L perfluoropentanoic acid in acetonitrile (99.5:0.5, v/v) |
| Flow rate: | 0.4 mL/min |
| Temperature: | 20 °C |
| Detection: | UV, 230 nm |

Peaks:

| | |
|---|---|
| 1. 3-Methylhistidine | $R_1$ = H, $R_2$ = $CH_3$ |
| 2. Histidine | $R_1$ = $R_2$ = H |
| 3. 1-Methylhistidine | $R_1$ = $CH_3$, $R_2$ = H |

In order to increase retention for polar compounds it is often necessary to decrease the organic ratio of the mobile phase to zero. Under these conditions many conventional $C_{18}$ phases display the so-called dewetting effect which means that the mobile phase is expelled from the pores. This phenomenon leads to a dramatic loss in retention. NUCLEODUR® PolarTec is stable in 100 % aqueous mobile phases and therefore especially suited for the separation of polar compounds like organic acids.

Due to the shielding effect of the embedded group NUCLEODUR® PolarTec shows an excellent base deactivation, which is at the top-notch of embedded polar group phases on the market. The pronounced steric selectivity (see Tanaka plot) is an additional tool for the separation of complex mixtures.

Due to low bleeding characteristics NUCLEODUR® PolarTec is also suitable for LC/MS.

Even after days or weeks of operation in purely aqueous eluents the $C_{18}$ chains of NUCLEODUR® PolarTec are neither folded nor show any collapsing. A significant reduction of retention time cannot be observed.

**Stability of NUCLEODUR® PolarTec**

MN Appl. No. 124610

| | |
|---|---|
| Column: | 150 x 3 mm NUCLEODUR® PolarTec, 3 µm |
| Eluent: | 30 mmol/L $KH_2PO_4$, pH 3.0 |
| Flow rate: | 0.5 mL/min |
| Temperature: | 30 °C |
| Detection: | UV, 220 nm |

Peaks:
1. Cytosine
2. Uracil
3. Adenine
4. Guanine
5. Thymine

In spite of the polar character of the embedded functional group NUCLEODUR® PolarTec exhibits sufficient hydrophobic properties and is very well suited for analyzing basic compounds.

## Ordering information

Eluent in column acetonitrile – water

| | ID | Length → 30 mm | 50 mm | 75 mm | 100 mm | 125 mm | 150 mm | 250 mm |
|---|---|---|---|---|---|---|---|---|
| **NUCLEODUR® PolarTec, 1.8 µm** particle size 1.8 µm · UHPLC | | | | | | | | |
| Analytical EC columns | | | | | | | | |
| | 2 mm | 760461.20 | 760463.20 | 760465.20 | 760466.20 | | 760468.20 | |
| | 3 mm | 760461.30 | 760463.30 | | 760466.30 | | | |
| | 4 mm | 760461.40 | 760463.40 | | 760466.40 | | | |
| | 4.6 mm | 760461.46 | 760463.46 | | 760466.46 | | | |
| EC guard columns* | | | 4 x 2 mm: 761980.20 | | 4 x 3 mm: 761980.30 | | | |
| **NUCLEODUR® PolarTec, 3 µm** particle size 3 µm | | | | | | | | |
| Analytical EC columns | | | | | | | | |
| | 2 mm | | 760473.20 | | 760476.20 | 760477.20 | 760478.20 | 760479.20 |
| | 3 mm | | 760473.30 | | 760476.30 | 760477.30 | 760478.30 | 760479.30 |
| | 4 mm | | 760473.40 | | 760476.40 | 760477.40 | 760478.40 | 760479.40 |
| | 4.6 mm | | 760473.46 | 760475.46 | 760476.46 | 760477.46 | 760478.46 | 760479.46 |
| EC guard columns* | | | 4 x 2 mm: 761981.20 | | 4 x 3 mm: 761981.30 | | | |
| **NUCLEODUR® PolarTec, 5 µm** particle size 5 µm | | | | | | | | |
| Analytical EC columns | | | | | | | | |
| | 2 mm | | 760483.20 | | 760486.20 | 760487.20 | 760488.20 | 760489.20 |
| | 3 mm | | 760483.30 | | 760486.30 | 760487.30 | 760488.30 | 760489.30 |
| | 4 mm | | 760483.40 | | 760486.40 | 760487.40 | 760488.40 | 760489.40 |
| | 4.6 mm | | 760483.46 | 760485.46 | 760486.46 | 760487.46 | 760488.46 | 760489.46 |
| EC guard columns* | | | 4 x 2 mm: 761982.20 | | 4 x 3 mm: 761982.30 | | | |
| Preparative VarioPrep columns | | | | | | | | |
| | 10 mm | | 762220.100 | | | 762221.100 | | 762223.100 |
| | 21 mm | | 762220.210 | | | 762221.210 | | 762223.210 |
| | 32 mm | | | | | | | 762223.320 |
| | 40 mm | | | | | | 762222.400 | 762223.400 |
| VP guard columns ** | | | 10 x 8 mm: 762224.80 | | 10 x 16 mm: 762224.160 | | 15 x 32 mm: 762226.320 | |

EC and VarioPrep columns in packs of 1, guard columns see below.

## Guard column systems

| Guard columns for EC columns with ID | | 2 mm | 3 mm | 4 mm | 4.6 mm | Guard column holder |
|---|---|---|---|---|---|---|
| * Column Protection System (pack of) | EC | 4/2 (3) | 4/3 (3) | 4/3 (3) | 4/3 (3) | 718966 |
| **Guard columns for VarioPrep columns with ID** | | **8, 10 mm** | **16, 21 mm** | **32, 40 mm** | **≥ 50 mm** | |
| ** VP guard columns (pack of) | VP | 10/8 (2) | 10/16 (2) | 15/32 (1) | 15/50 (1) | |
| VP guard column holder | | 718251 | 718256 | 718253 | 718255 | |

For details of our column systems see page 250.

## NUCLEODUR® Phenyl-Hexyl productive for polar / aromatic compunds · USP L11

### Key feature

- Hydrophobic phase with alternative selectivity compared to classical $C_{18}$ modifications
- Separation principle based on 2 retention mechanisms: π-π interactions and hydrophobic interactions
- Suitable for LC/MS due to low bleeding characteristics

### Technical data

- Phase with phenyl-hexyl modification and multi-endcapping; pore size 110 Å; particle sizes 1.8 µm, 3 µm and 5 µm; carbon content 10 %; pH stability 1–10

### Recommended application

- Aromatic and unsaturated compounds, polar compounds like pharmaceuticals, antibiotics

Phenylhexyl modified phases are an interesting alternative to classical $C_{18}$ phases due to an excellent separation of aromatic and unsaturated compounds especially with electron withdrawing groups.

The combination of hydrophobic and polar π-π interactions result in an interesting and alternate selectivity in comparison to $C_{18}$ and $C_8$ modified phases.

Through short phenylhexyl chains the NUCLEODUR® Phenyl-Hexyl is more polar than the bifunctional modified NUCLEODUR® Sphinx RP. Therefore shorter analysis times can be achieved with mixtures of structural similar aromatic and aliphatic unsaturated compounds.

With NUCLEODUR® Phenyl-Hexyl e.g., tricyclic antidepressants or water soluble vitamins can be separated in good resolution.

**Separation of water-soluble vitamins on NUCLEODUR® Phenyl-Hexyl**

MN Appl. No. 125920

| | |
|---|---|
| Column: | 100 x 3 mm NUCLEODUR® Phenyl-Hexyl, 3 µm |
| Eluent: | A) 0.1 % phosphoric acid in water<br>B) 0.1 % phosphoric acid in acetonitrile<br>0 % B for 2 min, then to 60 % B in 7 min |
| Flow rate: | 0.56 mL/min |
| Temperature: | 35 °C |
| Detection: | UV, 215 nm |
| Injection: | 0.8 µL, 1.0 mg/mL each compound 1 mg/mL in eluent |

Peaks:
1. Thiamine
2. Pyridoxine
3. p-aminobenzoic acid
4. Panthothenic acid
5. Folic acid
6. Biotin

**Tricyclic antidepressant (TCA)**

MN Appl. No. 126020

| | |
|---|---|
| Columns: | 150 x 3 mm<br>NUCLEODUR® Phenyl-Hexyl, 3 µm<br>Agilent ZORBAX® Eclipse Phenyl-Hexyl, 3.5 µm<br>Phenomenex Luna® Phenyl-Hexyl, 3 µm |
| Eluent: | A) 0.1 % formic acid in acetonitrile<br>B) 0.1 % formic acid in water<br>20–32.5 % A in 40 min |
| Flow rate: | 0.56 mL/min |
| Temperature: | 40 °C |
| Detection: | UV, 254 nm |
| Injection: | 0.2 µL, each compound 1 mg/mL in eluent |

Peaks:
1. Protriptyline
2. Nortriptyline
3. Imipramine
4. Amitriptyline
5. Trimipramine

## Ordering information

Eluent in column acetonitrile – water

| | ID | Length → 30 mm | 50 mm | 75 mm | 100 mm | 125 mm | 150 mm | 250 mm |
|---|---|---|---|---|---|---|---|---|
| **NUCLEODUR® Phenyl-Hexyl, 1.8 µm** particle size 1.8 µm · UHPLC | | | | | | | | |
| Analytical EC columns | | | | | | | | |
| | 2 mm | 760561.20 | 760563.20 | 760565.20 | 760566.20 | | 760568.20 | |
| | 3 mm | 760561.30 | 760563.30 | | 760566.30 | | | |
| | 4 mm | 760561.40 | 760563.40 | | 760566.40 | | | |
| | 4.6 mm | 760561.46 | 760563.46 | | 760566.46 | | | |
| EC guard columns* | | | 4 x 2 mm: 761985.20 | | 4 x 3 mm: 761985.30 | | | |
| **NUCLEODUR® Phenyl-Hexyl, 3 µm** particle size 3 µm | | | | | | | | |
| Analytical EC columns | | | | | | | | |
| | 2 mm | | 760573.20 | | 760576.20 | 760577.20 | 760578.20 | 760579.20 |
| | 3 mm | | 760573.30 | | 760576.30 | 760577.30 | 760578.30 | 760579.30 |
| | 4 mm | | 760573.40 | | 760576.40 | 760577.40 | 760578.40 | 760579.40 |
| | 4.6 mm | | 760573.46 | 760575.46 | 760576.46 | 760577.46 | 760578.46 | 760579.46 |
| EC guard columns* | | | 4 x 2 mm: 761986.20 | | 4 x 3 mm: 761986.30 | | | |
| **NUCLEODUR® Phenyl-Hexyl, 5 µm** particle size 5 µm | | | | | | | | |
| Analytical EC columns | | | | | | | | |
| | 2 mm | | 760583.20 | | 760586.20 | 760587.20 | 760588.20 | 760589.20 |
| | 3 mm | | 760583.30 | | 760586.30 | 760587.30 | 760588.30 | 760589.30 |
| | 4 mm | | 760583.40 | | 760586.40 | 760587.40 | 760588.40 | 760589.40 |
| | 4.6 mm | | 760583.46 | 760585.46 | 760586.46 | 760587.46 | 760588.46 | 760589.46 |
| EC guard columns* | | | 4 x 2 mm: 761987.20 | | 4 x 3 mm: 761987.30 | | | |
| Preparative VarioPrep columns | | | | | | | | |
| | 10 mm | | 762210.100 | | | 762211.100 | | 762213.100 |
| | 21 mm | | 762210.210 | | | 762211.210 | | 762213.210 |
| | 32 mm | | | | | | | 762213.320 |
| | 40 mm | | | | | | 762212.400 | 762213.400 |
| VP guard columns ** | | | 10 x 8 mm: 762234.80 | | 10 x 16 mm: 762234.160 | | 15 x 32 mm: 762236.320 | |

EC and VarioPrep columns in packs of 1, guard columns see below.

## Guard column systems

| Guard columns for EC columns with ID | | 2 mm | 3 mm | 4 mm | 4.6 mm | Guard column holder |
|---|---|---|---|---|---|---|
| * Column Protection System (pack of) | EC | 4/2 (3) | 4/3 (3) | 4/3 (3) | 4/3 (3) | 718966 |
| **Guard columns for VarioPrep columns with ID** | | **8, 10 mm** | **16, 21 mm** | **32, 40 mm** | **≥ 50 mm** | |
| ** VP guard columns (pack of) | VP | 10/8 (2) | 10/16 (2) | 15/32 (1) | 15/50 (1) | |
| VP guard column holder | | 718251 | 718256 | 718253 | 718255 | |

For details of our column systems see page 250.

## NUCLEODUR® $\pi^2$ hydrophobic biphenylpropyl phase · USP L11

### Key feature

- Hydrophobic phase with alternative selectivity compared to classical $C_{18}$ modifications
- Separation principle based on 2 retention mechanisms (π-π interactions and hydrophobic interactions)
- Better retention of aromatic and unsaturated substances
- Excellent performance under highly aqueous conditions

### Technical data

- Phase with biphenylpropyl modification and multi-endcapping; pore size 110 Å; particle size 5 µm; carbon content 17 %; pH stability 1.5–10

### Recommended application

- Overall sophisticated analytical separations, especially aromatic and unsaturated compounds, polar compounds like pharmaceuticals, antibiotics, steroids

Stationary HPLC phases with biphenyl ligands like NUCLEODUR® $\pi^2$ provide an interesting alternative to classical alkyl modified $C_{18}$ and $C_8$ HPLC phases due to their remarkable orthogonal selectivity.

Furthermore the NUCLEODUR® $\pi^2$ provides an excellent separation performance for aromatic and unsaturated analytes by combination of hydrophobic and π-π interactions.

A unique feature is the predominant separation mechanism (π-π or hydrophobic interactions) and thus the selectivity can be controlled by selection of the eluent. In acetonitrile / water NUCLEODUR® $\pi^2$ shows similar retention strength then $C_{18}$ modified phases and thereby displays a significantly stronger retention than phenyl phases. These interactions are even further enhanced in a methanol / water eluent.

NUCLEODUR® $\pi^2$ exceeds other aryl phases in terms of stability under strongly aqueous conditions. Therefore i.a. steroids, sulfonamides and acidic pharmaceuticals are separated in good resolution with NUCLEODUR® $\pi^2$. NUCLEODUR® $\pi^2$ is the stationary phase with the highest aromatic analyte selectivity.

**Sulfonamide antibiotics**

MN Appl. No. 127920

| | |
|---|---|
| Columns: | 100 x 3 mm each<br>NUCLEODUR® $\pi^2$, 5 µm<br>Pinnacle® DB Biphenyl, 5 µm<br>Ultra Biphenyl, 5 µm |
| Eluent: | A) 0.1 % TFA in water<br>B) 0.1 % TFA in methanol<br>20 % B for 2 min, 20–60 % B in 2 min, 60 % B for 10 min |
| Flow rate: | 0.56 mL/min |
| Temperature: | 30 °C |
| Detection: | UV, 280 nm |
| Injection: | 1 µL |

Peaks:
1. Sulfathiazole
2. Sulfadiazine
3. Sulfachloropyridazine
4. Sulfamerazine
5. Sulfadimidine
6. Sulfamethoxazole
7. Sulfadimethoxine
8. Sulfaquinoxaline

Steroids

MN Appl. No. 127910

Columns: 125 x 4 mm each
NUCLEODUR® $\pi^2$, 5 µm
NUCLEODUR® Phenyl-Hexyl, 5 µm
NUCLEODUR® $C_{18}$ Gravity, 5 µm

Eluent: acetonitrile – water (45:55, v/v)
Injection: 1 µL
Flow rate: 1 mL/min
Temperature: 25 °C
Detection: UV, 230 nm

Peaks:
1. Estriol
2. Hydrocortisone
3. Prednisone
4. β-Estradiol
5. Corticosterone
6. Cortisonacetate
7. Testosterone

## Ordering information

Eluent in column acetonitrile – water

| ID | Length → 50 mm | 75 mm | 100 mm | 125 mm | 150 mm | 250 mm |
|---|---|---|---|---|---|---|
| **NUCLEODUR® $\pi^2$, 5 µm** particle size 5 µm | | | | | | |
| Analytical EC columns | | | | | | |
| 2 mm | 760620.20 | 760621.20 | 760622.20 | 760623.20 | 760624.20 | 760625.20 |
| 3 mm | 760620.30 | 760621.30 | 760622.30 | 760623.30 | 760624.30 | 760625.30 |
| 4 mm | 760620.40 | 760621.40 | 760622.40 | 760623.40 | 760624.40 | 760625.40 |
| 4.6 mm | 760620.46 | 760621.46 | 760622.46 | 760623.46 | 760624.46 | 760625.46 |
| EC guard columns* | 4 x 2 mm: 761810.20 | | 4 x 3 mm: 761810.30 | | | |

EC columns in packs of 1, guard columns in packs of 3.

## Guard column systems

| Guard columns for EC columns with ID | | 2 mm | 3 mm | 4 mm | 4.6 mm | Guard column holder |
|---|---|---|---|---|---|---|
| * Column Protection System (pack of) | EC | 4/2 (3) | 4/3 (3) | 4/3 (3) | 4/3 (3) | 718966 |

For details of our column systems see page 250.

## NUCLEODUR® PFP hydrophobic pentafluorophenyl phase · USP L43

### Key feature

- Hydrophobic phase with alternative selectivity in comparison to classical $C_{18}$ modifications
- Separation principle based on 4 retention mechanisms (polar interactions (H bonds), dipole-dipole, π-π, and hydrophobic interactions)
- Suitable for LC/MS due to low bleeding characteristics

### Technical data

- Phase with pentafluorophenyl-propyl modification and multi-endcapping; pore size 110 Å; particle sizes 1.8 µm, 3 µm and 5 µm; carbon content 8 %; pH stability 1–9

### Recommended application

- Aromatic and unsaturated compounds, phenols, halogen compounds, isomers, polar compounds like pharmaceuticals, antibiotics; strong retention of basic compounds

## Orthogonality in selectivity

Fluorinated stationary phases in HPLC have gained increasing interest over the last years. Most common representative of fluorinated silica phases is the pentafluorophenyl modification (PFP or $F_5$). Especially the orthogonal selectivity compared to traditional alkyl phases widens the scope in analytical HPLC.

Thus NUCLEODUR® PFP offers an excellent selectivity especially for highly polar analytes like aromatic and unsaturated compounds, phenols or halogenated hydrocarbons.

While a typical $C_{18}$ phase just provides hydrophobic interactions between stationary phase and analyte NUCLEODUR® PFP offers four different retention mechanisms: polar interactions (H bonds), dipole-dipole, π-π, and hydrophobic interactions. Especially the pronounced ion exchange capacity and distinct steric selectivity are typical for fluorinated phases.

Due to low bleeding characteristics NUCLEODUR® PFP is also suitable for LC/MS. Based on a special surface modification procedure NUCLEODUR® PFP offers highest stability also at low pH values.

NUCLEODUR® PFP offers a completely different retention behavior compared to alkyl modified silica and is often used for separations which provide insufficient results on traditional $C_{18}$ phases.

Applications in the areas of (bio-)pharma, natural compounds and environment show the broad applicability of this phase.

**Separation of antihistamines**

MN Appl. No. 124861

| | |
|---|---|
| Columns: | 250 x 3 mm NUCLEODUR® PFP, 5 µm |
| | 250 x 3 mm NUCLEODUR® $C_{18}$ Gravity, 5 µm |
| Eluent: | acetonitrile – 20 mmol/L $KH_2PO_4$ (30:70, v/v) |
| Flow rate: | 1.3 mL/min |
| Temperature: | 30 °C |
| Detection: | UV, 210 nm |

Peaks:
1. Maleic acid
2. Chlorpheniramine
3. Brompheniramine
4. Triprolidine
5. Diphenhydramine
6. Promethazine
7. Cetirizine
8. Hydroxyzine

Separation of phenol isomers

MN Appl. No. 124531

Column: 125 x 4 mm NUCLEODUR® PFP, 5 µm
125 x 4 mm NUCLEODUR® $C_{18}$ HTec, 5 µm

Eluent: acetonitrile, 0.1 % formic acid – water, 0.1 % formic acid (35:65, v/v)

Flow rate: 1 mL/min

Temperature: 35 °C

Detection: UV, 280 nm

Peaks:

1. *o*-Kresol
2. *m*-Kresol
3. 3,4-Dimethylphenol
4. 3,5-Dimethylphenol
5. 2,5-Dimethylphenol
6. 2,6-Dichlorophenol
7. 2,3-Dichlorophenol
8. 2,4-Dichlorophenol
9. 3,4-Dichlorophenol
10. 2,4-Dibromophenol
11. 3,5-Dibromophenol

## Ordering information

Eluent in column acetonitrile – water

| | ID | Length → 30 mm | 50 mm | 75 mm | 100 mm | 125 mm | 150 mm | 250 mm |
|---|---|---|---|---|---|---|---|---|
| **NUCLEODUR® PFP, 1.8 µm** particle size 1.8 µm · UHPLC | | | | | | | | |
| Analytical EC columns | | | | | | | | |
| | 2 mm | 760431.20 | 760433.20 | 760435.20 | 760436.20 | | 760438.20 | |
| | 3 mm | 760431.30 | 760433.30 | | 760436.30 | | | |
| | 4 mm | 760431.40 | 760433.40 | | 760436.40 | | | |
| | 4.6 mm | 760431.46 | 760433.46 | | 760436.46 | | | |
| EC guard columns* | | | 4 x 2 mm: 761975.20 | | 4 x 3 mm: 761975.30 | | | |
| **NUCLEODUR® PFP, 3 µm** particle size 3 µm | | | | | | | | |
| Analytical EC columns | | | | | | | | |
| | 2 mm | | 760443.20 | | 760446.20 | 760447.20 | 760448.20 | 760449.20 |
| | 3 mm | | 760443.30 | | 760446.30 | 760447.30 | 760448.30 | 760449.30 |
| | 4 mm | | 760443.40 | | 760446.40 | 760447.40 | 760448.40 | 760449.40 |
| | 4.6 mm | | 760443.46 | 760445.46 | 760446.46 | 760447.46 | 760448.46 | 760449.46 |
| EC guard columns* | | | 4 x 2 mm: 761976.20 | | 4 x 3 mm: 761976.30 | | | |
| **NUCLEODUR® PFP, 5 µm** particle size 5 µm | | | | | | | | |
| Analytical EC columns | | | | | | | | |
| | 2 mm | | 760453.20 | | 760456.20 | 760457.20 | 760458.20 | 760459.20 |
| | 3 mm | | 760453.30 | | 760456.30 | 760457.30 | 760458.30 | 760459.30 |
| | 4 mm | | 760453.40 | | 760456.40 | 760457.40 | 760458.40 | 760459.40 |
| | 4.6 mm | | 760453.46 | 760455.46 | 760456.46 | 760457.46 | 760458.46 | 760459.46 |
| EC guard columns* | | | 4 x 2 mm: 761977.20 | | 4 x 3 mm: 761977.30 | | | |
| Preparative VarioPrep columns | | | | | | | | |
| | 10 mm | | 762210.100 | | | 762211.100 | | 762213.100 |
| | 21 mm | | 762210.210 | | | 762211.210 | | 762213.210 |
| | 32 mm | | | | | | | 762213.320 |
| | 40 mm | | | | | | 762212.400 | 762213.400 |
| VP guard columns ** | | | 10 x 8 mm: 762214.80 | | 10 x 16 mm: 762214.160 | | 15 x 32 mm: 762216.320 | |
| EC and VarioPrep columns in packs of 1, guard columns see below. | | | | | | | | |

## Guard column systems

| Guard columns for EC columns with ID | | 2 mm | 3 mm | 4 mm | 4.6 mm | Guard column holder |
|---|---|---|---|---|---|---|
| * Column Protection System (pack of) | EC | 4/2 (3) | 4/3 (3) | 4/3 (3) | 4/3 (3) | 718966 |
| **Guard columns for VarioPrep columns with ID** | | **8, 10 mm** | **16, 21 mm** | **32, 40 mm** | **≥ 50 mm** | |
| ** VP guard columns (pack of) | VP | 10/8 (2) | 10/16 (2) | 15/32 (1) | 15/50 (1) | |
| VP guard column holder | | 718251 | 718256 | 718253 | 718255 | |

For details of our column systems see page 250.

## NUCLEODUR® Sphinx RP bifunctional RP phase · USP L1 and L11

### Key feature

- Distinct selectivity based on well-balanced bifunctional surface coverage
- Widens the scope for method development based on additional π-π interactions
- Suitable for LC/MS due to low bleeding characteristics

### Technical data

- Octadecyl and propylphenyl modified silica; pore size 110 Å; particle sizes 1.8 µm, 3 µm and 5 µm; carbon content 15 %; pH stability 1–10; high reproducibility and consistent quality

### Recommended application

- Quinolone antibiotics, sulfonamides, xanthines, substituted aromatics

## Alternative RP selectivity

NUCLEODUR® Sphinx RP is characterized by exceptional selectivity features generated by a well-balanced ratio of covalently bonded octadecyl and phenyl groups. The combination of classical hydrophobic with π-π interactions (aromatic ring system) expands the scope of selectivity in comparison with conventional reversed phase packings. NUCLEODUR® Sphinx RP is particularly suited for the separation of molecules containing aromatic and multiple bonds.

For the separation of polar compounds NUCLEODUR® Sphinx RP can be especially recommended and can also outperform many customary $C_{18}$ phases. In addition, exhaustive endcapping steps minimize unwanted surface silanol activity and guarantee excellent peak shapes even for strong basic analytes.

**Stability of NUCLEODUR® Sphinx RP at pH 10**

MN Appl. No. 120900

| | |
|---|---|
| Column: | 50 x 4.6 mm NUCLEODUR® Sphinx RP, 5 µm |
| Eluent: | methanol – dil. $NH_3$, pH 10 (20:80, v/v) |
| Flow rate: | 1.0 mL/min, temperature 30 °C |
| Detection: | UV, 275 nm |
| Injection: | 3 µL |

Peaks:
1. Theophylline
2. Caffeine

Different from standard phenyl phases, NUCLEODUR® Sphinx RP is far more stable towards hydrolysis and is also suggested for LC/MS applications. Due to the additional intermolecular interactions NUCLEODUR® Sphinx RP is an interesting replenishment to the high density bonded phases NUCLEODUR® $C_8$/$C_{18}$ Gravity and the polar endcapped NUCLEODUR® $C_{18}$ Pyramid.

**Separation of flavonoids on three different NUCLEODUR® phases**

MN Appl. No. 119830

| | |
|---|---|
| Columns: | 150 x 4.6 mm |
| | NUCLEODUR® Sphinx RP, 5 µm |
| | NUCLEODUR® $C_{18}$ Gravity, 5 µm |
| | NUCLEODUR® $C_8$ Gravity, 5 µm |
| Eluent: | water – methanol (40:60, v/v) |
| Flow rate: | 1 mL/min |
| Temperature: | 30 °C |
| Detection: | UV, 270 nm |
| Injection: | 3 µL |

Peaks:

| | |
|---|---|
| 1. Catechin | |
| 2. Rutin | $R_1 = R_3 = OH$, $R_2$ = O-Rutinose |
| 3. Fisetin | $R_1 = R_2 = OH$, $R_3 = H$ |
| 4. Quercetin | $R_1 = R_2 = R_3 = OH$ |
| 5. Kaempferol | $R_1 = H$, $R_2 = R_3 = OH$ |
| 6. Isorhamnetin | $R_1 = OCH_3$, $R_2 = R_3 = OH$ |

## Ordering information

Eluent in column acetonitrile – water

| | ID | Length → 30 mm | 50 mm | 75 mm | 100 mm | 125 mm | 150 mm | 250 mm |
|---|---|---|---|---|---|---|---|---|
| **NUCLEODUR® Sphinx RP, 1.8 µm** particle size 1.8 µm · UHPLC | | | | | | | | |
| Analytical EC columns | | | | | | | | |
| | 2 mm | 760821.20 | 760822.20 | 760825.20 | 760823.20 | | 760824.20 | |
| | 3 mm | 760821.30 | 760822.30 | | 760823.30 | | | |
| | 4 mm | 760821.40 | 760822.40 | | 760823.40 | | | |
| | 4.6 mm | 760821.46 | 760822.46 | | 760823.46 | | | |
| EC guard columns* | | | 4 x 2 mm: 761920.20 | | 4 x 3 mm: 761920.30 | | | |
| **NUCLEODUR® Sphinx RP, 3 µm** particle size 3 µm | | | | | | | | |
| Analytical EC columns | | | | | | | | |
| | 2 mm | | 760806.20 | | 760812.20 | 760807.20 | 760805.20 | 760808.20 |
| | 3 mm | | 760806.30 | | 760812.30 | 760807.30 | 760805.30 | 760808.30 |
| | 4 mm | | 760806.40 | | 760812.40 | 760807.40 | 760805.40 | 760808.40 |
| | 4.6 mm | | 760806.46 | 760813.46 | 760812.46 | 760807.46 | 760805.46 | 760808.46 |
| EC guard columns* | | | 4 x 2 mm: 761921.20 | | 4 x 3 mm: 761921.30 | | | |
| **NUCLEODUR® Sphinx RP, 5 µm** particle size 5 µm | | | | | | | | |
| Analytical EC columns | | | | | | | | |
| | 2 mm | | 760800.20 | | 760809.20 | 760801.20 | 760802.20 | 760803.20 |
| | 3 mm | | 760800.30 | | 760809.30 | 760801.30 | 760802.30 | 760803.30 |
| | 4 mm | | 760800.40 | | 760809.40 | 760801.40 | 760802.40 | 760803.40 |
| | 4.6 mm | | 760800.46 | 760815.46 | 760809.46 | 760801.46 | 760802.46 | 760803.46 |
| EC guard columns* | | | 4 x 2 mm: 761922.20 | | 4 x 3 mm: 761922.30 | | | |
| Preparative VarioPrep columns | | | | | | | | |
| | 10 mm | | 762372.100 | | | 762375.100 | | 762373.100 |
| | 21 mm | | 762372.210 | | | 762375.210 | | 762373.210 |
| | 32 mm | | | | | | | 762373.320 |
| | 40 mm | | | | | | 762371.400 | 762373.400 |
| VP guard columns ** | | | 10 x 8 mm: 762390.80 | | 10 x 16 mm: 762390.160 | | 15 x 32 mm: 762392.320 | |

EC and VarioPrep columns in packs of 1, guard columns see below.

## Guard column systems

| Guard columns for EC columns with ID | | 2 mm | 3 mm | 4 mm | 4.6 mm | Guard column holder |
|---|---|---|---|---|---|---|
| * Column Protection System (pack of) | EC | 4/2 (3) | 4/3 (3) | 4/3 (3) | 4/3 (3) | 718966 |
| **Guard columns for VarioPrep columns with ID** | | **8, 10 mm** | **16, 21 mm** | **32, 40 mm** | **≥ 50 mm** | |
| ** VP guard columns (pack of) | VP | 10/8 (2) | 10/16 (2) | 15/32 (1) | 15/50 (1) | |
| VP guard column holder | | 718251 | 718256 | 718253 | 718255 | |

For details of our column systems see page 250.

## NUCLEODUR® $C_{18}$ HTec base-deactivated preparative octadecyl phase · USP L1

### Key feature

- Reliable and durable standard RP phase for up-scaling to preparative scale, suited for LC/MS
- High loading capacity and excellent stability
- Outstanding base deactivation

### Technical data

- High density octadecyl modification ($C_{18}$); pore size 110 Å; particle sizes 1.8 µm, 3 µm, 5 µm, 7 µm and 10 µm for analytical and preparative separations; carbon content 18 %, pH stability 1–11

### Recommended application

- Sophisticated analytical and preparative separations of basic, neutral and acidic pharmaceuticals, derivatized amino acids, pesticides, fat-soluble vitamins, aldehydes, ketones and phenolic compounds

Preparative separations place high demands on silica based HPLC materials. Apart from excellent selectivity and base deactivation, robustness (pH, pressure stability, …) and capacity are vital criteria for optimal and efficient separation at the preparative scale.

## Selectivity and base deactivation

The innovative endcapping procedure leads to exceptionally good base deactivation – the Engelhardt test demonstrates superb selectivity, peak symmetry and peak shape over the entire polarity range. In addition NUCLEODUR® $C_{18}$ HTec scores in low bleed characteristics and is therefore highly suitable for LC/MS.

**Engelhardt test**

MN Appl. No. 123580

| | |
|---|---|
| Column: | 250 x 4 mm NUCLEODUR® $C_{18}$ HTec, 5 µm |
| Eluent: | methanol – water (49:51, v/v) |
| Flow rate: | 1 mL/min |
| Temperature: | 40 °C |
| Detection: | UV, 254 nm |
| Injection: | 5 µL |

Peaks:

1. Uracil
2. Aniline
3. Phenol
4. *p*-Ethylaniline
5. *N*,*N*-Dimethylaniline
6. Toluene
7. Ethylbenzene

## Stability and lifetime

Based on fully synthetic and extremely robust totally spherical NUCLEODUR® silica, NUCLEODUR® $C_{18}$ HTec offers outstanding mechanical rigidity and is thus the perfect choice also for self-packing of prep-columns. The special surface modification and endcapping procedure results in high chemical stability even at extreme chromatographic conditions like high flow rates, temperature or critical solvents (DMSO). Furthermore, NUCLEODUR® $C_{18}$ HTec columns show a remarkably long lifetime in acidic (pH 1) as well as basic (pH 10) mobile phases.

**pH stability test**

| | |
|---|---|
| Column: | 150 x 4 mm NUCLEODUR® $C_{18}$ HTec, 5 µm |
| Flow rate: | 1 mL/min |
| Detection: | UV, 254 nm |
| Injection: | 5 µL |

• pH 1:
Eluent: acetonitrile – 1 % TFA in water (50:50, v/v); 80 °C
% initial retention of ethylbenzene
693 injections

• pH 10:
Eluent: methanol – 50 mmol/L triethylamine (25:85, v/v); 50 °C
% initial N of theophylline
1034 injections

Due to innovative surface coating procedures NUCLEODUR® $C_{18}$ HTec offers excellent analytical separation properties and is the first choice for up-scaling to preparative column dimensions.

## Up-scaling

Due to highest quality standards in silica production and phase chemistry combined with optimized packing technology, NUCLEODUR® $C_{18}$ HTec allows exceptional transferability from analytical to preparative scale with respect to different particle sizes (e.g., 5, 7 or 10 µm) as well as column dimensions (e.g., ID 4.6 to 21 mm).

### Up-scaling with NUCLEODUR® $C_{18}$ HTec

MN Appl. No. 123780

| | |
|---|---|
| Columns: | EC 250 x 4,6 mm NUCLEODUR® $C_{18}$ HTec, 5 µm<br>VP 250 x 21 mm NUCLEODUR® $C_{18}$ HTec, 5 µm |
| Eluent: | acetonitrile – water (80:20, v/v) |
| Flow rate: | 1.3 mL/min / 27 mL/min |
| Temperature: | 22 °C |
| Pressure: | 84 bar / 109 bar |
| Detection: | UV, 254 nm |
| Injection: | 3 µL / 60 µL |

Peaks: (1 mg/mL each)
1. Phenol
2. Naphthalene
3. Anthracene

## Capacity

A vital criterion for efficiency in preparative HPLC is the capacity of the separation medium. NUCLEODUR® $C_{18}$ HTec is characterized by a notably high loading capacity under both basic and acidic conditions, while competitor columns show overload effects even at lower loads (x).

### Loading capacity under acidic conditions

MN Appl. No. 123890

| | |
|---|---|
| Columns: | VP 100 x 21 mm NUCLEODUR® $C_{18}$ HTec, 5 µm<br>100 x 21.2 mm AXIA™ Gemini® 5 µm C18 110 Å |
| Eluent: | acetonitrile – formic acid in $H_2O$ pH 3.0<br>(30:70, v/v) |
| Flow rate: | 28 mL/min |
| Temperature: | 22 °C |
| Pressure: | 124 bar |
| Detection: | UV, 254 nm |

Peaks:
total load 40 mg
(sample dissolved in DMSO)
1. 4-Acetamidophenol (5 mg)
2. 2-Acetamidophenol (10 mg)
3. Acetylsalicylic acid (25 mg)

## Ordering information

Eluent in column acetonitrile – water

| | ID | Length → 30 mm | 50 mm | 75 mm | 100 mm | 125 mm | 150 mm | 250 mm |
|---|---|---|---|---|---|---|---|---|
| **NUCLEODUR® $C_{18}$ HTec, 1.8 µm** particle size 1.8 µm · UHPLC | | | | | | | | |
| Analytical EC columns | | | | | | | | |
| | 2 mm | 760301.20 | 760305.20 | 760304.20 | 760306.20 | | 760308.20 | |
| | 3 mm | 760301.30 | 760305.30 | | 760306.30 | | | |
| | 4 mm | 760301.40 | 760305.40 | | 760306.40 | | | |
| | 4.6 mm | 760301.46 | 760305.46 | | 760306.46 | | | |
| EC guard columns* | | | 4 x 2 mm: 761925.20 | | 4 x 3 mm: 761925.30 | | | |
| **NUCLEODUR® $C_{18}$ HTec, 3 µm** particle size 3 µm | | | | | | | | |
| Analytical EC columns | | | | | | | | |
| | 2 mm | | 760321.20 | | 760323.20 | 760324.20 | 760325.20 | 760326.20 |
| | 3 mm | | 760321.30 | | 760323.30 | 760324.30 | 760325.30 | 760326.30 |
| | 4 mm | | 760321.40 | | 760323.40 | 760324.40 | 760325.40 | 760326.40 |
| | 4.6 mm | | 760321.46 | 760322.46 | 760323.46 | 760324.46 | 760325.46 | 760326.46 |
| EC guard columns* | | | 4 x 2 mm: 761926.20 | | 4 x 3 mm: 761926.30 | | | |

# NUCLEODUR® columns

## Ordering information

Eluent in column acetonitrile – water

| | ID | Length → 30 mm | 50 mm | 75 mm | 100 mm | 125 mm | 150 mm | 250 mm |
|---|---|---|---|---|---|---|---|---|
| **NUCLEODUR® $C_{18}$ HTec, 5 µm** particle size 5 µm | | | | | | | | |
| Analytical EC columns | | | | | | | | |
| | 2 mm | | 760311.20 | | 760313.20 | 760314.20 | 760315.20 | 760316.20 |
| | 3 mm | | 760311.30 | | 760313.30 | 760314.30 | 760315.30 | 760316.30 |
| | 4 mm | | 760311.40 | | 760313.40 | 760314.40 | 760315.40 | 760316.40 |
| | 4.6 mm | | 760311.46 | 760312.46 | 760313.46 | 760314.46 | 760315.46 | 760316.46 |
| EC guard columns* | | | 4 x 2 mm: 761927.20 | | 4 x 3 mm: 761927.30 | | | |
| Preparative VarioPrep columns | | | | | | | | |
| | 10 mm | | 762551.100 | | | 762554.100 | | 762556.100 |
| | 21 mm | | 762551.210 | | 762553.210 | 762554.210 | | 762556.210 |
| | 32 mm | | | | 762553.320 | | 762555.320 | 762556.320 |
| | 40 mm | | | | | | 762555.400 | 762556.400 |
| | 50 mm | | | | 762553.500 | | 762555.500 | 762556.500 |
| VP guard columns ** | | | 10 x 8 mm: 762591.80 | | 10 x 16 mm: 762591.160 | | | |
| | | | 15 x 32 mm: 762592.320 | | 15 x 50 mm: 762592.500 | | | |
| **NUCLEODUR® $C_{18}$ HTec, 7 µm** particle size 7 µm | | | | | | | | |
| Preparative VarioPrep columns | | | | | | | | |
| | 10 mm | | 762561.100 | | | 762564.100 | | 762566.100 |
| | 21 mm | | 762561.210 | | 762563.210 | 762564.210 | | 762566.210 |
| | 32 mm | | | | 762563.320 | | 762565.320 | 762566.320 |
| | 40 mm | | | | | | 762565.400 | 762566.400 |
| | 50 mm | | | | 762563.500 | | 762565.500 | 762566.500 |
| VP guard columns ** | | | 10 x 8 mm: 762591.80 | | 10 x 16 mm: 762591.160 | | | |
| | | | 15 x 32 mm: 762592.320 | | 15 x 50 mm: 762592.500 | | | |
| **NUCLEODUR® $C_{18}$ HTec, 10 µm** particle size 10 µm | | | | | | | | |
| Preparative VarioPrep columns | | | | | | | | |
| | 10 mm | | 762571.100 | | | 762574.100 | | 762576.100 |
| | 21 mm | | 762571.210 | | 762573.210 | 762574.210 | | 762576.210 |
| | 32 mm | | | | 762573.320 | | 762575.320 | 762576.320 |
| | 40 mm | | | | | | 762575.400 | 762576.400 |
| | 50 mm | | | | 762573.500 | | 762575.500 | 762576.500 |
| VP guard columns ** | | | 10 x 8 mm: 762591.80 | | 10 x 16 mm: 762591.160 | | | |
| | | | 15 x 32 mm: 762592.320 | | 15 x 50 mm: 762592.500 | | | |

EC and VarioPrep columns in packs of 1, guard columns see below.

## Guard column systems

| Guard columns for EC columns with ID | | 2 mm | 3 mm | 4 mm | 4.6 mm | Guard column holder |
|---|---|---|---|---|---|---|
| * Column Protection System (pack of) | EC | 4/2 (3) | 4/3 (3) | 4/3 (3) | 4/3 (3) | 718966 |
| **Guard columns for VarioPrep columns with ID** | | **8, 10 mm** | **16, 21 mm** | **32, 40 mm** | **≥ 50 mm** | |
| ** VP guard columns (pack of) | VP | 10/8 (2) | 10/16 (2) | 15/32 (1) | 15/50 (1) | |
| VP guard column holder | | 718251 | 718256 | 718253 | 718255 | |

For details of our column systems see page 250.
NUCLEODUR® $C_{18}$ HTec bulk material in 7 and 10 µm for self-packing of preparative columns see page 256.

## NUCLEODUR® $C_{18}$ ec · $C_8$ ec · $C_4$ ec nonpolar phases for routine analysis · USP L1 ($C_{18}$) · L7 ($C_8$) · L26 ($C_4$)

### Key feature

- Ideal and reliable standard RP phase for daily routine analysis and up-scaling for preparative HPLC
- Medium density Octadecyl ($C_{18}$) and octyl ($C_8$) with pore size of 110 Å with exhaustive endcapping for a wide range of applications
- Octadecyl ($C_{18}$) and butyl ($C_4$) with pore size of 300 Å for the separation of biomolecules

### Technical data

- Pore size 110 Å:
  particle sizes 3 µm and 5 µm, 7 µm, 10 µm, 12 µm, 16 µm, 20 µm, 30 µm and 50 µm for preparative separations; carbon content 17.5 % for $C_{18}$, 10.5 % for $C_8$; pH stability 1–9; high reproducibility from lot to lot
- Pore size 300 Å:
  technical data and applications in chapter "HPLC column for biochemical separations" (see page 241)

### Recommended application

- 110 Å:
  basic, neutral or acidic drugs; derivatized amino acids; pesticides; fat-soluble vitamins; aldehydes and ketones; phenolic compounds
- 300 Å:
  biomolecular macromolecules, like proteins and peptides

## NUCLEODUR® $C_{18}$ ec for daily routine analysis

The efficiency of a separation is controlled by particle size and selectivity of the stationary phase. The exceptional surface coverage of monomeric bonded alkylsilanes, combined with an exhaustive endcapping, results in a surface with lowest silanol activity. This allows the tailing-free elution of polar compounds such as basic drugs. NUCLEODUR® $C_{18}$ ec is available in 9 different particle sizes (3, 5, 7, 10, 12, 16, 20, 30 and 50 µm) which cover the whole range from high speed analytical HPLC up to medium and low pressure prep LC. NUCLEODUR® $C_{18}$ ec is also an ideal tool for scale-up purposes.

## Loading capacity

Loading capacity, probably the most important feature for preparative LC applications, is determined by pore size, pore volume and surface area of the packing. However, it can also be influenced by the molecular weight of the analytes. In the figure below the mass loading curve for acetophenone and butyrophenone on a NUCLEODUR® 100-20 $C_{18}$ ec column describes the correlation between the increase of column loading and the decrease of separation efficiency.

**Loading curve**

| | |
|---|---|
| Column: | 250 x 4.6 mm NUCLEODUR® 100-20 $C_{18}$ ec |
| Eluent: | acetonitrile – $H_2O$ 80:20 (v/v) |
| Flow rate: | 1.0 mL/min |
| Temperature: | 25 °C |
| Detection: | UV, 280 – 370 nm |

**pH stability of NUCLEODUR® $C_{18}$ ec**

Separation of theophylline and caffeine at pH 10

| | |
|---|---|
| Column: | 30 x 3 mm NUCLEODUR® 100-5 $C_{18}$ ec |
| Eluent: | methanol – aq. $NH_3$ (20:80, v/v), pH 10 |
| Flow rate: | 0.5 mL/min |
| Temperature: | 25 °C |
| Detection: | UV, 254 nm |

Separation of uracil, veratrol, toluene and ethylbenzene at pH 1.5

| | |
|---|---|
| Column: | 30 x 3 mm NUCLEODUR® 100-5 $C_{18}$ ec |
| Eluent: | acetonitrile – $H_2O$ (65:35, v/v), TFA, pH 1.5 |
| Flow rate: | 1.0 mL/min |
| Temperature: | 25 °C |
| Detection: | UV, 254 nm |

## Chemical stability

The utmost purity of the base silica and the exceptional silane bonding chemistry minimize the risk of dissolution, or hydrolysis at pH extremes.

The chromatograms show the retention behavior at pH values of 1.5 and 10.0 for NUCLEODUR® 100-5 $C_{18}$ ec.

## NUCLEODUR® octyl phases

In addition to NUCLEODUR® $C_{18}$ phases MACHEREY-NAGEL offers octyl modified NUCLEODUR® $C_8$ Gravity and NUCLEODUR® $C_8$ ec columns to expand the RP tool box. Based on the same spherical high purity silica the $C_8$ phases exhibit the same chemical and mechanical stability as the $C_{18}$ counterparts. Indeed NUCLEODUR® $C_8$ Gravity can also be run at pH extremes (pH 1–11) by choosing appropriate elution parameters. Due to the shorter chain and less hydrophobic properties of the stationary phase the retention of non-polar compounds is decreased, and in consequence a reduction in time of analysis can be achieved. Moreover a stronger polar selectivity, particularly with the separation of ionizable analytes is frequently observed (as distinct from the $C_{18}$ phases). NUCLEODUR® $C_8$ ec and NUCLEODUR® $C_8$ Gravity are most suitable for the development of new methods but also for robust routine analyses.

There are no general guidelines which could make the choice between $C_8$ and $C_{18}$ phases easier but it will always be beneficial to add both phases to the existing pool of RP columns in the laboratory. Comparative studies reveal some different selectivity patterns of NUCLEODUR® $C_8$ ec and $C_{18}$ ec. The separation of phenols at right shows baseline separation for 2-ethoxyphenol and dimethoxybenzene (veratrol) and in addition a reversal of the elution order of phenol and 4-methoxyphenol can be shown on the octyl phase.

**Separation of phenols**

MN Appl. Nos. 120890 / 120891

| | |
|---|---|
| Columns: | 250 x 4 mm NUCLEODUR® 100-5 $C_8$ ec / $C_{18}$ ec |
| Eluent: | A) water, B) methanol |
| | $C_8$: 20 % B (2 min) → 60 % B in 12 min |
| | $C_{18}$: 25 % B (2 min) → 65 % B in 12 min |
| Flow rate: | 1.0 mL/min, temperature 25 °C |
| Detection: | UV, 275 nm, injection 10 µL |

Peaks:

1. Resorcinol
2. Pyrocatechol
3. 4-Methoxyphenol
4. Phenol
5. 2-Methoxyphenol
6. 2-Ethoxyphenol
7. Veratrol
8. Biphenyl-2-ol
9. Phenetole

### NUCLEODUR® phases for biochromatography

A description and applications for $C_{18}$ and $C_4$ modified 300 Å NUCLEODUR® widepore materials for the separation of biopolymers, like peptids and proteins can be found in chapter "HPLC column for biochemical separations" (see page 241).

### $C_{18}$ or $C_8$ · the best of both worlds

· Octyl phases ($C_8$) show superior polar selectivity.
· Octadecyl phases ($C_{18}$) show superior hydrophobic selectivity.
· Hydrophobic compounds show shorter retention times on $C_8$ phases.

### Ordering information

Eluent in column acetonitrile – water

| | ID | Length → 50 mm | 75 mm | 100 mm | 125 mm | 150 mm | 250 mm |
|---|---|---|---|---|---|---|---|
| **NUCLEODUR® 100-3 $C_{18}$ ec** octadecyl phase, particle size 3 µm, 17.5 % C | | | | | | | |
| Analytical EC columns | | | | | | | |
| | 2 mm | 760050.20 | | 760054.20 | 760051.20 | 760053.20 | 760052.20 |
| | 3 mm | 760050.30 | | 760054.30 | 760051.30 | 760053.30 | 760052.30 |
| | 4 mm | 760050.40 | | 760054.40 | 760051.40 | 760053.40 | 760052.40 |
| | 4.6 mm | 760050.46 | 760046.46 | 760054.46 | 760051.46 | 760053.46 | 760052.46 |
| EC guard columns* | | | 4 x 2 mm: 761931.20 | | 4 x 3 mm: 761931.30 | | |

## Ordering information

Eluent in column acetonitrile – water

| | ID | Length → 50 mm | 75 mm | 100 mm | 125 mm | 150 mm | 250 mm |
|---|---|---|---|---|---|---|---|
| **NUCLEODUR® 100-5 $C_{18}$ ec** octadecyl phase, particle size 5 µm, 17.5 % C | | | | | | | |
| Analytical EC columns | | | | | | | |
| | 2 mm | 760004.20 | | 760013.20 | 760001.20 | 760008.20 | 760002.20 |
| | 3 mm | 760004.30 | | 760013.30 | 760001.30 | 760008.30 | 760002.30 |
| | 4 mm | 760004.40 | | 760013.40 | 760001.40 | 760008.40 | 760002.40 |
| | 4.6 mm | 760004.46 | 760035.46 | 760013.46 | 760001.46 | 760008.46 | 760002.46 |
| EC guard columns* | | | 4 x 2 mm: 761932.20 | | 4 x 3 mm: 761932.30 | | |
| Preparative VarioPrep columns | | | | | | | |
| | 10 mm | 762003.100 | | | 762029.100 | | 762022.100 |
| | 21 mm | 762003.210 | | | 762029.210 | | 762022.210 |
| | 32 mm | | | | | | 762022.320 |
| | 40 mm | | | | | 762027.400 | 762022.400 |
| VP guard columns ** | | | 10 x 8 mm: 762090.80 | | 10 x 16 mm: 762090.160 | | |
| | | | 15 x 32 mm: 762311.320 | | 15 x 50 mm: 762311.500 | | |
| **NUCLEODUR® 100-10 $C_{18}$ ec** octadecyl phase, particle size 10 µm, 17.5 % C | | | | | | | |
| Preparative VarioPrep columns | | | | | | | |
| | 10 mm | 762011.100 | | | 762302.100 | | 762010.100 |
| | 21 mm | 762011.210 | | | 762302.210 | | 762010.210 |
| | 32 mm | | | | | | 762010.320 |
| | 40 mm | | | | | 762303.400 | 762010.400 |
| | 50 mm | | | | | | 762010.500 |
| VP guard columns ** | | | 10 x 8 mm: 762090.80 | | 10 x 16 mm: 762090.160 | | |
| | | | 15 x 32 mm: 762311.320 | | 15 x 50 mm: 762311.500 | | |

## Ordering information

Eluent in column acetonitrile – water

| | ID | Length → 50 mm | 75 mm | 100 mm | 125 mm | 150 mm | 250 mm |
|---|---|---|---|---|---|---|---|
| **NUCLEODUR® 100-3 $C_8$ ec** octyl phase, particle size 3 µm, 10.5 % C | | | | | | | |
| Analytical EC columns | | | | | | | |
| | 2 mm | 760063.20 | | 760059.20 | 760060.20 | | 760062.20 |
| | 3 mm | 760063.30 | | 760059.30 | 760060.30 | | 760062.30 |
| | 4 mm | 760063.40 | | 760059.40 | 760060.40 | | 760062.40 |
| | 4.6 mm | 760063.46 | 760064.46 | 760059.46 | 760060.46 | 760061.46 | 760062.46 |
| EC guard columns* | | | 4 x 2 mm: 761936.20 | | 4 x 3 mm: 761936.30 | | |
| **NUCLEODUR® 100-5 $C_8$ ec** octyl phase, particle size 5 µm, 10.5 % C | | | | | | | |
| Analytical EC columns | | | | | | | |
| | 2 mm | 760700.20 | | 760704.20 | 760701.20 | | 760703.20 |
| | 3 mm | 760700.30 | | 760704.30 | 760701.30 | | 760703.30 |
| | 4 mm | 760700.40 | | 760704.40 | 760701.40 | | 760703.40 |
| | 4.6 mm | 760700.46 | 760706.46 | 760704.46 | 760701.46 | 760702.46 | 760703.46 |
| EC guard columns* | | | 4 x 2 mm: 761937.20 | | 4 x 3 mm: 761937.30 | | |
| Preparative VarioPrep columns | | | | | | | |
| | 10 mm | 762072.100 | | | 762061.100 | | 762062.100 |
| | 21 mm | 762072.210 | | | 762061.210 | | 762062.210 |
| | 32 mm | | | | | | 762062.320 |
| | 40 mm | | | | | 762079.400 | 762062.400 |
| VP guard columns ** | | 10 x 8 mm: 762092.80 | | 10 x 16 mm: 762092.160 | | 15 x 32 mm: 762321.320 | |

EC and VarioPrep columns in packs of 1, guard columns see previous NUCLEODUR® phases.

Guard column systems see previous NUCLEODUR® phases. For details of our column systems see page 250.
NUCLEODUR® $C_{18}$ ec bulk material with 10–50 µm for self-packing of preparative columns see page 256.
The ordering information for $C_{18}$ and $C_4$ modified 300 Å NUCLEODUR® widepore materials for the separation of biopolymers can be found in the chapter "HPLC column for biochemical separations" (see page 241).
* and ** for corresponding guard column systems see page 180.

## NUCLEODUR® HILIC zwitterionic phase

### Key feature

- Ideal for reproducible and stable chromatography of highly polar analytes
- Suitable for analytical and preparative applications
- Very short column conditioning period

### Technical data

- Ammonium - sulfonic acid modified silica; pore size 110 Å; particle sizes 1.8, 3 and 5 µm; carbon content 7 %; pH stability 2–8.5

### Recommended application

- Hydrophilic compounds such as organic polar acids and bases, polar natural compounds, nucleosides, oligonucleotides, amino acids, peptides, water soluble vitamins

## Hydrophilic interaction chromatography

Especially for polar compounds reversed phase HPLC – the most common analytical method – is often limited. Here, hydrophilic stationary phases provide an additional tool for the separation of polar analytes in HPLC.

The expression HILIC (Hydrophilic Interaction Chromatography) was firstly published by Andrew Alpert in 1990 – since then it took quite some efforts to develop robust and reproducible hydrophilic HPLC phases for HILIC chromatography [7].

HILIC combines the characteristics of the 3 major methods in liquid chromatography – reversed phase (RPC), normal phase (NPC) and ion chromatography (IC):

- Stationary phases (adsorbents) are mostly polar modifications of silica or polymers (SiOH, $NH_2$, Diol, (zwitter) ions, …) – like in NPC.
- Mobile phases (eluents) are mixtures of aqueous buffer systems and organic modifier like acetonitrile or methanol - like in RPC.
- Fields of application include quite polar compounds as well as organic and inorganic ions – like in IC.

Summarized: "HILIC is NP chromatography of polar and ionic compounds under RP conditions."

NUCLEODUR® HILIC is a special zwitterionic modified stationary phase based on ultra spherical NUCLEODUR® particles. The betaine character of the ammoniumsulfonic acid ligands results in total charge equalization and in an overall neutrally charged but highly polar surface

## Retention characteristic

Commonly HILIC is described as partition chromatography or liquid-liquid extraction system between mobile and stationary phases. Versus a water-poor mobile phase a water-rich layer on the surface of the polar stationary phase is formed. Thus, a distribution of the analytes between these two layers will occur. Furthermore HILIC includes weak electrostatic mechanisms as well as hydrogen donor interactions between neutral polar molecules under high organic elution conditions. This distinguishes HILIC from ion exchange chromatography - main principle for HILIC separation is based on compound's polarity and degree of solvation.

**Separation of uracil and naphthalene**

MN Appl. Nos. 122911 / 122912

| | |
|---|---|
| Columns: | A) 125 x 4 mm NUCLEODUR® $C_{18}$ Pyramid, 3 µm |
| | B) 125 x 4 mm NUCLEODUR® HILIC, 3 µm |
| Eluent: | acetonitrile – water (90:10, v/v)) |
| Flow rate: | 1.0 mL/min, temperature 25 °C |
| Detection: | UV, 254 nm |

Peaks:
1. Uracil
2. Naphthalene

More polar compounds will have stronger interaction with the stationary aqueous layer than less polar compounds – resulting in a stronger retention. Nonpolar compounds exhibit faster elution profiles due to minor hydrophobic interactions. In the separation of uracil and naphthalene the elution order is quite often inverse on HILIC columns compared to RP columns.

## Stability features

Due to an advanced and unique surface modification procedure (pat. pend.) NUCLEODUR® HILIC columns provide short equilibration times – after just 20 min equilibration already the 2nd injection shows stable and reproducible results.

Beyond this, NUCLEODUR® HILIC columns are characterized by an outstanding column life time - even after nearly 800 runs the columns show no loss of pristine performance - peak shape and retention are still immaculate. Due to its high loading capacity NUCLEODUR® HILIC is absolutely suitable for preparative and semi-preparative applications.

Overall NUCLEODUR® HILIC provides excellent chromatographic features and is hereby the perfect choice for separation of polar or charged compounds.

Stability and equilibration

MN Appl. No. 123100

| | |
|---|---|
| Column: | 250 x 4 mm NUCLEODUR® HILIC, 5 µm |
| Eluent: | $CH_3CN$ – 5 mmol/L ammonium acetate (80:20, v/v) |
| Flow rate: | 0.6 mL/min |
| Temperature: | 25 °C |
| Detection: | UV, 254 nm |

Peaks:
1. Thymine
2. Uracil
3. Adenine
4. Cytosine
5. Guanosine

## Ordering information

Eluent in column acetonitrile – water (80:20, v/v)

| | ID | Length → 30 mm | 50 mm | 75 mm | 100 mm | 125 mm | 150 mm | 250 mm |
|---|---|---|---|---|---|---|---|---|
| **NUCLEODUR® HILIC, 1.8 µm** particle size 1.8 µm · UHPLC | | | | | | | | |
| Analytical EC columns | | | | | | | | |
| | 2 mm | 760521.20 | 760523.20 | 760525.20 | 760526.20 | | 760528.20 | |
| | 3 mm | 760521.30 | 760523.30 | | 760526.30 | | | |
| | 4 mm | 760521.40 | 760523.40 | | 760526.40 | | | |
| | 4.6 mm | 760521.46 | 760523.46 | | 760526.46 | | | |
| EC guard columns* | | | 4 x 2 mm: 761960.20 | | 4 x 3 mm: 761960.30 | | | |
| **NUCLEODUR® HILIC, 3 µm** particle size 3 µm | | | | | | | | |
| Analytical EC columns | | | | | | | | |
| | 2 mm | | 760532.20 | | 760534.20 | 760531.20 | 760533.20 | 760530.20 |
| | 3 mm | | 760532.30 | | 760534.30 | 760531.30 | 760533.30 | 760530.30 |
| | 4 mm | | 760532.40 | | 760534.40 | 760531.40 | 760533.40 | 760530.40 |
| | 4.6 mm | | 760532.46 | | 760534.46 | 760531.46 | 760533.46 | 760530.46 |
| EC guard columns* | | | 4 x 2 mm: 761961.20 | | 4 x 3 mm: 761961.30 | | | |
| **NUCLEODUR® HILIC, 5 µm** particle size 5 µm | | | | | | | | |
| Analytical EC columns | | | | | | | | |
| | 2 mm | | 760552.20 | | 760554.20 | 760551.20 | 760553.20 | 760550.20 |
| | 3 mm | | 760552.30 | | 760554.30 | 760551.30 | 760553.30 | 760550.30 |
| | 4 mm | | 760552.40 | | 760554.40 | 760551.40 | 760553.40 | 760550.40 |
| | 4.6 mm | | 760552.46 | | 760554.46 | 760551.46 | 760553.46 | 760550.46 |
| EC guard columns* | | | 4 x 2 mm: 761962.20 | | 4 x 3 mm: 761962.30 | | | |

## Guard column system

| Guard columns for EC columns with ID | | 2 mm | 3 mm | 4 mm | 4.6 mm | Guard column holder |
|---|---|---|---|---|---|---|
| * Column Protection System (pack of) | EC | 4/2 (3) | 4/3 (3) | 4/3 (3) | 4/3 (3) | 718966 |

For details of our column systems see page 250.

## NUCLEODUR® CN / CN-RP cyano-modified high purity silica phase · USP L10

### Key feature

- High retention capacity especially for very polar and unsaturated compounds
- Multi-mode column (RP and NP) widens scope of selectivity
- Stable against hydrolysis at low pH (working range pH 1–8)

### Technical data

- Cyanopropyl-modified high purity silica; pore size 110 Å; particle sizes 3 µm and 5 µm; carbon content 7 %; special endcapping
- High reproducibility from lot to lot; different retention characteristics in comparison to $C_8$ and $C_{18}$

### Recommended application

- Tricyclic antidepressants, steroids, organic acids

## Alternative bonded-phase functionality

In reversed phase HPLC it is fairly common to start with $C_{18}$ or $C_8$ columns, if new methods have to be developed. However, superior polarity and selectivity properties often required for more sophisticated separations, are not always sufficiently provided by classical RP phases, which are usually characterized by a hydrophobic layer of monomeric or polymeric bonded alkylsilanes.

One approach to improve the resolution of compounds poorly separated on nonpolar stationary phases, is to change bonded-phase functionality.

The fully endcapped and highly reproducible NUCLEODUR® 100-5 CN-RP phase has cyanopropyl groups on the surface able to generate a clearly recognizable different retention behavior compared to purely alkyl-functionalized surface modifications (see figure below).

**Separation of cold medicine ingredients on two different NUCLEODUR® phases**

MN Appl. No. 119340

| | |
|---|---|
| Columns: | 250 x 4 mm NUCLEODUR® 100-5 $C_{18}$ ec |
| | 250 x 4 mm NUCLEODUR® 100-5 CN-RP |
| Eluent: | acetonitrile – 100 mmol/L sodium citrate pH 2.5 (15:85, v/v) |
| Flow rate: | 1.0 mL/min, temperature 25 °C |
| Detection: | UV, 254 nm, injection 10 µL |

Peaks:
1. Maleic acid
2. Norephedrine
3. Ephedrine
4. Acetaminophen
5. Chlorpheniramine
6. Brompheniramine

The polarity of NUCLEODUR® 100-5 CN-RP can be classified as intermediate based on multiple retention mechanisms such as dipole-dipole, π-π, and also hydrophobic interactions [8]. Therefore, this phase shows a distinct selectivity for polar organic compounds as well as for molecules containing π electron systems (e.g., analytes with double bonds, tricyclic antidepressants) [9].

Short-chain bonded phases are sometimes suspected of revealing shortcomings in stability towards hydrolysis at low pH [10]. Application 119350 shows that even after 100 sample injections and four weeks storage at pH 1 (blue curve), neither a considerable shift in retention, nor a visible change in peak symmetry could be noticed (green curve = new column)

**Stability of NUCLEODUR® CN-RP at pH 1**

MN Appl. No. 119350

| | |
|---|---|
| Columns: | 125 x 4 mm NUCLEODUR® 100-5 CN-RP |
| Eluent: | acetonitrile – water, 2 % TFA pH 1 (50:50, v/v) |
| Flow rate: | 1.0 mL/min |
| Temperature: | 25 °C |
| Detection: | UV, 254 nm |
| Injection: | 5 µL |

Peaks:
1. Benzamide
2. Dimethyl phthalate
3. Phenetole
4. *o*-Xylene
5. Biphenyl

## Multi-mode columns

Due to its polarity the cyano phase can also be run in normal phase mode. NUCLEODUR® CN columns for NP applications are shipped in *n*-heptane. The change in selectivity and order of elution for a mixture of various steroids in NP and RP mode is displayed below. The high coverage combined with a thorough endcapping makes NUCLEODUR® 100-5 CN-RP suitable for separation of ionizable compounds such as basic drugs.

Separation of steroids in normal phase and reversed phase mode

MN Appl. Nos. 119271 / 119272

Normal phase mode

Column: 250 x 4 mm NUCLEODUR® 100-5 CN
Eluent: *n*-heptane – 2-propanol (90:10, v/v)
Flow rate: 1.0 mL/min, temperature 25 °C
Detection: UV, 254 nm, injection 10 µL

Reversed phase mode

Column: 250 x 4 mm NUCLEODUR® 100-5 CN-RP
Eluent: acetonitrile – water (25:75, v/v)
other conditions as for normal phase mode

Peaks:
1. Methyltestosterone
2. Testosterone
3. Norgestrel
4. Medrysone
5. Cortisone
6. Hydrocortisone
7. Prednisolone

### Ordering information

| | ID | Length → 50 mm | 125 mm | 150 mm | 250 mm |
|---|---|---|---|---|---|
| **NUCLEODUR® 100-3 CN-RP** particle size 3 µm; eluent in column acetonitrile – water | | | | | |
| Analytical EC columns | | | | | |
| | 2 mm | 760159.20 | 760157.20 | | |
| | 3 mm | | 760157.30 | | |
| | 4 mm | | | 760156.40 | |
| | 4.6 mm | | | 760156.46 | |
| EC guard columns* | | 4 x 2 mm: 761941.20 | | 4 x 3 mm: 761941.30 | |
| **NUCLEODUR® 100-5 CN-RP** particle size 5 µm; eluent in column acetonitrile – water | | | | | |
| Analytical EC columns | | | | | |
| | 4 mm | | 760153.40 | | 760152.40 |
| | 4.6 mm | | 760153.46 | 760154.46 | 760152.46 |
| EC guard columns* | | | | 4 x 3 mm: 761944.30 | |
| **NUCLEODUR® 100-5 CN** particle size 5 µm; eluent in column *n*-heptane | | | | | |
| Analytical EC columns | | | | | |
| | 4 mm | | 760151.40 | 760149.40 | 760150.40 |
| | 4.6 mm | | 760151.46 | 760149.46 | 760150.46 |
| EC guard columns* | | | | 4 x 3 mm: 761943.30 | |

EC columns in packs of 1, guard columns in packs of 3.

### Guard column system

| Guard columns for EC columns with ID | | 2 mm | 3 mm | 4 mm | 4.6 mm | Guard column holder |
|---|---|---|---|---|---|---|
| * Column Protection System (pack of) | EC | 4/2 (3) | 4/3 (3) | 4/3 (3) | 4/3 (3) | 718966 |

For details of our column systems see page 250.

## NUCLEODUR® $NH_2$ / $NH_2$-RP amino-modified high purity silica · USP L8

### Key feature

- Multi-mode columns (for RP, NP and IC)
- Stable against hydrolysis at low pH (working range pH 2–8), 100 % stable in water; suitable for LC/MS
- Widens scope of analytical HPLC into the polar range

### Technical data

- Aminopropyl modified high purity silica; pore size 110 Å; particle sizes 3, 5 and 7 µm; carbon content 2.5 %; not endcapped

### Recommended application

- Polar compounds under RP conditions (sugars, DNA bases), hydrocarbons under NP conditions

- Normal phase chromatography (NP) with hexane, dichloromethane or 2-propanol as mobile phase for polar compounds such as substituted anilines, esters, chlorinated pesticides
- Reversed phase chromatography (RP) of polar compounds in aqueous-organic eluent systems
- Ion exchange chromatography of anions and organic acids using conventional buffers and organic modifiers

Some compounds, especially polar substances, cannot be sufficiently resolved on $C_{18}$ phases. Polar-modified silica phases offer alternative selectivities thus expanding the spectrum of analytical HPLC into the polar range.

## Multi-mode columns

Besides cyano modifications, amino modifications belong to the most frequently used polar silica phases – both feature the important advantage, that they can be run in the RP mode using aqueous-organic eluent mixtures as well as in the NP mode, e.g., with hexane as mobile phase.

Reversed phase separation of sugars

MN Appl. No. 122160

Column: 250 x 4 mm NUCLEODUR® 100-5 $NH_2$-RP
Eluent: acetonitrile – water (79:21, v/v)
Flow rate: 2 mL/min
Detection: RI

Peaks:
1. Fructose
2. Glucose
3. Saccharose
4. Maltose
5. Lactose

NUCLEODUR® $NH_2$, too, belongs to the so-called multimode columns. It can be used for RP chromatography of polar compounds such as sugars in aqueous-organic eluent systems, for NP chromatography of substituted aromatics or chlorinated pesticides with organic mobile phases such as hexane, dichloromethane or 2-propanol, but also for ion exchange chromatography of anions and organic acids using conventional buffers and organic modifiers.

Main field of application of NUCLEODUR® $NH_2$ is the separation of simple and complex sugars, sugar alcohols and other hydroxy compounds under RP conditions as well as hydrocarbons under NP conditions.

Normal phase separation of middle distillates in accordance with DIN EN 12916

MN Appl. No. 122180

Columns: A) 250 x 4 mm NUCLEODUR® 100-5 $NH_2$
B) conventional aminopropyl phase
Eluent: heptane
Flow rate: 1 mL/min
Detection: RI

Peaks:
1. Cyclohexane
2. 1-Phenyldodecane
3. 1,2-Dimethylbenzene
4. Hexamethylbenzene
5. Naphthalene
6. Dibenzothiophene
7. 9-Methylanthracene

Due to the special method of surface modification NUCLEODUR® $NH_2$ features a pronounced stability at higher as well as at lower pH values. The following figure shows, that even after several days of exposure of the column material at pH 1.75 good separation efficiency and peak symmetry are maintained. The resulting high column life allows cost reduction due to lower column consumption.

This example shows the enhanced pH stability of NUCLEODUR® $NH_2$ and the outstanding suitability for the separation of total herbicides (AMPA, glyphosate, glufonisate, …) - see application 122190 in our online data base at *www.mn-net.com/apps*.

### Hydrolytical resistance of NUCLEODUR® $NH_2$-RP

Column: 250 x 4 mm NUCLEODUR® 100-5 $NH_2$-RP
Eluent: acetonitrile – 50 mmol/L $KH_2PO_4$, pH 1.75 (50:50, v/v)
Flow rate: 0.6 mL/min
Detection: UV, 254 nm

Peaks:
1. Aminomethylphosphonic acid (AMPA)

### Separation of DNA bases

MN Appl. No. 122170

Column: 250 x 4 mm NUCLEODUR® 100-5 $NH_2$-RP
Eluent: acetonitrile – water (80:20, v/v)
Flow rate: 0.6 mL/min
Temperature: 35 °C
Pressure: 30 bar
Detection: UV, 254 nm

Peaks:
1. Thymine
2. Uracil
3. Cytosine
4. Adenine

Based on superspherical NUCLEODUR® this phase features a high pressure stability, which makes it the perfect choice for preparative separations as well as for LC/MS. Additionally, the high batch-to-batch reproducibility of NUCLEODUR® $NH_2$ enables reliable analyses especially for routine work.

## Ordering information

| | ID | Length → 100 mm | 125 mm | 150 mm | 250 mm |
|---|---|---|---|---|---|
| **NUCLEODUR® 100-3 $NH_2$-RP** particle size 3 µm; eluent in column acetonitrile – water | | | | | |
| Analytical EC columns | | | | | |
| | 2 mm | 760740.20 | 760741.20 | | |
| | 4.6 mm | | | 760742.46 | 760739.46 |
| EC guard columns* | | 4 x 2 mm: 761951.20 | | 4 x 3 mm: 761951.30 | |
| **NUCLEODUR® 100-5 $NH_2$-RP** particle size 5 µm; eluent in column acetonitrile – water | | | | | |
| Analytical EC columns | | | | | |
| | 2 mm | | 760730.20 | | 760732.20 |
| | 3 mm | | 760730.30 | | 760732.30 |
| | 4 mm | | 760730.40 | | 760732.40 |
| | 4.6 mm | | 760730.46 | 760731.46 | 760732.46 |
| EC guard columns* | | 4 x 2 mm: 761953.20 | | 4 x 3 mm: 761953.30 | |
| **NUCLEODUR® 100-5 $NH_2$** particle size 5 µm; eluent in column *n*-heptane | | | | | |
| Analytical EC columns | | | | | |
| | 4 mm | | 760720.40 | | 760722.40 |
| | 4.6 mm | | 760720.46 | 760721.46 | 760722.46 |
| EC guard columns* | | | | 4 x 3 mm: 761952.30 | |

EC columns in packs of 1, guard columns in packs of 3.

## Guard column system

| Guard columns for EC columns with ID | | 2 mm | 3 mm | 4 mm | 4.6 mm | Guard column holder |
|---|---|---|---|---|---|---|
| * Column Protection System (pack of) | EC | 4/2 (3) | 4/3 (3) | 4/3 (3) | 4/3 (3) | 718966 |

For details of our column systems see page 250.

## NUCLEODUR® SiOH unmodified silica for normal phase · USP L3

### Key feature
- Totally spherical high purity silica
- Pressure stable up to 600 bar
- Suitable for analytical and preparative separation of polar and midpolar compounds

### Technical data
- Unmodified high purity silica; pore size 110 Å; particle sizes 3 to 50 µm; pore volume 0.9 mL/g; surface area (BET) 340 $m^2/g$; pH stability 2–8; metal content < 10 ppm (see page 150)

### Recommended application
- Polar and midpolar compounds under normal phase conditions

### Ordering information

Eluent in column *n*-heptane

| | ID | Length → 50 mm | 125 mm | 150 mm | 250 mm |
|---|---|---|---|---|---|
| **NUCLEODUR® 100-3** particle size 3 µm | | | | | |
| Analytical EC columns | | | | | |
| | 4.6 mm | 760170.46 | | 760172.46 | 760173.46 |
| EC guard columns* | | | | 4 x 3 mm: 761966.30 | |
| **NUCLEODUR® 100-5** particle size 5 µm | | | | | |
| Analytical EC columns | | | | | |
| | 4 mm | | | | 760007.40 |
| | 4.6 mm | 760023.46 | | 760012.46 | 760007.46 |
| EC guard columns* | | | | 4 x 3 mm: 761967.30 | |
| Preparative VarioPrep columns | | | | | |
| | 10 mm | 762077.100 | 762078.100 | | 762007.100 |
| | 21 mm | 762077.210 | 762078.210 | | 762007.210 |
| | 40 mm | | | 762075.400 | 762007.400 |
| VP guard columns * | | 10 x 8 mm: 762094.80 | | 10 x 16 mm: 762094.160 | |
| | | 15 x 32 mm: 762330.320 | | | |
| EC and VarioPrep columns in packs of 1, guard columns see below. | | | | | |

### Guard column systems

| Guard columns for EC columns with ID | | 2 mm | 3 mm | 4 mm | 4.6 mm | Guard column holder |
|---|---|---|---|---|---|---|
| * Column Protection System (pack of) | EC | 4/2 (3) | 4/3 (3) | 4/3 (3) | 4/3 (3) | 718966 |
| **Guard columns for VarioPrep columns with ID** | | **8, 10 mm** | **16, 21 mm** | **32, 40 mm** | **≥ 50 mm** | |
| ** VP guard columns (pack of) | VP | 10/8 (2) | 10/16 (2) | 15/32 (1) | 15/50 (1) | |
| VP guard column holder | | 718251 | 718256 | 718253 | 718255 | |

For details of our column systems see page 250.
Unmodified NUCLEODUR® bulk material in 10–50 µm for self-packing of preparative columns see page 256.

# MACHEREY-NAGEL
## your partner in HPLC · also online

### Besides to this catalog our website provides useful information

- Applications
  Database without registration, with more than 3000 free chromatography applications for your separation task.
- Instruction manuals
  General advises for column care and individual column cleaning are available in the attached instruction manual or online.
- HPLC troubleshooting
  Sometimes during chromatographic separation unexpected effects occur. We give advise of possible reasons and how to avoid or remedy these.
- Flyers, brochures, catalogs
  Our product information is available online as PDF file at any time.

# NUCLEOSHELL® core-shell silica for HPLC

## Core-shell technology

### Key feature

- Solid core of silicon dioxide, homogeneous shell of porous silica
- Highest efficiency compared to traditional totally porous materials
- Pore size 90 Å; particle size 2.7 µm (core 1.7 µm) and 5 µm (core 3.8 µm); specific surface 130 (2.7 µm) and 90 (5 µm) $m^2/g$ lower back pressure enables use on conventional LC systems
- Pressure stability 600 bar

Demands on HPLC separations are constantly increasing with respect to separation efficiency, detection limits, and the time requirements for each analysis.

Several approaches have been made to achieve fast separations without losing chromatographic performance. HPLC columns packed with particles < 2 µm show very high efficiencies (plates/meter) and allow the use of smaller column sizes with the positive side effect of significant solvent saving. However they generate a high back pressure of the mobile phase during column runs which requires specifically designed equipment.

Electron microscopic image of NUCLEOSHELL®

NUCLEOSHELL® silica particles consist of a non-porous solid core of 1.7 µm diameter and a porous outer shell of 0.5 µm thickness. Accordingly the total diameter of the particle is 2.7 µm.

Utilizing a proprietary process of synthesis, NUCLEOSHELL® particles exhibit a distinct narrow particle size distribution (d90/d10 ~ 1.1). Columns packed with NUCLEOSHELL core shell particles feature exceptional separation efficiencies with theoretical plate numbers easily comparable to totally porous sub 2 micron particles.

$$R_s = \frac{\sqrt{N}}{4}\left(\frac{\alpha - 1}{\alpha}\right)\left(\frac{k'_i}{k'_i + 1}\right)$$

$R_s$ = resolution, $\alpha$ = selectivity (separation factor), $k_i'$ = retention
N = plate number with $N \propto 1/d_P$, $d_P$ = particle diameter

**Resolution $R_S$ as function of particle size**

MN Appl. No. 125270

| | |
|---|---|
| Columns: | 50 x 4 mm |
| | NUCLEOSHELL® RP 18, 2.7 µm |
| | NUCLEODUR® $C_{18}$ Gravity, 3 µm |
| | NUCLEODUR® $C_{18}$ Gravity, 1.8 µm |
| Eluent: | acetonitrile – water (60:40, v/v) |
| Flow rate: | 1 mL/min |
| Temperature: | 25 °C |
| Detection: | UV, 254 nm |

Peaks:
1. Naphthalene
2. Ethylbenzene

# NUCLEOSHELL® core-shell silica for HPLC

## Theoretical column efficiency (optimal conditions)

| Silica | $d_p$ [µm] | L [m] | HETP [µm] | Efficiency [plates/m] | L [mm] | N | $R_s$ | Analysis time |
|---|---|---|---|---|---|---|---|---|
| NUCLEOSHELL® | 2.7 | 1 | 4 | 250 000 | 100 | 25 000 | 112 % | 40 % |
| | 5 | 1 | 6.5 | 154 000 | 150 | 23 000 | 115 % | 60 % |
| NUCLEODUR® | 1.8 | 1 | 4.5 | 222 222 | 100 | 22 000 | 105 % | 40 % |
| | 3 | 1 | 7.5 | 133 333 | 150 | 20 000 | 100 % | 60 % |
| | 5 | 1 | 12.5 | 80 000 | 250 | 20 000 | 100 % | 100 % |

## Benefits of core-shell technology

### Core-shell particles vs. totally porous silica

### Short diffusion paths

- Fast mass transfer (term C of Van Deemter equation)
- High flow velocity without peak broadening for fast LC

### Narrow particle size distribution ($d_{90}/d_{10}$ ~ 1.1)

- Stable packing

### High heat transfer

- Minimized influence of frictional heat
- Efficiency of NUCLEOSHELL® ~ 250 000 $m^{-1}$ (HETP ~ 4 µm)

With conventional fully porous particles the mass transfer between stationary and mobile phase usually results in peak broadening at higher flow rates (C-term in van Deemter equation). The short diffusion paths in the core-shell particles reduce the dwell time of the analyte molecules in the stationary phase, so that even at high flow velocities of the mobile phase, optimal separation results can be obtained.

The van Deemter plots demonstrate how efficiency is affected by flow rate.

In comparison with fully porous silicas, core-shell particles from various manufacturers maintain the efficiency optimum (max. plates/m) over a long range of increasing linear mobile phase velocity.

$$H = A + \frac{B}{u} + C \cdot u$$

A term = eddy-diffusion, B term = longitudinal diffusion coefficient, C term = mass transfer coefficient

Van Deemter curves

MN Appl. No. 125500

Column: 50 x 4.6 mm
Eluent: $CH_3CN - H_2O$ (70:30, v/v)
Temperature: 25 °C
Sample: Acenaphthene

# NUCLEOSHELL® core-shell silica for HPLC

In direct comparison with conventional sub 2 micron phases, NUCLEOSHELL® columns only generate about 60 % of the back pressure and can be operated with the majority of conventional HPLC systems. In order to develop the maximum performance of NUCLEOSHELL® columns, we recommend reducing extra column voids by using suitable capillaries (< 0.15 mm inner diameter) and specially adapted detector cells. Moreover detector settings should be optimized by increasing the measuring rate or by decrease of the time constant.

$$\Delta_P = \frac{\Phi \cdot L_C \cdot \eta \cdot u}{d_P^2}$$

$\Delta_P$ = pressure drop, $\Phi$ = flow resistance (nondimensional), LC = column length, $\eta$ = viscosity, u = linear velocity, $d_P$ = particle diameter

Pressure drop

MN Appl. No. 125510

Column: 50 x 4.6 mm
Eluent: $CH_3CN – H_2O$ (70:30, v/v)
Temperature: 25 °C

Core-shell particle technology from MACHEREY-NAGEL is an alternate route to gain highest column efficiency and resolution in HPLC at short run time, but with moderate back pressure.

## Features of NUCLEOSHELL® particles

A criterion for the long-term stability of the column at pH extremes is the percentage decrease of initial retention and initial plates, respectively.

The following figure shows a column stability test of NUCLEOSHELL® RP 18 at mobile phase levels pH 1 and pH 10 compared with three competing phases.

Stability under acidic and basic conditions

MN Appl. Nos. 125520 / 125530

Columns: 50 x 4.6 mm NUCLEOSHELL® RP 18, 2.7 µm
50 x 4.6 mm Kinetex® 2.6 µm C18
Eluent: acetonitrile – 1 % TFA in water, pH 1 (50:50, v/v)
Flow rate: 1.3 mL/min
Temperature: 80 °C
Detection: UV, 254 nm
Analyt: anthracene

Columns: 50 x 4.6 mm NUCLEOSHELL® RP 18, 2.7 µm
50 x 4.6 mm Ascentis® Express C18, 2.7 µm
50 x 4.6 mm Poroshell® 120 EC-C18
50 x 4.6 mm Kinetex® 2,6 µm C18
Eluent: 20 mmol/L Na borate – 10 mmol/L NaOH – methanol, pH 10 (21:49:30, v/v/v)
Flow rate: 1.5 mL/min
Temperature: 40 °C
Detection: UV, 220 nm
Analyt: toluidine

Columns can be operated at elevated temperatures without loss in retention, efficiency or peak symmetry.

### Temperature stability

MN Appl. No. 125400

Stability test:

| | |
|---|---|
| Column: | 50 x 2 mm NUCLEOSHELL® RP 18, 2.7 µm |
| Eluent: | A) 10 mmol/L ammonium formate – methanol (9:1, v/v) + 120 µL formic acid, ~ pH 4<br>B) 10 mmol/L ammonium formate – methanol (1:9, v/v) + 120 µL formic acid, ~ pH 4<br>0–100 % B in 7 min |
| Flow rate: | 0.5 mL/min, |
| Temperature: | 100 °C |
| Detection: | UV, 220 nm |

Peaks:
1. Phenol
2. Naphthalene

Efficiency test:

| | |
|---|---|
| Eluent: | Acetonitrile – water (60:40, v/v) |
| Flow rate: | 0.33 mL/min; |
| Temperature: | 25 °C |
| Detection: | UV, 254 nm |
| Analyte: | Anthracene |

| | HETP [µm] | Asymmetry |
|---|---|---|
| Start (t = 0) | 5.2 | 0.98 |
| End (t = 40 h) | 5.2 | 1.01 |

Uniformly shaped NUCLEOSHELL® particles combined with optimized bonding technology safeguard tightly packed columns for 100 % reproducible results.

### Batch-to-batch reproducibility

MN Appl. No. 125410

| | |
|---|---|
| Column: | 50 x 4 mm NUCLEOSHELL® RP 18, 2.7 µm |
| Eluent: | methanol – 25 mmol/L $KH_2PO_4$, pH 7 (70:30, v/v) |
| Flow rate: | 1 mL/min |
| Temperature: | 40 °C |
| Detection: | UV, 254 nm |

Peaks:
1. Uracil
2. Toluene
3. Ethylbenzene
4. Acenapthene
5. Amitriptyline
6. *o*-Terphenyl
7. Triphenylene

## Peak capacity

The peak capacity is a measure for the number of sample analytes that can be separated on HPLC columns per time unit. Narrow peaks increase the peak capacity and thus the efficiency of the analytical column.

Comparison of peak capacities

$$n_c = 1 + \left(\frac{t_g}{W}\right)$$

$n_c$: peak capacity
$t_g$: gradient time
W: peak width (at baseline)

The example shows, that in comparison with totally porous NUCLEODUR® silica (1.8 µm) NUCLEOSHELL® provides 33 % higher peak capacity.

Peak capacity

MN Appl. No. 125540

| | |
|---|---|
| Columns: | 100 x 4.6 mm each |
| | NUCLEOSHELL® RP 18, 2.7 µm |
| | NUCLEODUR® $C_{18}$ Gravity, 1.8 µm |
| | NUCLEODUR® $C_{18}$ Gravity, 3 µm |
| | NUCLEODUR® $C_{18}$ Gravity, 5 µm |
| Eluent: | A) acetonitrile, B) water, 40–100 % A in 4 min |
| Flow rate: | 1.5 mL/min |
| Temperature: | 25 °C |
| Detection: | UV, 230 nm |

Peaks:
1. Acetophenone
2. Benzoin
3. Propiophenone
4. Butyrophenone
5. Benzophenone
6. Valerophenone

| | Max. pressure [bar] | Resolution (4.5) |
|---|---|---|
| NUCLEOSHELL®, 2.7 µm | 255 | 5.45 |
| NUCLEODUR®, 1.8 µm | 450 | 4.14 |
| NUCLEODUR®, 3 µm | 214 | 2.97 |
| NUCLEODUR®, 5 µm | 142 | 2.30 |

## Loading capacity

NUCLEOSHELL® columns allow reliable quantification in a wide analytical detection range. Retention time and peak width at 50 % height remain constant with increasing columns load although core-shell particles are suspected of showing a slightly lower loading capacity compared to fully porous silica materials.

Normalized column parameters

Loading capacity

| | |
|---|---|
| Column: | 50 x 3 mm NUCLEOSHELL® RP 18, 2.7 µm |
| Eluent: | acetonitrile – 25 mmol/L $KH_2PO_4$, pH 3 (70:30, v/v) |
| Flow rate: | 0.66 mL/min |
| Temperature: | 30 °C |
| Detection: | UV, 285 nm |

Peaks:
1. Valerophenone

## Method transfer of 5 µm particle columns

NUCLEOSHELL® is also available in 5 µm particle size to offer all benefits of core-shell technology to all applications which are bound to particle size.

Separation of cephalosporin antibiotics

MN Appl. No. 126630

Comparison of 5 µm core-shell and totally porous phase

| | |
|---|---|
| Columns: | each 100 x 4.6 mm |
| | A) NUCLEOSHELL® RP 18plus, 5 µm |
| | B) NUCLEODUR® Gravity $C_{18}$, 5 µm |
| Eluent: | methanol – water + 0.1 % formic acid (35:65, v/v) |
| Flow rate: | 1.3 mL/min |
| Pressure: | 182 bar, 219 bar |
| Temperature: | 25 °C |
| Detection: | UV, 254 nm |
| Injection: | 4.0 µL |

| Peaks: | Ret. time [min] | | Asymmetry (EP) | | Plates (EP) | |
|---|---|---|---|---|---|---|
| | A | B | A | B | A | B |
| 1 Cefotaxime | 1.30 | 1.96 | 1.19 | 1.12 | 6800 | 2218 |
| 2 Cefoxitin | 2.14 | 4.72 | 1.22 | 1.20 | 6599 | 3471 |
| 3 Cefamandole | 2.97 | 6.57 | 1.24 | 1.25 | 6259 | 3367 |
| 4 Cefalotine | 5.33 | 13.73 | 1.32 | 1.61 | 6948 | 3672 |

# NUCLEOSHELL® phase overview

## Overview of NUCLEOSHELL® HPLC phases

| Phase | Specification | Page | Characteristic* | Stability | Structure |
|---|---|---|---|---|---|
| RP 18 | octadecyl, multi-endcapping<br>7.8 % C (2.7 µm particles)<br>6.1 % C (5 µm particles)<br>USP L1 | 200 | A ●●●●●<br>B ◖<br>C ●●◖ | pH 1–11,<br>suitable for LC/MS | NUCLEOSHELL® $(Si\text{-}O_2)_n$ |
| RP 18plus | octadecyl (monomeric),<br>multi-endcapping<br>5.7 % C (2.7 µm particles)<br>4.4 % C (5 µm particles)<br>USP L1 | 202 | A ●●●●<br>B ●●◖<br>C - | pH 2–9,<br>suitable for LC/MS | NUCLEOSHELL® $(Si\text{-}O_2)_n$ |
| Phenyl-Hexyl | phenylhexyl,<br>multi-endcapping<br>4.5 % C (2.7 µm particles)<br>USP L11 | 204 | A ●●<br>B ●●●<br>C ● | pH 1–10,<br>suitable for LC/MS | NUCLEOSHELL® $(Si\text{-}O_2)_n$ |
| PFP | pentafluorophenyl,<br>multi-endcapping<br>~ 3 % C (2.7 µm particles)<br>USP L43 | 206 | A ●●<br>B ●●●●<br>C ●●●● | pH 1–9,<br>suitable for LC/MS | NUCLEOSHELL® $(Si\text{-}O_2)_n$ |
| HILIC | zwitterionic ammonium – sulfonic acid<br>1.3 % C (2.7 µm particles) | 208 | A ●<br>B ●●●●●<br>C - | pH 2–8.5,<br>suitable for LC/MS | NUCLEOSHELL® $(Si\text{-}O_2)_n$ |

* A = ● hydrophobic selectivity, B = ● polar / ionic selectivity, C = ● steric selectivity

# NUCLEOSHELL® phase overview

| Application | Similar phases** | Interactions · retention mechanism | |
|---|---|---|---|
| overall sophisticated analytical separations, e.g., analgesics, anti-inflammatory drugs, antidepressants; herbicides; phytopharmaceuticals; immunosuppressants | Kinetex® C18; Cortecs® C18; Raptor® C18; Accucore® C18; Ascentis® Express C18 | hydrophobic (van der Waals interactions) | |
| overall sophisticated analytical separations, especially for polar compounds, e.g., pharmaceuticals like antibiotics, water-soluble vitamins, organic acids | Kinetex® XB-C18; Bonshell® ASB-C18; Raptor® ARC-C18; | hydrophobic (van der Waals interactions) | |
| aromatic and unsaturated compounds, polar compounds like pharmaceuticals, antibiotics | Ascentis® Express Phenyl-Hexyl; Kinetex® Phenyl-Hexyl; Accucore® Phenyl-Hexyl; Ultracore® Phenyl-Hexyl; Poroshell® Phenyl-Hexyl | π-π and hydrophobic | |
| aromatic and unsaturated compounds, phenols, halogenated hydrocarbons, isomers, polar compounds like pharmaceuticals, antibiotics | Kinetex® PFP; Ascentis® Express F5; Accucore® PFP | polar (H bond), dipole-dipole, π-π and hydrophobic | |
| hydrophilic compounds such as organic polar acids and bases, polar natural compounds | – | ionic / hydrophilic and electrostatic | |

** phases which provide a similar selectivity based on chemical and physical properties

## NUCLEOSHELL® RP 18 nonpolar high density phase · USP L1

### Key feature

- Core-shell technology for fast and efficient HPLC
- Suitable for LC/MS and HPLC at pH extremes (pH 1–11)
- Superior base deactivation, ideal for method development

### Technical data

- Octadecyl modification, multi-end-capped; pore size 90 Å, particle size 2.7 and 5 µm, carbon content 7.8 % for 2.7 µm, 6.1 % for 5 µm; pH stability 1–11; suitable for LC/MS

### Recommended application

- Overall sophisticated analytical separations, e.g., analgesics, anti-inflammatory drugs, antidepressants; herbicides; phytopharmaceuticals; immunosuppressants

NUCLEOSHELL® RP 18 is based on core-shell silica. A unique derivatization process generates a homogeneous surface with a high density of bonded silanes. The following thorough endcapping suppresses any unwanted polar interactions between the silica surface and the sample, which makes NUCLEOSHELL® RP 18 particularly suitable for the separation of basic and other ionizable analytes. The extremely reduced silanol activity of the phase can be demonstrated by applying basic analytes, such as tricyclic antidepressants. The chromatogram below shows a sharp elution profile (superior resolution!) of these highly polar compounds with an excellent asymmetry value for amitriptyline of 1.12.

**Tricyclic antidepressants · comparison of selectivity and resolution**

MN Appl. No. 124960

| | |
|---|---|
| Columns: | 50 x 4.6 mm each<br>NUCLEOSHELL® RP 18, 2.7 µm<br>Ascentis® Express C18<br>Kinetex® 2.6 µm C18<br>Poroshell® 120 EC-C18 |
| Eluent: | methanol – acetonitrile – 25 mmol/L $KH_2PO_4$, pH 7 (22.5:22.5:55, v/v/v) |
| Flow rate: | 2 mL/min |
| Pressure: | 224 bar, 239 bar, 248 bar, 212 bar |
| Temperature: | 40 °C |
| Detection: | UV, 220 nm |

Peaks:
1. Protriptyline
2. Desipramine
3. Maprotiline
4. Nortriptyline
5. Doxepin
6. Imipramine
7. Amitriptyline
8. Clomipramine
9. Trimipramine

| | Asymmetry (amitriptyline) | Resolution (8, 9) |
|---|---|---|
| NUCLEOSHELL® | 1.12 | 3.35 |
| Ascentis® Express | 2.07 | 1.91 |
| Kinetex® | 1.33 | n.a. |
| Poroshell® | 1.05 | 1.95 |

NUCLEOSHELL® RP 18 combines innovative silica technology and excellent surface deactivation, that outperforms conventional $C_{18}$ silicas in terms of efficiency, resolution and speed.

Due to the applied core-shell particle design the back pressure at elevated flow rates remains at a moderate level and in many cases permits the use of existing HPLC equipment. NUCLEOSHELL® RP 18 with extended pH stability, low bleed characteristics in LC/MS applications, and overall robustness is an ideal tool for method development and routine analyses in modern HPLC.

The separation of 13 β-lactam antibiotics illustrates how time of analysis can be shortened to a fractional part by using core-shell particles without loss of resolution at moderate back pressure.

13 β-lactam antibiotics in less than 3 min

MN Appl. No. 124940

| | |
|---|---|
| Columns: | 50 x 4 mm NUCLEOSHELL® RP 18, 2.7 µm<br>150 x 4 mm NUCLEODUR® $C_{18}$ Gravity, 5 µm |
| Eluent: | A) acetonitrile B) 20 mmol/L $KH_2PO_4$, pH 3.5<br>10 % A (0,5 min) → 50 % A in 1.5 min (0.5 min 50 % A)<br>10 % A (3 min) → 50 % A in 9 min (3 min 50 % A) |
| Flow rate: | 2 mL/min, 1 mL/min |
| Pressure: | 270 bar, 110 bar |
| Temperature: | 25 °C |
| Detection: | UV, 220 nm |

Peaks:

1. Amoxicillin
2. Ampicillin
3. Cephalexin
4. Cefotaxime
5. Cefoxitin
6. Cefamandole
7. Cephalothin
8. Piperacillin
9. Penicillin V
10. Oxacillin
11. Cloxacillin
12. Nafcillin
13. Dicloxacillin

## Ordering information

Eluent in column acetonitrile – water

| ID | Length → 50 mm | 100 mm | 150 mm | 250 mm | EC guard columns* |
|---|---|---|---|---|---|
| **NUCLEOSHELL® RP 18, 2.7 µm** particle size 2.7 µm | | | | | |
| Analytical EC columns | | | | | |
| 2 mm | 763132.20 | 763134.20 | 763136.20 | | 763138.20 |
| 3 mm | 763132.30 | 763134.30 | 763136.30 | | 763138.30 |
| 4 mm | 763132.40 | 763134.40 | 763136.40 | | 763138.30 |
| 4.6 mm | 763132.46 | 763134.46 | 763136.46 | | 763138.30 |
| **NUCLEOSHELL® RP 18, 5 µm** particle size 5 µm | | | | | |
| Analytical EC columns | | | | | |
| 2 mm | 763152.20 | 763154.20 | 763156.20 | 763157.20 | 763158.20 |
| 3 mm | 763152.30 | 763154.30 | 763156.30 | 763157.30 | 763158.30 |
| 4 mm | 763152.40 | 763154.40 | 763156.40 | 763157.40 | 763158.30 |
| 4.6 mm | 763152.46 | 763154.46 | 763156.46 | 763157.46 | 763158.30 |

EC columns in packs of 1, guard columns in packs of 3.

## Guard column system

| Guard columns for EC columns with ID | | 2 mm | 3 mm | 4 mm | 4.6 mm | Guard column holder |
|---|---|---|---|---|---|---|
| * Column Protection System (pack of) | EC | 4/2 (3) | 4/3 (3) | 4/3 (3) | 4/3 (3) | 718966 |

For details of the EC column system please see page 250.

## NUCLEOSHELL® RP 18plus $C_{18}$ phase with polar selectivity · USP L1

### Key feature

- Based on core-shell particle technology for fast and efficient HPLC
- Hydrophobic $C_{18}$ phase with distinct polar selectivity, ideal for method development
- Excellent performance under highly aqueous conditions

### Technical data

- Monomeric octadecyl modification, multi-endcapped; pore size 90 Å, available particle sizes 2.7 µm and 5 µm, carbon content 5.7 % for 2.7 µm, 4.4 % for 5 µm; pH stability 2–9; suitable for LC/MS

### Recommended application

- Overall sophisticated analytical separations, especially for polar compounds, e.g., pharmaceuticals like antibiotics, water-soluble vitamins, organic acids

NUCLEOSHELL® RP 18plus is a $C_{18}$ modified core-shell silica. Due to a monomeric bonding chemistry this HPLC phase offers hydrophobic characteristics with distinct polar selectivity. A special derivatization process generates a medium density of bonded silanes with reduced steric selectivity compared to NUCLEOSHELL® RP 18.

**Bleeding characterisitics**

MN Appl. No. 126640

| | |
|---|---|
| Column: | 50 x 2 mm NUCLEOSHELL® RP 18plus, 2.7 µm |
| Eluent: | A) 0.1 % formic acid in water<br>B) 0.1 % formic acid in acetonitrile<br>95 % A → 5 % A in 4.5 min (0.5 min) → 95 % A in 0.5 min (4.5 min) |
| Flow rate: | 0.5 mL/min |
| Temperature: | 25 °C |
| Detection: | MS |

NUCLEOSHELL® RP 18plus combines superbly hydrophobic and polar selectivity – so it is a useful tool for method development in RP chromatography. Good pH stability and low bleeding characteristics make it ideal especially for LC/MS applications.

**pH stability of NUCLEOSHELL® RP 18plus**

MN Appl. No. 126650

| | |
|---|---|
| Column: | 100 x 4 mm NUCLEOSHELL® RP 18plus, 2.7 µm |
| Eluent pH 1: | 1 % TFA in water - acetonitrile (50:50, v/v) |
| Eluent pH 9: | 50 mmol/L triethylammonium acetate adjusted to pH 9 |
| Flow rate: | for pH 1: 0.8 mL/min, for pH 9: 0.56 mL/min |
| Temperature: | for pH 1: 60 °C, for pH 9: 50 °C |
| Detection: | UV, 254 nm |
| Injection: | 1 µL |

Also a comparison of retention of the glycopeptide antibiotic vancomycin on several octadecyl modified core-shell phases underlines the polar selectivity of NUCLEOSHELL® RP 18plus.

Polar selectivity shown for vancomycin

MN Appl. No. 126660

| | |
|---|---|
| Columns: | 50 x 3 mm each<br>NUCLEOSHELL® RP 18plus, 2.7 µm<br>NUCLEOSHELL® RP 18, 2.7 µm<br>Kinetex® 2.6 µm C18 |
| Eluent: | water – methanol – acetonitrile – glacial acetic acid (100:8:2:0.3, v/v/v/v) adjusted to pH 3.2 with sodium hydroxide solution |
| Flow rate: | 0.9 mL/min |
| Temperature: | 35 °C |
| Detection: | UV, 240 nm |
| Injection: | 10 µL |

In addition NUCEOSHELL® RP 18plus provides a good stability under highly aqueous conditions. Even by long term usage or storage of the phase phase collapse and loss of retention are hardly observed. The original performance can be regained after a short regeneration procedure.

Phase collapse and regeneration

MN Appl. No. 126670

| | |
|---|---|
| Column: | 100 x 4 mm NUCLEOSHELL® RP 18plus, 2.7 µm |
| Eluent: | 20 mmol/L $KH_2PO_4$, pH 2.6 |
| Flow rate: | 0.5 mL/min |
| Temperature: | 20 °C |
| Detection: | UV, 215 nm |
| Injection: | 0.5 µL |

## Ordering information

Eluent in column acetonitrile – water

| | ID | Length → 50 mm | 100 mm | 150 mm | 250 mm | EC guard columns* |
|---|---|---|---|---|---|---|
| **NUCLEOSHELL® RP 18plus, 2.7 µm** particle size 2.7 µm | | | | | | |
| Analytical EC columns | | | | | | |
| | 2 mm | 763232.20 | 763234.20 | 763236.20 | | 763238.20 |
| | 3 mm | 763232.30 | 763234.30 | 763236.30 | | 763238.30 |
| | 4 mm | 763232.40 | 763234.40 | 763236.40 | | 763238.30 |
| | 4.6 mm | 763232.46 | 763234.46 | 763236.46 | | 763238.30 |
| **NUCLEOSHELL® RP 18plus, 5 µm** particle size 5 µm | | | | | | |
| Analytical EC columns | | | | | | |
| | 2 mm | 763252.20 | 763254.20 | 763256.20 | 763257.20 | 763258.20 |
| | 3 mm | 763252.30 | 763254.30 | 763256.30 | 763257.30 | 763258.30 |
| | 4 mm | 763252.40 | 763254.40 | 763256.40 | 763257.40 | 763258.30 |
| | 4.6 mm | 763252.46 | 763254.46 | 763256.46 | 763257.46 | 763258.30 |

EC columns in packs of 1, guard columns in packs of 3.

## Guard column system

| Guard columns for EC columns with ID | | 2 mm | 3 mm | 4 mm | 4.6 mm | Guard column holder |
|---|---|---|---|---|---|---|
| * Column Protection System (pack of) | EC | 4/2 (3) | 4/3 (3) | 4/3 (3) | 4/3 (3) | 718966 |

For details of the EC column system please see page 250.

## NUCLEOSHELL® Phenyl-Hexyl nonpolar high density phase · USP L11

### Key feature

- Based on core-shell particle technology for fast and efficient HPLC
- Hydrophobic phase with alternative selectivity compared to classical $C_{18}$ modifications
- Separation principle based on 2 retention mechanisms: π-π interactions and hydrophobic interactions

### Technical data

- Phenyl-Hexyl modification, multi-end-capped; pore size 90 Å, particle size 2.7 µm; carbon content 4.5 %; pH stability 1–10; suitable for LC/MS

### Recommended application

- Aromatic and unsaturated compounds, polar compounds like pharmaceuticals, antibiotics

Phenyl-Hexyl modified phases offer an excellent separation efficiency especially for aromatic and unsaturated compounds with electron-withdrawing groups. The combination of hydrophobic and π-π interactions results in an alternative and interesting selectivity profile compared to $C_{18}$ or $C_8$ modifications. NUCLEOSHELL® Phenyl-Hexyl is based on a unique surface bonding chemistry - therefore it is suitable for LC/MS due to low bleeding characteristics and offers high temperature stability and pH stability from 1 to 10.

**Stability of NUCLEOSHELL® Phenyl-Hexyl at pH 10**

MN Appl. No. 126420

Column: 50 x 4 mm NUCLEOSHELL® Phenyl-Hexyl, 2.7 µm
Eluent: acetonitrile – 50 mmol/L TEA pH 10 (60:40, v/v); pH of the mixture 10.4
Flow rate: 1 mL/min
Temperature: 40 °C
Detection: UV, 254 nm
Injection: 1 µL

Peaks:
1. Phenol
2. Naphthalene
3. Anthracene

Relative plate numbers

NUCLEOSHELL® Phenyl-Hexyl is a robust phase with an alternative RP selectivity for aromatic and unsaturated analytes compared to classical $C_{18}$ / $C_8$ phases – it is an additional and useful tool for all chromatography users.

**Bleeding characteristics of NUCLEOSHELL® Phenyl-Hexyl**

MN Appl. No. 126400

Columns: 50 x 2 mm each
NUCLEOSHELL® Phenyl-Hexyl, 2.7 µm
Kinetex® Phenyl-Hexyl
Eluent: A) acetonitrile, B) water
5–95 % A in 25 min
Flow rate: 0.2 mL/min
Temperature: 25 °C
Detection: MS

The pyridine-phenol test shows that NUCLEOSHELL® Phenyl-Hexyl provides a symmetrical peak for pyridine and higher resolution in comparison to other core-shell based Phenyl-Hexyl phases, which underlines the excellent base deactivation.

**Pyridine-phenol test of NUCLEOSHELL® Phenyl-Hexyl**

MN Appl. No. 126410

Columns: 50 x 2 mm each
NUCLEOSHELL® Phenyl-Hexyl, 2.7 µm
Kinetex® Phenyl-Hexyl
Ascentis® Express Phenyl-Hexyl
Eluent: acetonitrile – water (70:30, v/v)
Flow rate: 0.3 mL/min
Temperature: 40 °C
Detection: UV, 254 nm
Injection: 0.2 µL

Peaks:
1. Pyridine
2. Phenol

Comparing the separation of sulfonamides on NUCLEODUR® Phenyl-Hexyl with different particle sizes

MN Appl. No. 125860

Columns: 150 x 3 mm each
NUCLEOSHELL® Phenyl-Hexyl, 2.7 µm
NUCLEODUR® Phenyl-Hexyl, 1.8 µm
NUCLEODUR® Phenyl-Hexyl, 3 µm
NUCLEODUR® Phenyl-Hexyl, 5 µm

Eluent: A) methanol
B) 0.1 % formic acid in water
20–80 % A in 10 min

Flow rate: 0.56 mL/min
Temperature: 40 °C
Detection: UV, 254 nm
Injection: 0.5 µL

Peaks:
1. Sulfadiazine
2. Sulfachlorpyridazine
3. Sulfapyridine
4. Sulfamerazine
5. Sulfadimidine
6. Sulfathiazole
7. Sulfadimethoxine

On NUCLEOSHELL® Phenyl-Hexyl the resolution of the last two peaks is higher than on the fully porous 1.8 µm NUCLEODUR® Phenyl-Hexyl.

The separation of sulfonamides proves the scalability from fully porous NUCLEODUR® to NUCLEOSHELL® Phenyl-Hexyl. Hereby the core-shell silica exhibits identical selectivity, narrower peaks and slightly shorter retention under the same conditions.

Thus, method transferability between NUCLEODUR® and NUCLEOSHELL® is guaranteed, either for speeding up your methods or scaling up for preparative requirements.

## Ordering information

Eluent in column acetonitrile – water

| | ID | Length → 50 mm | 100 mm | 150 mm | EC guard columns* |
|---|---|---|---|---|---|
| **NUCLEOSHELL® Phenyl-Hexyl, 2.7 µm** particle size 2.7 µm | | | | | |
| Analytical EC columns | | | | | |
| | 2 mm | 763732.20 | 763734.20 | 763736.20 | 763738.20 |
| | 3 mm | 763732.30 | 763734.30 | 763736.30 | 763738.30 |
| | 4 mm | 763732.40 | 763734.40 | 763736.40 | 763738.30 |
| | 4.6 mm | 763732.46 | 763734.46 | 763736.46 | 763738.30 |

EC columns in packs of 1, guard columns in packs of 3.

## Guard column system

| Guard columns for EC columns with ID | | 2 mm | 3 mm | 4 mm | 4.6 mm | Guard column holder |
|---|---|---|---|---|---|---|
| * Column Protection System (pack of) | EC | 4/2 (3) | 4/3 (3) | 4/3 (3) | 4/3 (3) | 718966 |

For details of the EC column system please see page 250.

## NUCLEOSHELL® PFP hydrophobic pentafluorophenyl phase · USP L43

### Key feature

- Core-shell technology for fast and efficient HPLC
- Hydrophobic phase with alternative selectivity in comparison to classical $C_{18}$ modifications
- Separation principle based on 4 retention mechanisms (polar interactions (H bonds), dipole-dipole, π-π, hydrophobic interactions)

### Technical data

- Phase with pentafluorophenylpropyl modification, multi-endcapping; pore size 90 Å, particle size 2.7 µm; carbon content ~ 3 %; pH stability 1–9; suitable for LC/MS

### Recommended application

- Aromatic and unsaturated compounds, phenols, halogen compounds, isomers, polar compounds like pharmaceuticals, antibiotics; strong retention of basic compounds

## Orthogonality in selectivity

Fluorinated stationary phases in HPLC have gained increasing interest over the last years. Most common representative of fluorinated silica phases is the pentafluorophenyl modification (PFP or $F_5$). Especially the orthogonal selectivity compared to traditional alkyl phases widens the scope in analytical HPLC. Thus NUCLEOSHELL® PFP offers an excellent selectivity especially for highly polar analytes, aromatic and unsaturated compounds, phenols or halogenated hydrocarbons.

While a typical $C_{18}$ phase just provides hydrophobic interactions between stationary phase and analyte NUCLEOSHELL® PFP offers four different retention mechanisms: polar interactions (H bonds), dipole-dipole interactions, π-π interactions and hydrophobic interactions. Especially the pronounced ion exchange capacity and distinct steric selectivity are typical for the character of fluorinated phases.

**Stability of NUCLEOSHELL® PFP at pH 1**

MN Appl. No. 125560

| | |
|---|---|
| Columns: | 100 x 4.6 mm NUCLEOSHELL® PFP, 2.7 µm<br>100 x 4.6 mm Kinetex® PFP, 2.6 µm F5 |
| Eluent: | acetonitrile – 0.5 % TFA, pH 1 (50:50, v/v) |
| Flow rate: | 1.3 mL/min |
| Temperature: | 60 °C |
| Detection: | UV, 254 nm |
| Sample: | ethylbenzene |

**β-Blockers · orthogonal selectivity of NUCLEOSHELL® PFP**

MN Appl. No. 125610

| | |
|---|---|
| Columns: | 100 x 4.6 mm<br>NUCLEOSHELL® RP 18, 2.7 µm<br>NUCLEOSHELL® PFP, 2.7 µm |
| Eluent: | A) acetonitrile + 0.1 % formic acid<br>B) 0.1 % formic acid<br>10–35 % A in 2.5 min, 35-50 % A in 2 min |
| Flow rate: | 1.7 mL/min |
| Temperature: | 25 °C |
| Detection: | UV, 280 nm |

Peaks:

1. Atenolol
2. Pindolol
3. Metroprolol
4. Labetalol
5. Alprenolol
6. Propranolol

Methylacetophenones

MN Appl. No. 125590

Columns: 100 x 4.6 mm NUCLEOSHELL® PFP, 2.7 µm
250 x 4 mm NUCLEODUR® PFP, 5 µm
100 x 4.6 mm Kinetex® 2.6 µm F5

Eluent: Methanol – water (35:65, v/v)

Flow rate: 1.5 mL/min, 3 mL/min, 1 mL/min, 1.5 mL/min

Temperature: 35 °C

Detection: UV, 254 nm

Peaks:
1. *o*-Methylacetophenone
2. *p*-Methylacetophenone
3. *m*-Methylacetophenone

NUCLEOSHELL® PFP combines the benefits of core-shell technology, high stability, and orthogonal selectivity. Thus it is a useful complementary tool for highly efficient separations especially of isomers, halogenated, aromatic and / or polar compounds.

## Ordering information

Eluent in column acetonitrile – water

| ID | Length → 50 mm | 100 mm | 150 mm | EC guard columns* |
|---|---|---|---|---|
| **NUCLEOSHELL® PFP, 2.7 µm** particle size 2.7 µm | | | | |
| Analytical EC columns | | | | |
| 2 mm | 763532.20 | 763534.20 | 763536.20 | 763538.20 |
| 3 mm | 763532.30 | 763534.30 | 763536.30 | 763538.30 |
| 4 mm | 763532.40 | 763534.40 | 763536.40 | 763538.30 |
| 4.6 mm | 763532.46 | 763534.46 | 763536.46 | 763538.30 |

EC columns in packs of 1, guard columns in packs of 3.

## Guard column system

| Guard columns for EC columns with ID | | 2 mm | 3 mm | 4 mm | 4.6 mm | Guard column holder |
|---|---|---|---|---|---|---|
| * Column Protection System (pack of) | EC | 4/2 (3) | 4/3 (3) | 4/3 (3) | 4/3 (3) | 718966 |

For details of the EC column system please see page 250.

## NUCLEOSHELL® HILIC zwitterionic phase

### Key feature

- Core-shell technology for fast and efficient HPLC
- Ideal for reproducible and stable chromatography of highly polar analytes
- Very short column equilibration times

### Technical data

- Ammonium - sulfonic acid modified silica; pore size 90 Å, particle size 2.7 µm; carbon content 1.3 %; pH stability 2–8.5; suitable for LC/MS

### Recommended application

- Hydrophilic compounds such as polar organic acids and bases, polar natural compounds, nucleosides, oligonucleotides, amino acids, peptides, water-soluble vitamins

## Hydrophilic interaction chromatography

Hydrophilic interaction chromatography (HILIC) is a separation technique using polar stationary phases and organic-aqueous mobile phases. A minimum water content of at least 2 % is indispensable to provide a permanent water layer between the adsorbent surface and the organic fraction of the mobile phase. The sample molecules become separated in a partition chromatography, in which polar analytes are more strongly retained than neutral, less hydrophilic compounds. Consequently, increasing the aqueous part in the mobile phase will diminish retention of the polar sample constituents. In this way HILIC behaves inverse to classical RP chromatography. The particular retention profile of HILIC enables the chromatography of very polar and often small molecules, which won't show any retention on $C_8$ or $C_{18}$ reversed phases.

### Ultra-fast separations at moderate back pressure

NUCLEOSHELL® HILIC is a core-shell technology based stationary phase with a covalently bonded 3-*N,N*-dimethylaminopropane sulfonic acid ligand (pat. p nd.). The betaine character of the strong ion-exchanger results in full charge balancing and facilitates fast equilibration times.

Good separation of polar compounds like the physiologically important substances creatine and creatinine can be achieved on NUCLEOSHELL® HILIC as well as on NUCLEODUR® HILIC, 1.8 µm at similar retention, but much lower back pressure.

**Separation of creatine and creatinine**

MN Appl. No. 124990

| | |
|---|---|
| Columns: | 50 x 4 mm NUCLEOSHELL® HILIC, 2.7 µm |
| | 50 x 4 mm NUCLEODUR® HILIC, 1.8 µm |
| Eluent: | acetonitrile – 10 mmol/L ammonium acetate, pH 4.0 (90:10, v/v) |
| Flow rate: | 1.7 mL/min |
| Pressure: | 129 bar |
| | 180 bar |
| Temperature: | 25 °C |
| Detection: | UV, 210 nm |

Peaks:
1. Creatinine
2. Creatine

The following chromatograms show the method transfer from a fully porous 3 µm HILIC phase to 2.7 µm core-shell silica with equal selectivity features.

Run time has been cut down to 1 min. Column back pressure remains modest < 400 bar, while solvent demand is reduced to less than 35 %.

Separation of catecholamines

MN Appl. No. 125440

| | |
|---|---|
| Columns: | 100 x 4 mm NUCLEOSHELL® HILIC, 2.7 µm |
| | 100 x 4 mm NUCLEOSHELL® HILIC, 2.7 µm |
| | 250 x 4 mm NUCLEODUR® HILIC, 3 µm |
| Eluent: | acetonitrile – 100 mmol/L ammonium formate, pH 3.2 (80:20, v/v) |
| Flow rate: | 4 mL/min, 1 mL/min, 1 mL/min |
| Pressure: | 395 bar, 95 bar, 116 bar |
| Temperature: | 25 °C |
| Detection: | UV, 280 nm |

Peaks:

1. DOPAC
2. Serotonin
3. Dopamine
4. Epinephrine
5. Norepinephrine
6. DOPA
7. DOPS

Core-shell silica: separation in 1 min pressure < 400 bar

NUCLEOSHELL® HILIC provides stable and reproducible chromatography, comprising all the benefits of a state-of-the-art core-shell silica.

## Ordering information

Eluent in column acetonitrile – water

| ID | Length → 50 mm | 100 mm | 150 mm | EC guard columns* |
|---|---|---|---|---|
| **NUCLEOSHELL® HILIC, 2.7 µm** particle size 2.7 µm | | | | |
| Analytical EC columns | | | | |
| 2 mm | 763332.20 | 763334.20 | 763336.20 | 763338.20 |
| 3 mm | 763332.30 | 763334.30 | 763336.30 | 763338.30 |
| 4 mm | 763332.40 | 763334.40 | 763336.40 | 763338.30 |
| 4.6 mm | 763332.46 | 763334.46 | 763336.46 | 763338.30 |

EC columns in packs of 1, guard columns in packs of 3.

## Guard column system

| Guard columns for EC columns with ID | | 2 mm | 3 mm | 4 mm | 4.6 mm | Guard column holder |
|---|---|---|---|---|---|---|
| * Column Protection System (pack of) | EC | 4/2 (3) | 4/3 (3) | 4/3 (3) | 4/3 (3) | 718966 |

For details of the EC column system please see page 250.

## MACHEREY-NAGEL
## Column Protection System

### The guard column system for HPLC / UHPLC from MN

- Ideal protection for your analytical main column:
  significant increase in column lifetime
- Minimized void volume:
  suitable also for ultra fast HPLC (UHPLC)
- Special ferrules:
  pressure stability up to 1300 bar (18850 psi)
- Cartridges filled with NUCLEODUR®, NUCLEOSIL® and NUCLEOSHELL® HPLC adsorbents.
- Universal screw-on guard column holder system
- Suitable for all analytical HPLC columns with 1/16“ fittings

Further information on page 251.

## NUCLEOSIL®

Key feature

- NUCLEOSIL® is a family of totally porous spherical silicas. They feature a very pure and uniform $SiO_2$ structure and have gained wide acceptance as routine chromatographic packings for very different fields of modern chromatography.
- One of the first spherical silicas used in HPLC
- Developed in the early seventies, it became a world-renowned HPLC packing
- Absolutely reliable choice for routine analyses
- Largest variety of modified HPLC silicas available
- pH stability 2–8 (for NUCLEOSIL® 100-5 $C_{18}$ AB 1–9)
- Due to its particle sizes NUCLEOSIL® finds application in analytical as well as in preparative columns.

## Benefits of NUCLEOSIL® silica

- High efficiency due to narrow particle size distribution
- High separation performance due to optimized binding techniques
- High chemical and mechanical stability
- High load capacity and recovery rates
- High reproducibility from lot to lot

## Physical properties

NUCLEOSIL® is manufactured with different pore diameters (50, 100, 120, 300, 500, 1000 and 4000 Å) and particle sizes from 3 µm (only NUCLEOSIL® 50, 100 and 120) to 10 µm with very narrow fractionation. All narrow-pore NUCLEOSIL® packings are stable up to 500 bar (7 250 psi), the wide-pore NUCLEOSIL® silicas are stable up to 300 or 400 bar (4 200 or 5 600 psi).

### Physical properties of unmodified NUCLEOSIL® materials

| Phase | Pore size | Pore volume | Surface (BET) | Density | Pressure stability* |
|---|---|---|---|---|---|
| NUCLEOSIL® 50 | 50 Å | 0.8 mL/g | 420 $m^2/g$ | 0.45 g/mL | 500 bar |
| NUCLEOSIL® 100 | 100 Å | 1 mL/g | 350 $m^2/g$ | 0.36 g/mL | 500 bar |
| NUCLEOSIL® 120 | 120 Å | 0.65 mL/g | 200 $m^2/g$ | 0.55 g/mL | 500 bar |
| NUCLEOSIL® 300 | 300 Å | 0.8 mL/g | 100 $m^2/g$ | 0.45 g/mL | 400 bar |
| NUCLEOSIL® 500 | 500 Å | 0.8 mL/g | 35 $m^2/g$ | 0.45 g/mL | 400 bar |
| NUCLEOSIL® 1000 | 1000 Å | 0.8 mL/g | 25 $m^2/g$ | 0.45 g/mL | 300 bar |
| NUCLEOSIL® 4000 | 4000 Å | 0.7 mL/g | 10 $m^2/g$ | 0.48 g/mL | 300 bar |

* Maximum packing pressure of NUCLEOSIL® bulk packings

## NUCLEOSIL® modifications

- NUCLEOSIL® packings are available as unmodified silica or with numerous chemically bonded phases: RP phases like $C_{18}$ AB, $C_{18}$ HD, $C_{18}$ Nautilus, $C_{18}$, $C_{18}$ ec, Protect I, $C_8$ HD, $C_8$ ec, $C_8$, $C_4$, $C_2$ and $C_6H_5$ separate mainly by hydrophobic interactions (van der Waals forces). The less polar the sample molecules, the more they are retained – the more polar the sample, the weaker are the hydrophobic interactions and consequently the retention times are shorter.
- Phases with chemically bonded polar groups such as CN, $NH_2$, $N(CH_3)_2$, OH show selective separation properties. Due to the availability of different functional groups it is possible to vary the chemical characteristics of the surface and consequently the adsorption characteristics of the stationary phase.
- Silica-based ion exchangers (NUCLEOSIL® SA and SB) are stable from pH 2 to 8 and do not swell. Compared to resin-based ion exchangers they offer the advantage of constant permeability, even when the ionic strength and/or pH of the eluent are changed. The separation can be influenced by
  – the type of buffer
  – the ionic strength and
  – the pH value.

A tabular overview of NUCLEOSIL® phases can be found on page 212.

# NUCLEOSIL® phase overview

## Overview of NUCLEOSIL® HPLC phases

| Phase | Specification | Page | Stability | Interactions | Structure |
|---|---|---|---|---|---|
| NUCLEOSIL® RP-Phasen | | | | | |
| $C_{18}$ | octadecyl phase, medium density modification, endcapping<br>15 % C · USP L1 | 214 | pH 2–8 | hydrophobic (van der Waals) interactions<br>slight residual silanol interactions | |
| $C_{18}$ HD | octadecyl phase, high density monomeric modification, endcapping<br>20 % C · USP L1 | 214 | pH 2–9 | hydrophobic (van der Waals) interactions | |
| $C_{18}$ AB | octadecyl phase, special crosslinked modification, endcapping<br>25 % C · USP L1 | 214 | pH 1–9 | steric and hydrophobic interactions | |
| $C_{18}$ Nautilus | octadecyl phase, embedded polar group, endcapping<br>16 % C · USP L60 | 214 | pH 2–8<br>up to 100 % $H_2O$ | hydrophobic and polar interactions | |
| Protect I | special RP phase, protective polar group, monomeric modification, endcapping<br>11 % C | 216 | pH 2–8<br>up to 100 % $H_2O$ | hydrophobic and polar interactions | |
| $C_8$ ec | octyl phase, medium density modification, endcapping<br>9 % C · USP L7 | 217 | pH 2–8 | hydrophobic (van der Waals) interactions<br>slight residual silanol interactions | |
| $C_8$ | octyl phase, no endcapping<br>8.5 % C · USP L7 | 217 | pH 2–8 | hydrophobic (van der Waals)<br>interactions noticeable residual silanol interactions | |
| $C_8$ HD | octyl phase, high density modification, endcapping<br>13 % C · USP L7 | 218 | pH 2–8 | hydrophobic (van der Waals) interactions | |
| $C_4$ | butyl phase, medium density modification, endcapping<br>~ 2 % C · USP L26 | 219 | pH 2–8 | hydrophobic (van der Waals) interactions<br>residual silanol interactions | |

# NUCLEOSIL® phase overview

## Overview of NUCLEOSIL® HPLC phases

| Phase | Specification | Page | Stability | Interactions | Structure |
|---|---|---|---|---|---|
| $C_2$ | dimethyl phase<br>3.5 % C · USP L16 | 219 | pH 2–8 | hydrophobic (van der Waals) interactions noticeable residual silanol interactions | NUCLEOSIL® $(Si\text{-}O_2)_n$ |
| $C_6H_5$ | phenyl phase, no endcapping<br>8 % C · USP L11 | 220 | pH 2–8 | π–π interactions and hydrophobic interactions noticeable residual silanol interactions | NUCLEOSIL® $(Si\text{-}O_2)_n$ |
| **Polar NUCLEOSIL® phases and NUCLEOSIL® ion exchangers** | | | | | |
| CN / CN-RP | cyano (nitrile) phase<br>USP L10 | 222 | pH 2–8 | π–π, polar and hydrophobic interactions | NUCLEOSIL® $(Si\text{-}O_2)_n$ |
| OH (Diol) | diol · USP L20 | 220 | pH 2–8 | polar interactions (hydrogen bonds) | NUCLEOSIL® $(Si\text{-}O_2)_n$ |
| $NH_2$ / $NH_2$-RP | amino · USP L8 | 221 | pH 2–8 | polar and hydrophobic interactions, weak ion exchange interactions | NUCLEOSIL® $(Si\text{-}O_2)_n$ |
| $N(CH_3)_2$ | dimethylamino | 221 | pH 2–8 | polar and hydrophobic interactions, weak ion exchange interactions | NUCLEOSIL® $(Si\text{-}O_2)_n$ |
| SA | sulfonic acid, strongly acid cation exchanger (SCX) USP L9 | 223 | pH 2–8 | strong ion exchange interactions | NUCLEOSIL® $(Si\text{-}O_2)_n$ |
| SB | quaternary ammonium, strongly basic anion exchanger (SAX)<br>USP L14 | 223 | pH 2–8 | strong ion exchange interactions | NUCLEOSIL® $(Si\text{-}O_2)_n$ |
| SiOH | unmodified spherical silica<br>USP L3 | 224 | pH 2–8 | polar | NUCLEOSIL® $(Si\text{-}O_2)_n$ |

## NUCLEOSIL® octadecyl phases ($C_{18}$)

### NUCLEOSIL® standard octadecyl phases · USP L1

$-(CH_2)_{17}-CH_3$

**Technical data**

- Nonpolar phases
- pH stability at 20 °C: 2–8
- carbon content depending on pore size (see table)
- Corresponding NUCLEODUR® phases see $C_{18}$ ec page 181

### NUCLEOSIL® $C_{18}$ HD · USP L1

$-(CH_2)_{17}-CH_3$

**Technical data**

- Nonpolar hydrophobic high density phases; monomeric modification
- pH stability 2–9
- Carbon content 20 %
- Corresponding NUCLEODUR® phases see $C_{18}$ Gravity page 158

### NUCLEOSIL® $C_{18}$ AB · USP L1

$-(CH_2)_{17}-CH_3$

**Technical data**

- Crosslinked hydrophobic phase; polymeric modification; inert towards acidic and basic substances with high affinity for silica
- pH stability 1–9
- Carbon content 25 %; distinct steric selectivity
- Corresponding NUCLEODUR® phases see $C_{18}$ Isis page 164

### NUCLEOSIL® $C_{18}$ Nautilus · USP L60

$-(CH_2)_{17}-CH_3$

**Technical data**

- Stable in 100 % aqueous eluents
- Carbon content 16 %
- Interesting polar selectivity features; very good base deactivation
- Corresponding NUCLEODUR® phases see $C_{18}$ PolarTec page 168

All NUCLEOSIL® octadecyl phases are endcapped.
Custom-packed columns with different column dimensions are available on request.

## Ordering information

Eluent in column acetonitrile – water

| ID | Length → 100 mm | 125 mm | 150 mm | 250 mm | EC guard columns* |
|---|---|---|---|---|---|
| **NUCLEOSIL® 50-5 $C_{18}$ ec** particle size 5 µm, pore size 50 Å, endcapped, 14.5 % C | | | | | |
| Analytical EC columns | | | | | |
| 4.6 mm | | | | 720098.46 | 721473.30 |
| **NUCLEOSIL® 100-3 $C_{18}$** particle size 3 µm, pore size 100 Å, endcapped, 15 % C | | | | | |
| Analytical EC columns | | | | | |
| 4 mm | | 720150.40 | | 720133.40 | 721022.30 |
| 4.6 mm | 720841.46 | 720150.46 | 720949.46 | 720133.46 | 721022.30 |
| **NUCLEOSIL® 100-5 $C_{18}$** particle size 5 µm, pore size 100 Å, endcapped, 15 % C | | | | | |
| Analytical EC columns | | | | | |
| 2 mm | | 720002.20 | | 720014.20 | 721074.20 |
| 3 mm | | 720002.30 | | 720014.30 | 721074.30 |
| 4 mm | 720141.40 | 720002.40 | 720120.40 | 720014.40 | 721074.30 |
| 4.6 mm | 720141.46 | 720002.46 | 720120.46 | 720014.46 | 721074.30 |

## Ordering information

Eluent in column acetonitrile – water

| ID | Length → 100 mm | 125 mm | 150 mm | 250 mm | EC guard columns* |
|---|---|---|---|---|---|
| **NUCLEOSIL® 100-7 $C_{18}$** particle size 7 µm, pore size 100 Å, endcapped, 15 % C | | | | | |
| Analytical EC columns | | | | | |
| 4 mm | | | | 720018.40 | |
| 4.6 mm | | 720951.46 | 720110.46 | 720018.46 | |
| **NUCLEOSIL® 100-10 $C_{18}$** particle size 10 µm, pore size 100 Å, endcapped, 15 % C | | | | | |
| Analytical EC columns | | | | | |
| 4 mm | | | | 720023.40 | |
| 4.6 mm | | 720701.46 | 720140.46 | 720023.46 | |
| **NUCLEOSIL® 120-3 $C_{18}$** particle size 3 µm, pore size 120 Å, endcapped, 11 % C | | | | | |
| Analytical EC columns | | | | | |
| 4 mm | 720149.40 | 720040.40 | | 720055.40 | 721075.30 |
| 4.6 mm | 720149.46 | 720040.46 | 720740.46 | 720055.46 | 721075.30 |
| **NUCLEOSIL® 120-5 $C_{18}$** particle size 5 µm, pore size 120 Å, endcapped, 11 % C | | | | | |
| Analytical EC columns | | | | | |
| 4 mm | | 720051.40 | | 720041.40 | 721070.30 |
| 4.6 mm | | 720051.46 | 720730.46 | 720041.46 | 721070.30 |
| **NUCLEOSIL® 120-7 $C_{18}$** particle size 7 µm, pore size 120 Å, endcapped, 11 % C | | | | | |
| Analytical EC columns | | | | | |
| 4 mm | | | | 720042.40 | |
| **NUCLEOSIL® 120-10 $C_{18}$** particle size 10 µm, pore size 120 Å, endcapped, 11 % C | | | | | |
| Analytical EC columns | | | | | |
| 4 mm | | | | 720043.40 | |
| 4.6 mm | | | | 720043.46 | |
| **NUCLEOSIL® 100-3 $C_{18}$ HD** particle size 3 µm, pore size 100 Å, 20 % C | | | | | |
| Analytical EC columns | | | | | |
| 4 mm | | 720191.40 | | | 721196.30 |
| 4.6 mm | | 720191.46 | 720193.46 | | 721196.30 |
| **NUCLEOSIL® 100-5 $C_{18}$ HD** particle size 5 µm, pore size 100 Å, 20 % C | | | | | |
| Analytical EC columns | | | | | |
| 4 mm | | 720296.40 | | 720280.40 | 721072.30 |
| 4.6 mm | | 720296.46 | 720294.46 | 720280.46 | 721072.30 |
| **NUCLEOSIL® 100-5 $C_{18}$ AB** particle size 5 µm, pore size 100 Å, 25 % C | | | | | |
| Analytical EC columns | | | | | |
| 4 mm | | 720935.40 | | 720936.40 | 721073.30 |
| 4.6 mm | | 720935.46 | 720305.46 | 720936.46 | 721073.30 |
| **NUCLEOSIL® 100-3 $C_{18}$ Nautilus** particle size 3 µm, pore size 100 Å, 16 % C | | | | | |
| Analytical EC columns | | | | | |
| 4 mm | | 720472.40 | | | 721649.30 |
| 4.6 mm | | 720472.46 | 720471.46 | | 721649.30 |
| **NUCLEOSIL® 100-5 $C_{18}$ Nautilus** particle size 5 µm, pore size 100 Å, 16 % C | | | | | |
| Analytical EC columns | | | | | |
| 4 mm | | 720430.40 | | 720431.40 | 721133.30 |
| 4.6 mm | | 720430.46 | 720432.46 | 720431.46 | 721133.30 |

## Guard column system

| Guard columns for EC columns with ID | | 2 mm | 3 mm | 4 mm | 4.6 mm | Guard column holder |
|---|---|---|---|---|---|---|
| * Column Protection System (pack of) | EC | 4/2 (3) | 4/3 (3) | 4/3 (3) | 4/3 (3) | 718966 |

EC columns in packs of 1, guard columns in packs of 3. For details of our column systems see page 250.

## NUCLEOSIL® octadecyl phases ($C_{18}$) wide pore octadecyl phases · USP L1

$-(CH_2)_{17}-CH_3$

### Technical data

- Many biologically interesting molecules can not be separated using conventional narrow pore silicas with pore sizes of about 100 Å. This is why MACHEREY-NAGEL offers a complete line of wide pore packings with pore sizes of 300, 500, 1000 and 4000 Å.
- These materials can also be used for size exclusion chromatography (SEC).

All NUCLEOSIL® octadecyl phases are endcapped.
Custom-packed columns with different column dimensions are available on request.

### Ordering information

Eluent in column acetonitrile – water

| ID | Length → 250 mm | EC guard columns* |
|---|---|---|
| **NUCLEOSIL® 300-5 $C_{18}$** particle size 5 µm, pore size 300 Å, endcapped, 6.5 % C | | |
| Analytical EC columns | | |
| 4 mm | 720065.40 | 721085.30 |
| 4.6 mm | 720065.46 | 721085.30 |
| **NUCLEOSIL® 500-7 $C_{18}$** particle size 7 µm, pore size 500 Å, endcapped, 2 % C | | |
| Analytical EC columns | | |
| 4.6 mm | 720074.46 | |
| **NUCLEOSIL® 1000-7 $C_{18}$** particle size 7 µm, pore size 1000 Å, endcapped, ~ 1 % C | | |
| Analytical EC columns | | |
| 4.6 mm | 720077.46 | |

EC columns in packs of 1, guard columns in packs of 3.

VarioPrep preparative HPLC columns with NUCLEOSIL® packing material on request.

## NUCLEOSIL® 100 Protect I special RP phase with protective polar group

### Technical data

- RP phase with pronounced hydrophilic properties
- Monomeric coating
- Endcapped
- Carbon content 11 %

### Ordering information

Eluent in column acetonitrile – water

| ID | Length → 125 mm | 150 mm | 250 mm | EC guard columns* |
|---|---|---|---|---|
| **NUCLEOSIL® 100-5 Protect I** particle size 5 µm, pore size 100 Å | | | | |
| Analytical EC columns | | | | |
| 4 mm | 720175.40 | | 720170.40 | 721157.30 |
| 4.6 mm | 720175.46 | 720174.46 | 720170.46 | 721157.30 |

### Guard column system

| Guard columns for EC columns with ID | | 2 mm | 3 mm | 4 mm | 4.6 mm | Guard column holder |
|---|---|---|---|---|---|---|
| * Column Protection System (pack of) | EC | 4/2 (3) | 4/3 (3) | 4/3 (3) | 4/3 (3) | 718966 |

EC columns in packs of 1, guard columns in packs of 3. For details of our column systems see page 250.

## NUCLEOSIL® octyl phases ($C_8$) NUCLEOSIL® standard octyl phases · USP L7

$-(CH_2)_7-CH_3$

### Technical data

- Nonpolar phases for RP and ion-pairing chromatography
- Endcapped and non-endcapped modifications available; pH stability at 20 °C: 2–8
- Carbon content depending on pore size (see table)

### Recommended application

- Separation of moderately to highly polar (water-soluble) compounds: steroids, nucleosides, cyclodextrins, pharmacological plant constituents
- Corresponding NUCLEODUR® phases see $C_8$ ec page 183

### Ordering information

Eluent in column acetonitrile – water

| ID | Length → 125 mm | 150 mm | 250 mm | EC guard columns* |
|---|---|---|---|---|
| **NUCLEOSIL® 100-5 $C_8$ ec** particle size 5 µm, pore size 100 Å, endcapped, 9 % C | | | | |
| Analytical EC columns | | | | |
| 4.6 mm | | | 720165.46 | 721096.30 |
| **NUCLEOSIL® 100-5 $C_8$** particle size 5 µm, pore size 100 Å, not endcapped, 8.5 % C | | | | |
| Analytical EC columns | | | | |
| 4 mm | 720001.40 | | 720013.40 | 721194.30 |
| 4.6 mm | 720001.46 | 720990.46 | 720013.46 | 721194.30 |
| **NUCLEOSIL® 100-7 $C_8$** particle size 7 µm, pore size 100 Å, not endcapped, 8.5 % C | | | | |
| Analytical EC columns | | | | |
| 4.6 mm | | | 720017.46 | |
| **NUCLEOSIL® 100-10 $C_8$** particle size 10 µm, pore size 100 Å, not endcapped, 8.5 % C | | | | |
| Analytical EC columns | | | | |
| 4 mm | | | 720022.40 | |
| 4.6 mm | | | 720022.46 | |
| **NUCLEOSIL® 120-3 $C_8$** particle size 3 µm, pore size 120 Å, not endcapped, 6.5 % C | | | | |
| Analytical EC columns | | | | |
| 4 mm | 720071.40 | | | 721093.30 |
| 4.6 mm | 720071.46 | 720214.46 | | 721093.30 |
| **NUCLEOSIL® 120-5 $C_8$** particle size 5 µm, pore size 120 Å, not endcapped, 6.5 % C | | | | |
| Analytical EC columns | | | | |
| 4 mm | 720050.40 | | 720052.40 | 721095.30 |
| 4.6 mm | 720050.46 | 720735.46 | 720052.46 | 721095.30 |
| **NUCLEOSIL® 300-5 $C_8$** particle size 5 µm, pore size 300 Å, not endcapped, ~ 3 % C | | | | |
| Analytical EC columns | | | | |
| 4.6 mm | | | 720062.46 | 721061.30 |

EC columns in packs of 1, guard columns in packs of 3.

Custom-packed columns with different column dimensions are available on request.

### Guard column system

| Guard columns for EC columns with ID | | 2 mm | 3 mm | 4 mm | 4.6 mm | Guard column holder |
|---|---|---|---|---|---|---|
| * Column Protection System (pack of) | EC | 4/2 (3) | 4/3 (3) | 4/3 (3) | 4/3 (3) | 718966 |

EC columns in packs of 1, guard columns in packs of 3. For details of our column systems see page 250.

## NUCLEOSIL® octyl phases ($C_8$) NUCLEOSIL® $C_8$ HD · USP L7

$-(CH_2)_7-CH_3$

### Technical data

- Nonpolar high density phases; monomeric modification; endcapped; carbon content 13 %
- Corresponding NUCLEODUR® phases see $C_8$ Gravity page 158

### Recommended application

- Separation of moderate to strong polar (water soluble) analytes like steroids, cyclodextrines, pharmalogical plant ingredients

### Ordering information

Eluent in column acetonitrile – water

| ID | Length → 125 mm | 150 mm | 250 mm | EC guard columns* |
|---|---|---|---|---|
| **NUCLEOSIL® 100-5 $C_8$ HD** particle size 5 µm, pore size 100 Å | | | | |
| Analytical EC columns | | | | |
| 4 mm | | | 720196.40 | 721071.30 |
| 4.6 mm | | 720194.46 | 720196.46 | 721071.30 |

EC columns in packs of 1, guard columns in packs of 3.

Custom-packed columns with different column dimensions are available on request.

### Guard column system

| Guard columns for EC columns with ID | | 2 mm | 3 mm | 4 mm | 4.6 mm | Guard column holder |
|---|---|---|---|---|---|---|
| * Column Protection System (pack of) | EC | 4/2 (3) | 4/3 (3) | 4/3 (3) | 4/3 (3) | 718966 |

EC columns in packs of 1, guard columns in packs of 3. For details of our column systems see page 250.

Beside analytical HPLC columns we also produce VarioPrep columns (see page 252) for preparative applications.

## NUCLEOSIL® butyl phases ($C_4$) · USP L26

$-(CH_2)_3-CH_3$

### Technical data

- Endcapped phases for RP and ion-pairing chromatography
- pH stability at 20 °C: 2–8; carbon content ~ 2 %
- Retention times are shorter than on $C_8$ and $C_{18}$ phases

### Recommended application

- For separation of macromolecules and hydrophobic substances
- For butyl phases for biochemical separations please refer to page 241

### Ordering information

Eluent in column acetonitrile – water

| ID | Length → 250 mm | EC guard columns* |
|---|---|---|
| **NUCLEOSIL® 120-5 $C_4$** particle size 5 µm, pore size 120 Å | | |
| Analytical EC columns | | |
| 4.6 mm | 720096.46 | 721083.30 |
| **NUCLEOSIL® 300-5 $C_4$** particle size 5 µm, pore size 300 Å | | |
| Analytical EC columns | | |
| 4 mm | 720059.40 | 721916.30 |
| 4.6 mm | 720059.46 | 721916.30 |

EC columns in packs of 1, guard columns in packs of 3.

### Guard column system

| Guard columns for EC columns with ID | | 2 mm | 3 mm | 4 mm | 4.6 mm | Guard column holder |
|---|---|---|---|---|---|---|
| * Column Protection System (pack of) | EC | 4/2 (3) | 4/3 (3) | 4/3 (3) | 4/3 (3) | 718966 |

## NUCLEOSIL® dimethyl phase ($C_2$) · USP L16

$-(CH_3)_2$

### Technical data

- Non-endcapped phase for RP and ion-pairing chromatography
- pH stability at 20 °C: 2–8; carbon content 3.5 %
- Retention times are much shorter than for the other RP phases

### Ordering information

Eluent in column acetonitrile – water

| ID | Length → 250 mm | EC guard columns* |
|---|---|---|
| **NUCLEOSIL® 100-7 $C_2$** particle size 7 µm, pore size 100 Å | | |
| Analytical EC columns | | |
| 4.6 mm | 720089.46 | 721030.30 |

EC columns in packs of 1, guard columns in packs of 3. For details of our column systems see page 250.

## NUCLEOSIL® phenyl phases ($C_6H_5$) · USP L11

### Technical data

- Relatively nonpolar, non-endcapped phases for RP and ion pairing chromatography
- Polarity similar to $C_8$, but with different selectivity for PAHs, polar aromatics, fatty acids etc.
- pH stability at 20 °C: 2–8; carbon content 8 %

### Recommended application

- Separation of moderately polar compounds

### Ordering information

Eluent in column acetonitrile – water

| ID | Length → 250 mm | EC guard columns* |
|---|---|---|
| **NUCLEOSIL® 100-5 $C_6H_5$** particle size 5 µm, pore size 100 Å, not endcapped | | |
| Analytical EC columns | | |
| 4.6 mm | 720956.46 | 721137.30 |
| **NUCLEOSIL® 100-7 $C_6H_5$** particle size 7 µm, pore size 100 Å, not endcapped | | |
| Analytical EC columns | | |
| 4 mm | 720019.40 | |
| 4.6 mm | 720019.46 | |

## NUCLEOSIL® diol phases · USP L20

### Technical data

- Dihydroxypropyl modified silica for RP and NP chromatography
- Less polar than unmodified silica, very easily wettable with water
- pH stability at 20 °C: 2-8; carbon content 5 %

### Ordering information

Eluent in column is *n*-heptane. When using an eluent which is not miscible with *n*-heptane (e.g., water), it is necessary to rinse the column with THF first.

| ID | Length → 250 mm | EC guard columns* |
|---|---|---|
| **NUCLEOSIL® 100-5 OH (Diol)** particle size 5 µm, pore size 100 Å | | |
| Analytical EC columns | | |
| 4.6 mm | 720143.46 | 721142.30 |

### Guard column system

| Guard columns for EC columns with ID | | 2 mm | 3 mm | 4 mm | 4.6 mm | Guard column holder |
|---|---|---|---|---|---|---|
| * Column Protection System (pack of) | EC | 4/2 (3) | 4/3 (3) | 4/3 (3) | 4/3 (3) | 718966 |

EC columns in packs of 1, guard columns in packs of 3. For details of our column systems see page 250.

## NUCLEOSIL® amino phases · USP L8

$-(CH_2)_3-NH_2$

### Technical data

- Aminopropyl modified polar silica phase; pH stability at 20 °C: 2–8; carbon content 3.5 %
- Corresponding NUCLEODUR® phases see page 188

### Recommended application

Multi-mode chromatography

- NP chromatography with hexane, dichloromethane or 2-propanol as mobile phase for polar compounds such as substituted anilines, esters, chlorinated pesticides
- RP chromatography of polar compounds like carbohydrates in aqueous-organic eluent systems
- Anion exchange chromatography of anions and organic acids using common buffers (e.g., acetate or phosphate) in conjunction with organic modifiers (e.g., acetonitrile)

### Ordering information

Eluent in column is *n*-heptane (except for $NH_2$ RP). When using an eluent which is not miscible with *n*-heptane (e.g., water), it is necessary to rinse the column with THF first.

| ID | Length → 250 mm | EC guard columns* |
|---|---|---|
| **NUCLEOSIL® 100-5 $NH_2$** particle size 5 µm, pore size 100 Å; eluent in column *n*-heptane | | |
| Analytical EC columns | | |
| 4.6 mm | 720095.46 | 721020.30 |
| **NUCLEOSIL® 100-5 $NH_2$-RP** particle size 5 µm, pore size 100 Å; eluent in column acetonitrile – water (80:20) | | |
| Analytical EC columns | | |
| 4.6 mm | 720095.46RP | 721155.30 |
| **NUCLEOSIL® 100-10 $NH_2$** particle size 10 µm, pore size 100 Å; eluent in column *n*-heptane | | |
| Analytical EC columns | | |
| 4.6 mm | 720025.46 | |

## NUCLEOSIL® dimethylamino phase

$-(CH_2)_3-N(CH_3)_2$

### Technical data

- Weakly basic anion exchanger, pH stability at 20 °C: 2–8; carbon content 4 %

### Recommended application

- Separation of many anions; can also be used in a similar way as the $NH_2$ phase

### Ordering information

Eluent in column is *n*-heptane. When using an eluent which is not miscible with *n*-heptane (e.g., water), it is necessary to rinse the column with THF first.

| ID | Length → 250 mm | EC guard columns* |
|---|---|---|
| **NUCLEOSIL® 100-5 $N(CH_3)_2$** particle size 5 µm, pore size 100 Å | | |
| Analytical EC columns | | |
| 4.6 mm | 720994.46 | 721158.30 |

### Guard column system

| Guard columns for EC columns with ID | | 2 mm | 3 mm | 4 mm | 4.6 mm | Guard column holder |
|---|---|---|---|---|---|---|
| * Column Protection System (pack of) | EC | 4/2 (3) | 4/3 (3) | 4/3 (3) | 4/3 (3) | 718966 |

EC columns in packs of 1, guard columns in packs of 3. For details of our column systems see page 250.

## NUCLEOSIL® cyano phases · USP L10

$-(CH_2)_3-CN$

### Technical data

- Polar to midpolar cyano (nitrile) modified silica
- pH stability at 20 °C: 2–8; carbon content 5 % for 100 Å pores, ~ 3 % for 120 Å pores
- Corresponding NUCLEODUR® phases see page 186

### Recommended application

Reversed phase and normal phase chromatography

- Normal phase:
  with low-polarity solvents for many compounds, which can also be separated on unmodified silica, however, due to the rapid equilibration much more suitable for gradient separations
- Reversed phase:
  with different selectivity than $C_{18}$, $C_8$ or phenyl modified packings

### Ordering information

Eluent in column (except for NUCLEOSIL® 100-5 CN-RP) is *n*-heptane. When using an eluent which is not miscible with *n*-heptane (e.g., water), it is necessary to rinse the column with THF first.

| ID | Length → 250 mm | EC guard columns* |
|---|---|---|
| **NUCLEOSIL® 100-5 CN** particle size 5 µm, pore size 100 Å; eluent in column *n*-heptane | | |
| Analytical EC columns | | |
| 4 mm | 720090.40 | 721078.30 |
| 4.6 mm | 720090.46 | 721078.30 |
| **NUCLEOSIL® 100-5 CN-RP** particle size 5 µm, pore size 100 Å; eluent in column acetonitrile – water | | |
| Analytical EC columns | | |
| 4 mm | 720205.40 | 721039.30 |
| 4.6 mm | 720205.46 | 721039.30 |
| **NUCLEOSIL® 100-10 CN** particle size 10 µm, pore size 100 Å; eluent in column *n*-heptane | | |
| Analytical EC columns | | |
| 4 mm | 720024.40 | |
| 4.6 mm | 720024.46 | |
| **NUCLEOSIL® 120-7 CN** particle size 7 µm, pore size 120 Å; eluent in column *n*-heptane | | |
| Analytical EC columns | | |
| 4 mm | 720057.40 | |
| 4.6 mm | 720057.46 | |

## NUCLEOSIL® SA phases · USP L9

### Technical data

- Strongly acidic cation exchanger (SCX) with benzenesulfonic acid modification
- Capacity ~ 1 meq/g; pH stability at 20 °C: 2–8; carbon content 6.5 %

### Ordering information

Eluent in column 0.15 mol/L $(NH_4)_2HPO_4$, pH 5

| ID | Length → 125 mm | 150 mm | 250 mm | EC guard columns* |
|---|---|---|---|---|
| **NUCLEOSIL® 100-5 SA** particle size 5 µm, pore size 100 Å | | | | |
| Analytical EC columns | | | | |
| 4 mm | | | 720097.40 | 721024.30 |
| 4.6 mm | 720709.46 | 720182.46 | 720097.46 | 721024.30 |
| **NUCLEOSIL® 100-10 SA** particle size 10 µm, pore size 100 Å | | | | |
| Analytical EC columns | | | | |
| 4.6 mm | | | 720028.46 | |

## NUCLEOSIL® SB phases · USP L14

### Technical data

- Strongly basic anion exchanger (SAX) with quaternary ammonium modification
- Capacity ~ 1 meq/g; pH stability at 20 °C: 2–8; carbon content 10 %

### Ordering information

Eluent in column 0.15 mol/L $(NH_4)_2HPO_4$, pH 5

| ID | Length → 125 mm | 150 mm | 250 mm | EC guard columns* |
|---|---|---|---|---|
| **NUCLEOSIL® 100-5 SB** particle size 5 µm, pore size 100 Å | | | | |
| Analytical EC columns | | | | |
| 4 mm | | | 720996.40 | 721025.30 |
| 4.6 mm | 720989.46 | 720183.46 | 720996.46 | 721025.30 |
| **NUCLEOSIL® 100-10 SB** particle size 10 µm, pore size 100 Å | | | | |
| Analytical EC columns | | | | |
| 4.6 mm | | | 720029.46 | |

## NUCLEOSIL® SiOH unmodified silica · USP L3

### Technical data

- Spherical silica, pH stability 2–8
- For physical properties of unmodified NUCLEOSIL® materials please see page 211.
- Maximum working pressure for the EC columns listed below is 400 bar.

### Ordering information

Eluent in column is *n*-heptane. When using an eluent which is not miscible with *n*-heptane (e.g., water), it is necessary to rinse the column with THF first.

| ID | Length → 250 mm | EC guard columns* |
|---|---|---|
| **NUCLEOSIL® 50-5** particle size 5 µm, pore size 50 Å | | |
| Analytical EC columns | | |
| 4.6 mm | 720093.46 | 721167.30 |
| **NUCLEOSIL® 100-5** particle size 5 µm, pore size 100 Å | | |
| Analytical EC columns | | |
| 4.6 mm | 720099.46 | 721518.30 |

### Guard column system

| Guard columns for EC columns with ID | | 2 mm | 3 mm | 4 mm | 4.6 mm | Guard column holder |
|---|---|---|---|---|---|---|
| * Column Protection System (pack of) | EC | 4/2 (3) | 4/3 (3) | 4/3 (3) | 4/3 (3) | 718966 |

EC columns in packs of 1, guard columns in packs of 3. For details of our column systems see page 250.

## LiChrospher® packings manufactured by E. Merck (D)

| Phase | USP | Particle size | Pore size | Modification | Endcapped | Carbon content |
|---|---|---|---|---|---|---|
| LiChrospher® 100 RP 18, 5 µm | L1 | nom. 5 µm | 100 Å | Octadecyl | – | 21 % |
| LiChrospher® 100 RP 18 ec, 5 µm | L1 | nom. 5 µm | 100 Å | Octadecyl | + | 21 % |
| LiChrospher® 60 RP select B, 5 µm | L7 | nom. 5 µm | 60 Å | Octyl | + | 12 % |
| All phases as packed ChromCart® cartridges | | | | | | |
| ChromCart® columns require the CC connecting kit (REF 721690). | | | | | | |

## Ordering information

Eluent in column acetonitrile – water

| ID | Length → 125 mm | 150 mm | 250 mm | Guard columns* |
|---|---|---|---|---|
| **LiChrospher® 100 RP 18, 5 µm** particle size 5 µm, pore size 100 Å | | | | |
| 2 mm | 728031.20 | | 728032.20 | 728053.30 |
| 3 mm | 728031.30 | | 728032.30 | 728053.30 |
| 4 mm | 728031.40 | | 728032.40 | 728053.40 |
| 4.6 mm | 728031.46 | 728033.46 | 728032.46 | 728053.40 |
| **LiChrospher® 100 RP 18 ec, 5 µm** particle size 5 µm, pore size 100 Å | | | | |
| 2 mm | 728034.20 | | 728035.20 | 728054.30 |
| 3 mm | 728034.30 | | 728035.30 | 728054.30 |
| 4 mm | 728034.40 | | 728035.40 | 728054.40 |
| 4.6 mm | 728034.46 | 728036.46 | 728035.46 | 728054.40 |
| **LiChrospher® 60 RP select B, 5 µm** particle size 5 µm, pore size 100 Å | | | | |
| 2 mm | 728037.20 | | 728038.20 | 728055.30 |
| 3 mm | 728037.30 | | 728038.30 | 728055.30 |
| 4 mm | 728037.40 | | 728038.40 | 728055.40 |
| 4.6 mm | 728037.46 | 728039.46 | 728038.46 | 728055.40 |

* can directly be used with the CC connecting kit (REF 721690).

8 mm ChromCart® guard column cartridges in packs of 3, all other columns in packs of 1.

# Phase overview for special separations

## Overview

| Separation / mechanism | Recommended column | Specification of the phase | Page |
|---|---|---|---|
| **Environmental analysis** | | | |
| Anion exchange chromatography of inorganic anions | NUCLEOGEL® Anion I | Strongly basic polymer-based anion exchanger | 230 |
| | NUCLEOSIL® Anion II | Strongly basic silica-based anion exchanger | |
| RP chromatography of PAHs | NUCLEODUR® $C_{18}$ PAH | NUCLEODUR® polymer-coated with $C_{18}$ groups<br>USP L1 | 227 |
| | NUCLEOSIL® 100-5 $C_{18}$ PAH | NUCLEOSIL® 100 polymer-coated with $C_{18}$ groups<br>USP L1 | 229 |
| **Enantiomer separation** | | | |
| Polar and π-π interactions | NUCLEOCEL *DELTA* | Silica-based modified cellulose phases<br>USP L40 | 233 |
| Formation of inclusion complexes | NUCLEODEX α-PM, β-PM, γ-PM and β-OH | Silica-based permethylated and underivatized cyclodextrin phases<br>USP L45 | 231 |
| Enantioselective binding to chiral protein surface structures | RESOLVOSIL BSA-7 | Silica-based protein phase (BSA) | 234 |
| Ligand exchange | NUCLEOSIL® CHIRAL-1 | Covalently bonded amino acid – Cu(II) complexes<br>USP L32 | 235 |
| Charge-transfer, dipole-dipole interactions and others | NUCLEOSIL® CHIRAL-2<br>NUCLEOSIL® CHIRAL-3 | Silica-based brush type phases<br>USP L36 | 236 |
| **Separation of biological macromolecules** | | | |
| Anion exchange chromatography of oligonucleotides and nucleic acids | NUCLEOGEN® DEAE | Silica-based DEAE anion exchanger | 237 |
| Anion exchange chromatography of peptides, large proteins and oligonucleotides | NUCLEOGEL® SAX | Polymer-based strongly basic anion exchanger<br>USP L23 | 240 |
| Cation exchange chromatography of proteins, peptides and carbohydrates | NUCLEOGEL® SCX | Polymer-based strong cation exchanger<br>USP L22 | 240 |
| Reversed phase chromatography of proteins, peptides and oligonucleotides | NUCLEOSIL® MPN | Monomerically bonded alkyl chains on silica<br>USP L1 / USP L26 | 243 |
| | NUCLEOSIL® PPN | Polymerically bonded alkyl chains on silica<br>USP L1 | 244 |
| | NUCLEOGEL® RP 300 | Polystyrene – divinylbenzene polymer<br>USP L21 | 245 |
| Reversed phase chromatography of small molecules | NUCLEOGEL® RP 100 | Small pore macroporous PS-DVB polymer<br>USP L21 | 245 |
| **Food analysis · sugars** | | | |
| RP chromatography of mono- and oligosaccharides | NUCLEOSIL® Carbohydrate | Silica-based special amino phase<br>USP L8 | 246 |
| Separation of sugars, alcohols, org. acids based on ion exclusion, ion exchange, size exclusion, ligand exchange, NP and RP effects | NUCLEOGEL® SUGAR 810 H, Ca | Resins with sulfonic acid modification in different ionic forms H form USP L17 / Ca form L19 / Pb form L34 / Na form L58 | 247 |
| Separation of sugars, alcohols, org. acids based on steric exclusion, ligand exchange and partition effects | NUCLEOGEL® SUGAR Ca, Na, Pb<br>NUCLEOGEL® ION 300 OA | | 248 |
| **Gel permeation chromatography (GPC)** | | | |
| Water-insoluble compounds | NUCLEOGEL® GPC | Polystyrene – divinylbenzene polymer | 249 |

## NUCLEODUR® $C_{18}$ PAH special octadecyl phase for PAH analysis · USP L1

### Technical data

- Base material NUCLEODUR® silica, particle sizes 1.8 and 3 µm, pore size 110 Å; polymeric coating

### Recommended application

- Allows efficient gradient separation of the 16 PAHs according to EPA

**Analysis of 16 EPA PAHs with or without acetonitrile**

MN Appl. Nos. 123820 / 123830

Separation with acetonitrile

| | |
|---|---|
| Column: | 100 x 4 mm<br>NUCLEODUR® C18 PAH, 3 µm |
| Eluent: | A) methanol – water (80:20, v/v)<br>B) acetonitrile 2–20 % B in 1.2 min, 20–100 % B in 0.5 min, 100 % B for 2.5 min, 100–2 % B in 0.4 min |
| Flow rate: | 2.5 mL/min, temperature 35 °C |
| Detection: | UV, 254 nm<br>fluorescence (see chromatogram) |

Separation without acetonitrile

| | |
|---|---|
| Column: | 125 x 4 mm<br>NUCLEODUR® C18 PAH, 3 µm |
| Eluent: | A) water<br>B) methanol 65–97 % B in 6 min, 97 % B for 5 min, 97–65 % B in 0.5 min |
| Flow rate: | 2 mL/min, temperature 35 °C |
| Detection: | fluorescence (see chromatogram) |

Peaks:

1. Naphthalene
2. Acenaphthylene (not detectable by fluorescence)
3. Acenaphthene
4. Fluorene
5. Phenantrene
6. Anthracene
7. Fluoranthene
8. Pyrene
9. Benz[*a*]anthracene
10. Chrysene
11. Benzo[*b*]fluoranthene
12. Benzo[*k*]fluoranthene
13. Benzo[*a*]pyrene
14. Dibenz[*ah*]anthracene
15. Benzo[*ghi*]perylene
16. Indeno[1,2,3-*cd*]pyrene

Detection of separated PAHs with UV (250–280 nm), diode array or fluorescence detection at different wavelengths for excitation and emission (acenaphthylene cannot be analyzed with fluorescence detection).

## Ordering information

Eluent in column acetonitrile – water (70:30, v/v)

| ID | Length → 100 mm | 125 mm | 150 mm | 250 mm | EC guard columns* |
|---|---|---|---|---|---|
| **NUCLEODUR® $C_{18}$ PAH, 1.8 µm** particle size 1.8 µm · UHPLC | | | | | |
| Analytical EC columns | | | | | |
| 2 mm | 760773.20 | | | | 761970.20 |
| 3 mm | 760773.30 | | | | 761970.30 |
| 4 mm | 760773.40 | | | | 761970.30 |
| **NUCLEODUR® $C_{18}$ PAH, 3 µm** particle size 3 µm | | | | | |
| Analytical EC columns | | | | | |
| 3 mm | 760783.30 | 760784.30 | 760785.30 | 760786.30 | 761971.30 |
| 4 mm | 760783.40 | 760784.40 | 760785.40 | 760786.40 | 761971.30 |

## Guard column system

| Guard columns for EC columns with ID | | 2 mm | 3 mm | 4 mm | 4.6 mm | Guard column holder |
|---|---|---|---|---|---|---|
| * Column Protection System (pack of) | EC | 4/2 (3) | 4/3 (3) | 4/3 (3) | 4/3 (3) | 718966 |

Separation of 18 PAHs on NUCLEODUR® $C_{18}$ PAH

MN Appl. No. 123840

| | |
|---|---|
| Column: | 125 x 4 mm<br>NUCLEODUR® $C_{18}$ PAH, 3 µm |
| Eluent: | A) methanol – water<br>(70:30, v/v); B) acetonitrile<br>0–20 % B in 1.5 min,<br>20–50 % B in 1.5 min,<br>50–100 % B in 1.0 min,<br>100 % B for 3 min,<br>100–0 % B in 0.5 min |
| Flow rate: | 1.5 mL/min |
| Temperature: | 35 °C |
| Injection: | UV: 1 µL, |
| Fluorescence: | 0.5 µL |
| Detection: | UV, 254 nm<br>fluorescence<br>(see chromatogram) |

Peaks:
(concentrations 10 ng/µL per compound)
1.–16. see page 227
1-me-n: 1-methylnaphthalene
2-me-n: 2-methylnaphthalene

## Analysis of polycyclic aromatic hydrocarbons (PAHs) by HPLC

Polycyclic aromatic hydrocarbons (PAHs) are chemical compounds that consist of fused aromatic rings and do not contain heteroatoms or carry substituents. As a pollutant, they are of concern because some compounds have been identified as carcinogenic, mutagenic, and teratogenic. PAHs are natural components of coal or gas. They are delivered to our environment by pyrolysis (incomplete burning) of organic materials like coal, oil, fuel, wood, tobacco, … and hence can be found globally. Today most PAHs accrue from anthropogenic processes – but also natural origins (forest fire) are possible. Regarding to past pollutions an important impact had production of coke and gas from black coal. Waste products (e.g., tar) from coking or gas plants are often origin of serious ground water pollutions.

Since a number of PAHs (e.g., benzo[a]pyrene, 3-methylcholanthrene and benzanthracene) have been proven to be carcinogenic, control of the PAH content of food, water and soil is an important task for routine analysis. For choice and limiting values of the polycyclics we refer to the governmental regulations, which exist in many countries (e.g., EPA method 610 of the United States Environmental Protection Agency).

PAHs can be determined by different chromatographic techniques (TLC, GC, HPLC). Thus the 6 PAHs according to German drinking water specification (TVO) can, e.g., be analyzed by TLC (see German Standard DIN 38 409), while a much larger number of polycyclic aromatics can be determined by GC or HPLC.

Benzo[a]anthracen

Benzo[a]pyren

### HPLC columns for PAH analysis

For PAH analyses we have developed specially modified $C_{18}$ phases based on NUCLEODUR® and NUCLEOSIL® which allow efficient gradient separation of 16 PAHs according to EPA. Detection of the separated PAHs can be achieved by UV (250–280 nm), with diode array or with fluorescence detection at different wavelengths for excitation and emission. Acenaphthylene cannot be analyzed with fluorescence detection. For cost-effective routine PAH analysis we recommend applications using methanol instead of acetonitrile as eluent. For rapid analysis NUCLEODUR® $C_{18}$ PAH (3 µm) in short columns (100 mm) provides excellent results at high flow rates. Hereby separation of 16 PAHs according to EPA can be achieved in less than 3 min.

Tightened regulations require determination of 2 additional PAHs (1- and 2-methylnaphthalene) – so we developed highly efficient methods for 18 PAHs on the NUCLEODUR® $C_{18}$ PAH.

## NUCLEOSIL® 100-5 $C_{18}$ PAH special octadecyl phase for PAH analysis · USP L1

### Technical data

- Base material NUCLEOSIL® silica, particle size 5 µm, pore size 100 Å; polymeric coating
- Detection of the separated PAH with UV (250–280 nm), diode array or fluorescence detection at different wavelengths for excitation and emission (acenaphthylene cannot be analyzed with fluorescence detection)

### Recommended application

- Efficient gradient separation of the 16 PAHs according to EPA

Separation of the PAH standard according to EPA (REF 722393)

MN Appl. No. 115040

| | |
|---|---|
| Column: | 150 x 4 mm NUCLEOSIL® 100-5 $C_{18}$ PAH |
| Eluent: | A) methanol – water (80:20) |
| | B) acetonitrile – tetrahydrofuran (93:7) |
| | 0–100 % B in 10 min, 5 min 100 % B |
| Flow rate: | 1 mL/min |
| Pressure: | 140 bar |
| Temperature: | 20 °C |
| Detection: | UV, 260 nm |

Peaks: (10 µg/mL each in acetonitrile)

1. Naphthalene
2. Acenaphthylene
3. Acenaphthene
4. Fluorene
5. Phenanthrene
6. Anthracene
7. Fluoranthene
8. Pyrene
9. Benz[*a*]anthracene
10. Chrysene
11. Benzo[*b*]fluoranthene
12. Benzo[*k*]fluoranthene
13. Benzo[*a*]pyrene
14. Dibenz[*ah*]anthracene
15. Benzo[*ghi*]perylene
16. Indeno[1,2,3-*cd*]pyrene

## Ordering information

Eluent in column acetonitrile – water 70:30

| ID | Length → 150 mm | 250 mm | EC guard columns* |
|---|---|---|---|
| **NUCLEOSIL® 100-5 $C_{18}$ PAH** particle size 5 µm, pore size 100 Å | | | |
| Analytical EC columns | | | |
| 2 mm | | 720117.20 | 721168.20 |
| 3 mm | 720923.30 | 720117.30 | 721168.30 |
| 4 mm | 720923.40 | 720117.40 | 721168.30 |
| 4.6 mm | | 720117.46 | 721168.30 |
| **PAH standard according to EPA for HPLC** | | | |
| Analytical EC columns | | | |
| PAH standard for HPLC | 16 PAH according to EPA method 610 in acetonitrile (1 mL) for composition see chromatogram above | | 722393 |

## Guard column system

| Guard columns for EC columns with ID | | 2 mm | 3 mm | 4 mm | 4.6 mm | Guard column holder |
|---|---|---|---|---|---|---|
| * Column Protection System (pack of) | EC | 4/2 (3) | 4/3 (3) | 4/3 (3) | 4/3 (3) | 718966 |

EC columns in packs of 1, guard columns in packs of 3. For details of our column systems see page 250.
# This product contains harmful substances which must be specially labeled as hazardous. For detailed information please see SDS.

## Anion columns for analysis of inorganic anions

### NUCLEOGEL® Anion I

#### Technical data

- Strongly basic polymer-based anion exchanger, particle size 10 µm; pH stability 1–14
- Eluent in column 4 mmol/L salicylate buffer pH 7.8
- Contrary to the silica-based phase also suited for fluoride analysis

### NUCLEOSIL® Anion II

#### Technical data

- Base material NUCLEOSIL® silica, particle size 10 µm, pore size 300 Å strongly basic anion exchanger, exchange capacity 50 µeq/g, pH stability 2–7.5
- Eluent in column 0.15 mol/L $(NH_4)_2HPO_4$ buffer pH 5.2 recommended buffer concentration for separation of inorganic anions: 2 mmol/L phthalate
- Preferred method of detection: conductivity or negative UV detection

**Separation of an anion standard**

MN Appl. No. 106440

Column: 250 x 4 mm NUCLEOSIL® Anion II
Eluent: 2 mmol/L potassium hydrogen phthalate, pH 5.7
Flow rate: 2 mL/min
Detection: UV, 280 nm

Peaks:
1. $H_2PO^{4-}$
2. $Cl^-$
3. $NO^{2-}$
4. $NO^{3-}$
5. $SO_4^{2-}$

**Separation of inorganic anions**

MN Appl. No. 115050

Column: 120 x 4.6 mm NUCLEOGEL® Anion I
Eluent: 4 mmol/L salicylic acid – Tris pH 7.8
Flow rate: 1 mL/min
Detection: UV, 254 nm

Peaks:
1. $F^-$
2. $Cl^-$
3. $NO^{2-}$
4. $Br^-$
5. $NO_3^-$
6. $PO_4^{3-}$
7. $SO_4^{2-}$

### Ordering information

| ID | Length → 120 mm | 250 mm | Guard columns* |
|---|---|---|---|
| **NUCLEOGEL® Anion I** eluent 4 mmol/L salicylate buffer pH 7.8 | | | |
| Analytical Valco type columns | | | |
| 4.6 mm | 719533 | | 719543 |
| **NUCLEOSIL® Anion II** eluent 0.15 mol/L $(NH_4)_2HPO_4$ buffer pH 5.2 | | | |
| Analytical EC columns | | | |
| 4 mm | | 720094.40 | 721169.30 |

* NUCLEOGEL® Anion I Valco type guard columns cartridges are 21 x 4 mm, require guard column holder C, REF 719538, see page 250 (columns in packs of 1, guard columns in packs of 2)
NUCLEOSIL® Anion II guard columns are used with the Column Protection System (REF 718966, see page 251).

## NUCLEODEX columns enantiomer separation based on cyclodextrins

### NUCLEODEX β-OH β-cyclodextrin (R = H; n = 2) · USP L45

**Technical data**

- Base material NUCLEOSIL® silica, particle size 5 µm, pore size 100 Å modified cyclodextrins as chiral selectors
- Separation based on hydrogen bonds and dipole interactions between functional groups of the analyte and hydroxyl groups of the cyclodextrin
- Examples for successful enantiomer separations: chlorthalidone and other compounds, which require free hydroxyl groups for enantioselective interactions
- Eluent in column $CH_3OH$ – 0.1 % TEAA pH 4 (55:45)

### NUCLEODEX α-PM permethylated α-cyclodextrin (R = $CH_3$; n = 1)

**Technical data**

- Base material NUCLEOSIL® silica, particle size 5 µm, pore size 100 Å modified cyclodextrins as chiral selectors
- Examples for successful enantiomer separations: mecoprop and dichlorprop as free carboxylic acids, trans-stilbene oxide, styrene oxide
- Eluent in column $CH_3OH$ – 50 mmol/L phosphate pH 3 (70:30)

### NUCLEODEX β-PM permethylated β-cyclodextrin (R = $CH_3$; n = 2) · USP L45

**Technical data**

- Base material NUCLEOSIL® silica, particle size 5 µm, pore size 100 Å modified cyclodextrins as chiral selectors
- Examples for successful enantiomer separations: mephobarbital (prominal), pesticide derivatives mecoprop methyl and dichlorprop methyl
- Eluent in column $CH_3OH$ – 0.1 % TEAA pH 4 (65:35)

### NUCLEODEX γ-PM permethylated γ-cyclodextrin (R = $CH_3$; n = 3)

**Technical data**

- Base material NUCLEOSIL® silica, particle size 5 µm, pore size 100 Å modified cyclodextrins as chiral selectors
- Examples for successful enantiomer separations: steroids or other larger molecules
- Eluent in column $CH_3OH$ – 0.1 % TEAA pH 4 (55:45)

**Recommended application**

- NUCLEODEX phases are especially suited for the control of optical purity, but also for semipreparative separations and for the analysis of positional and cis-trans isomers.
- For numerous separations on NUCLEODEX phases please visit our website: *www.mn-net.com/apps*

# HPLC columns for enantiomer separations

### Separation of the positional isomers of nitroaniline

MN Appl. No. 101420

| | |
|---|---|
| Column: | 200 x 4 mm NUCLEODEX β-OH |
| Eluent: | methanol – 0.1 % triethylammonium acetate pH 4.0 (50:50, v/v) |
| Flow rate: | 0.7 mL/min |
| Pressure: | 180 bar |
| Detection: | UV, 254 nm |
| Injection: | 1 µL |

Peaks:
1. *m*-Nitroaniline
2. *o*-Nitroaniline
3. *p*-Nitroaniline

### Enantiomer separation of styrene oxide

MN Appl. No. 106160

| | |
|---|---|
| Column: | 200 x 4 mm NUCLEODEX α-PM |
| Eluent: | methanol – 0.1 % triethylammonium acetate pH 4.0 (60:40, v/v) |
| Flow rate: | 0.7 mL/min |
| Pressure: | 160 bar |
| Detection: | UV, 230 nm |
| Injection: | 2 µL |

### Enantiomer separation of mephobarbital

MN Appl. No. 105800

| | |
|---|---|
| Column: | 200 x 4 mm NUCLEODEX β-PM |
| Eluent: | methanol – 0.1 % triethylammonium acetate pH 4.0 (55:45, v/v) |
| Flow rate: | 0.7 mL/min |
| Pressure: | 180 bar |
| Detection: | UV, 254 nm |
| Injection: | 1 µL |

## Ordering information

| ID | Length → 200 mm | EC guard columns* |
|---|---|---|
| **NUCLEODEX β-OH** eluent methanol – 0.1 % TEAA pH 4 (55:45) | | |
| Analytical EC columns | | |
| 4 mm | 720124.40 | 721171.30 |
| **NUCLEODEX α-PM** eluent methanol – 50 mmol/L phosphate pH 3 (70:30) | | |
| Analytical EC columns | | |
| 4 mm | 720127.40 | 721469.30 |
| **NUCLEODEX β-PM** eluent methanol – 0.1 % TEAA pH 4 (65:35) | | |
| Analytical EC columns | | |
| 4 mm | 720125.40 | 721176.30 |
| **NUCLEODEX γ-PM** eluent methanol – 0.1 % TEAA pH 4 (55:45) | | |
| Analytical EC columns | | |
| 4 mm | 720752.40 | 721178.30 |
| **NUCLEODEX CC screening kit** | | |
| contains one CC 30/4 each with NUCLEODEX β-OH, α-PM, β-PM and γ-PM as well as one CC column holder 30 mm | 721920 | |

* EC 4/3 guard columns for EC columns with 4 mm ID require the Column Protection System guard column holder (REF 718966, see page 251). Columns and guard columns in packs of 1.

## NUCLEOCEL *DELTA* enantiomer separation based on a cellulose derivative · USP L40

### Technical data

- Base material silica, chiral selector cellulose tris-(3,5-dimethylphenylcarbamate)
  High resolution type (S) with 5 µm particle size, allows use of shorter columns (150 mm) for faster separations, pressure stability up to ~150 bar (2000 psi), pH stability 1–9

NUCLEOCEL *DELTA* for normal phase applications: eluent in column *n*-heptane – 2-propanol (90:10, v/v) typical eluents are heptane – propanol mixtures

NUCLEOCEL *DELTA*-RP for reversed phase applications: eluent in column acetonitrile – water (40:60, v/v) designed for use either in polar organic mode or with eluents containing high concentrations of chaotropic salts such as perchlorate

### Recommended application

- Pharmaceutically active compounds, chiral pollutants (e.g., herbicides, PCB), chiral compounds in food (dyes, preservatives), chiral catalysts and bioorganic compounds

Similar phases: Chiralcel® OD, Kromasil® CelluCoat™, Eurocel® 01, Lux™ Cellulose-1

**Enantiomer separation of indapamide**

MN Appl. No. 121230

| | |
|---|---|
| Column: | 250 x 4,6 mm NUCLEOCEL *DELTA-RP S* |
| Eluent: | acetonitrile – water (40:60, v/v) |
| Flow rate: | 0.5 mL/min |
| Temperature: | 40 °C |
| Detection: | UV, 254 nm |
| Injection: | 5 µL |
| Concentration: | 1 µg/µL |

α = 1.3
$R_s$ = 2.6

**Enantiomer separation of flavanone**

MN Appl. No. 121260

| | |
|---|---|
| Column: | 250 x 4,6 mm NUCLEOCEL *DELTA S* |
| Eluent: | *n*-heptane – 2-propanol (90:10, v/v) |
| Flow rate: | 1 mL/min |
| Temperature: | 25 °C |
| Detection: | UV, 254 nm |
| Injection: | 5 µL |
| Concentration: | 1 µg/µL |

α = 1.29
$R_s$ = 2.6

## Ordering information

| ID | Length → 150 mm | 250 mm | EC guard columns* |
|---|---|---|---|
| **NUCLEOCEL *DELTA S*, 5 µm** eluent n-heptane – 2-propanol (90:10, v/v) | | | |
| Analytical EC columns | | | |
| 4.6 mm | | 720445.46 | 721185.30 |
| **NUCLEOCEL *DELTA-RP S*, 5 µm** eluent acetonitrile – water (40:60, v/v) | | | |
| Analytical EC columns | | | |
| 4.6 mm | 720451.46 | 720450.46 | 721186.30 |

* EC 4/3 guard column cartridges are used for EC columns of 4.6 mm ID with the Column Protection System guard column holder (REF 718966, see page 251). Columns and guard columns in packs of 1.

## RESOLVOSIL BSA-7 protein phase for enantiomer separation · USP L75

### Technical data

- Base material NUCLEOSIL® silica, particle size 7 µm, pore size 300 Å chiral selector bovine serum albumin (BSA)
- Separation based on selective interaction of proteins with low molecular compounds, i.e. principles of bioaffinity, including hydrophobic interactions (similar to a true reversed phase), interactions of polar groups and steric effects

### Recommended application

- Amino acid derivatives, aromatic amino acids, aromatic sulfoxides, barbiturates, benzodiazepinones, benzoin and benzoin derivatives, β-blockers, coumarin derivatives, and for monitoring stereoselective microbial and enzymatic conversions

Enantiomer separation of *N*-benzoyl-*D*,*L*-amino acids

MN Appl. No. 105450

S. Allenmark et al. in "Affinity chromatography and biological recognition" (I. Chaiken, M. Wilchek, and I. Parikh. Eds.), Academic Press, New York, 1983, 259–260

| | |
|---|---|
| Column: | 150 x 4 mm RESOLVOSIL BSA-7 |
| Eluent: | 50 mmol/L phosphate buffer pH 6.5 |
| | + 1 % 1-propanol |
| Flow rate: | 0.70 mL/min |
| Detection: | UV, 225 nm |

Peaks:
1. Serine
2. Alanine
3. Phenylalanine

### Ordering information

Eluent in column 0.1 mol/L phosphate buffer pH 7.5, 2 % 1-propanol

| ID | Length → 150 mm | EC guard columns* |
|---|---|---|
| **RESOLVOSIL BSA-7** | | |
| Analytical EC columns | | |
| 4 mm | 720046.40 | 721402.30 |

* EC 4/3 guard columns for EC columns with 4 mm ID require the Column Protection System guard column holder (REF 718966, see page 251). Columns and guard columns in packs of 1.

## NUCLEOSIL® CHIRAL-1 enantiomer separation based on ligand exchange · USP L32

### Technical data

- Base material NUCLEOSIL® silica, particle size 5 µm, pore size 120 Å chiral selector L-hydroxyproline – $Cu^{2+}$ complexes
- Principal interaction mode:
- formation of ternary mixed-ligand complexes with Cu(II) ions; differences in the stability of the diastereomeric complexes cause chromatographic separation

### Recommended application

- Enantiomers with two polar functional groups with the correct spacing such as α-amino acids, α-hydroxycarboxylic acids (e.g., lactic acid), *N*-alkyl-α-amino acids etc.

*D,L*-alanine enantiomers

MN Appl. No. 105410

| | |
|---|---|
| Column: | 250 x 4 mm NUCLEOSIL® CHIRAL-1 |
| Eluent: | 0.5 mmol/L $CuSO_4$ |
| Flow rate: | 1 mL/min |
| Pressure: | 60 bar |
| Temperature: | 60 °C |
| Detection: | UV, 250 nm |

*D,L*-threonine enantiomers

MN Appl. No. 105410

| | |
|---|---|
| Column: | 250 x 4 mm NUCLEOSIL® CHIRAL-1 |
| Eluent: | 0.25 mmol/L $CuSO_4$ |
| Flow rate: | 0.8 mL/min |
| Pressure: | 65 bar |
| Temperature: | 60 °C |
| Detection: | UV, 240 nm |

Lactic acid enantiomers

MN Appl. No. 105560

| | |
|---|---|
| Column: | 250 x 4 mm NUCLEOSIL® CHIRAL-1 |
| Eluent: | 0.5 mmol/L $CuSO_4$ |
| Flow rate: | 0.8 mL/min |
| Temperature: | 60 °C |
| Detection: | UV, 240 nm |
| Injection: | 1 µL |

## Ordering information

Eluent in column 0.5 mmol/L copper sulfate solution

| ID | Length → 250 mm | EC guard columns* |
|---|---|---|
| **NUCLEOSIL® CHIRAL-1** | | |
| Analytical EC columns | | |
| 4 mm | 720081.40 | 721188.30 |

* EC 4/3 guard columns for EC columns with 4 mm ID require the Column Protection System guard column holder (REF 718966, see page 251). Columns and guard columns in packs of 1.

## NUCLEOSIL® CHIRAL-2 · CHIRAL-3 enantiomer separation in organic eluent systems · USP L36

### Technical data

- Base material NUCLEOSIL® silica, particle size 5 µm, pore size 100 Å chiral selector for NUCLEOSIL® CHIRAL-2 is *N*-(3,5-dinitrobenzoyl)-D-phenylglycine, for CHIRAL-3 the optical antipode is used, "brush type" phases
- Principle interaction modes: charge-transfer interactions, hydrogen bonds, dipole-dipole interactions and steric effects

### Recommended application

- analysis of stereoisomers such as separation of enantiomers and diastereomers, control of optical purity of plant protectives (pesticides, e.g., propionic acid derived herbicides) pharmaceuticals etc. and for product control in chiral organic syntheses
- For control of optical purity of a substance, the columns NUCLEOSIL® CHIRAL-2 and NUCLEOSIL® CHIRAL-3 allow to select conditions such that the minor enantiomer, present as an impurity, is eluted before the main peak. Overlapping peaks are avoided. This makes an exact quantification of the impurity much easier.

### Enantiomer separation of *D*,*L*-supidimide

MN Appl. No. 105690

Column: 250 x 4 mm NUCLEOSIL® CHIRAL-2
Eluent: tetrahydrofuran – *n*-heptane (10:3, v/v)
Flow rate: 1.0 mL/min
Detection: UV, 220 nm

### Control of optical purity of mecoprop methyl

MN Appl. No. 111360

Columns: a) 250 x 4 mm NUCLEOSIL® CHIRAL-2
b) 250 x 4 mm NUCLEOSIL® CHIRAL-3
Eluent: *n*-heptane – 2-propanol – TFA (100:0.05:0.05, v/v/v)
Flow rate: 1 mL/min, ambient temperature
Detection: UV, 230 nm, Injection 1 µL (sample with 90 % ee)

## Ordering information

Eluent in column *n*-heptane – 2-propanol – TFAA (100:0.05:0.05, v/v/v)

| ID | Length → 250 mm | EC guard columns* |
|---|---|---|
| **NUCLEOSIL® CHIRAL-2** | | |
| Analytical EC columns | | |
| 4 mm | 720088.40 | 721190.30 |
| **NUCLEOSIL® CHIRAL-3** | | |
| Analytical EC columns | | |
| 4 mm | 720350.40 | 721190.30 |

Guard columns for NUCLEOSIL® CHIRAL-2 and CHIRAL-3 are identical.
* EC 4/3 guard columns for EC columns with 4 mm ID require the Column Protection System guard column holder (REF 718966, see page 251). EC columns and EC guard columns in packs of 1.

## NUCLEOGEN® columns anion exchange chromatography of nucleic acids

### NUCLEOGEN® 60-7 DEAE pore size 60 Å

**Technical data**

- Base material silica, particle size 7 µm; DEAE anion exchanger
- For the separation of oligonucleotides up to chain lengths of 40 bases with recoveries > 95 % capacity 200 $A_{260}$/mL (~ 300 $A_{260}$ for a 125 x 4 mm ID column, 1875 $A_{260}$ for a 125 x 10 mm ID column)
- Preparative separations possible when using higher flow rates and longer gradient times

### NUCLEOGEN® 500-7 DEAE pore size 500 Å

**Technical data**

- Base material silica, particle size 7 µm; DEAE anion exchanger
- For the separation of tRNA, 5S RNA, viroids and messenger RNA in the intermediate molecular weight range (25–1 000 kDa) with recoveries > 95 %
- Capacity 730 $A_{260}$ for a 125 x 6 mm ID column, 1940 $A_{260}$ for a 125 x 10 mm ID column

### NUCLEOGEN® 4000-7 DEAE pore size 4000 Å

**Technical data**

- Base material silica, particle size 7 µm; DEAE anion exchanger
- For the separation of plasmids, DNA restriction fragments, ribosomal RNA, messenger RNA and viral RNA, i.e. very high molecular weight nucleic acids (e.g., 1–50 MDa)
- Capacity 120 $A_{260}$ for a 125 x 6 mm ID column, 350 $A_{260}$ for a 125 x 10 mm ID column

For more separations of deoxyoligonucleotides, plasmids and DNA restriction fragments visit our website *www.mn-net.com/apps*

## Separation of plasmid pBR 322

MN Appl. No. 107480

M. Colpan, D. Riesner, private communication

A) isolation of plasmid DNA from a crude cell lysate

Sample: 5 µg plasmid pBR 322 containing cleared lysate from *E. coli*

Column: 125 x 6 mm NUCLEOGEN® 4000-7 DEAE

Eluent: A) 20 mmol/L K phosphate buffer pH 6.9; 5 mol/L urea
B) eluent A + 1.5 mol/L KCl
20–100 % B in 50 min;
arrow = ionic strength of 850 mmol/L

Flow rate: 1.0 mL/min, 70 bar, ambient temperature

Detection: UV, 260 nm

B) separation of supercoiled plasmid from relaxed and linear forms

Sample: plasmid pBR 322, supercoiled, relaxed and linear

Column: 125 x 6 mm NUCLEOGEN® 4000-7 DEAE

Eluent: A) 20 mmol/L K phosphate buffer pH 6.8; 6 mol/L urea
B) eluent A + 2 mol/L KCl
42–100 % B in 230 min

Flow rate: 1.5 mL/min, 45 bar, ambient temperature

## Separation of oligo(rA)$_n$

MN Appl. No. 115180

Column: 125 x 4 mm NUCLEOGEN® 60-7 DEAE

Eluent: A) 20 mmol/L phosphate buffer, pH 5.5, 5 mol/L urea
B) buffer A + 1 mol/L KCl
0–100 % B in 200 min

Flow rate: 2 mL/min

Pressure: 110 bar

Temperature: ambient

Detection: UV, 260 nm

## Preparative separation of a crude RNA extract of viroid (PSTV) infected tomato plants

MN Appl. No. 107490

D. Riesner, BioEngineering 1 (1988) 42–48

Column: 125 x 6 mm NUCLEOGEN® 500-7 DEAE

Eluent: A) `250 mmol/L KCl, 20 mmol/L phosphate buffer, pH 6.6, 5 mol/L urea
B) 1 mol/L KCl, 20 mmol/L phosphate buffer, pH 6.6, 5 mol/L urea
0–50 % B in 120 min, 50–100 % B in 250 min

Flow rate: 3 mL/min

Pressure: 40 bar, ambient temperature

Detection: 260 nm

## Ordering information

Eluent in column methanol

| ID | Length → 125 mm | Guard columns* |
|---|---|---|
| **NUCLEOGEN® 60-7 DEAE** particle size 7 µm, pore size 60 Å | | |
| Analytical EC columns | | |
| 4 mm | 736596.40 | 736400.40 |
| Preparative VarioPrep columns | | |
| 10 mm | 736597.100 | 736400.40 |
| **NUCLEOGEN® 500-7 DEAE** particle size 7 µm, pore size 500 Å | | |
| Analytical Valco type columns | | |
| 6 mm | 736598 | 736400.40 |
| Preparative VarioPrep columns | | |
| 10 mm | 736599.100 | 736400.40 |
| **NUCLEOGEN® 4000-7 DEAE** particle size 7 µm, pore size 4000 Å | | |
| Analytical Valco type columns | | |
| 6 mm | 736601 | 736400.40 |
| Preparative VarioPrep columns | | |
| 10 mm | 736602.100 | 736400.40 |

* NUCLEOGEN® guard columns are 30 mm long and require the CC column holder 30 mm (REF 721823).
Columns in packs of 1, guard columns in packs of 2.

# HPLC columns for biochemical separations

## NUCLEOGEL® SAX anion exchange of biological macromolecules · USP L23

### Technical data

- Polymer-based strongly basic anion exchanger $-N^+(CH_3)_3$, gel matrix quaternized PEI; particle size 8 µm, pore size 1000 Å
- pH working range 1–13, max. working pressure 200 bar

### Recommended application

- Purification of peptides, large proteins and oligonucleotides, high capacity for proteins even at pH 10

## NUCLEOGEL® SCX cation exchange of biological macromolecules · USP L22

### Technical data

- Polymer-based strongly acidic cation exchanger $-SO_3^-$, hydrophilic gel matrix; particle size 8 µm, pore size 1000 Å
- pH working range 1–13, max. working pressure 200 bar

### Recommended application

- Proteins, peptides and carbohydrates with high isoelectric point

**Separation of hen's egg white**

MN Appl. No. 115200

| | |
|---|---|
| Sample: | frozen egg white was thawed, filtered and diluted 1:8 with eluent A |
| Column: | 50 x 4.6 mm NUCLEOGEL® SAX 1000-8 |
| Eluent: | A) 0.01 mol/L Tris-HCl, pH 7.5; B) A + 0.5 mol/L NaAc, pH 7.5; 0–100 % B in 20 min |
| Flow rate: | 1 mL/min |
| Inj.volumen: | 50 µL |
| Detection: | UV, 280 nm |

Peaks:
1. Conalbumin
2. Ovalbumin
3. not identified

**Separation of protein standards**

MN Appl. No. 108261

| | |
|---|---|
| Column: | 50 x 4.6 mm NUCLEOGEL® SCX 1000-8 |
| Eluent: | A) 0.02 mol/L $KH_2PO_4$, pH 6.0<br>B) A + 0,5 mol/L NaCl, pH 6.0<br>0–100 % B in 20 min |
| Flow rate: | 1 mL/min |
| Detection: | UV, 280 nm |

Peaks:
1. Myoglobin
2. α-Chymotrypsinogen A
3. Cytochrome C
4. Lysozyme

## Ordering information

Eluent in column 0.1 mol/L $Na_2SO_4$ + 0.2 % $NaN_3$

| ID | Length → 50 mm | Guard columns* |
|---|---|---|
| **NUCLEOGEL® SAX pore size 1000 Å** | | |
| Analytical Valco type columns | | |
| 4.6 mm | 719469 | 719600 |
| **NUCLEOGEL® SCX pore size 1000 Å** | | |
| Analytical Valco type columns | | |
| 4.6 mm | 719475 | 719540 |

* NUCLEOGEL® SAX and SCX Valco type guard columns measure 5 x 3 mm and require the guard column holder B, REF 719539 (see page 250)
Columns in packs of 1, guard columns in packs of 2.

## NUCLEODUR® 300 $C_{18}$ ec · $C_4$ ec wide pore silica for biochromatography · USP L1 ($C_{18}$) · USP L26 ($C_4$)

### Key feature

- Reliable wide pore RP phases for daily routine analysis
- Medium density octadecyl or butyl modification with exhaustive endcapping
- Ideal phases for separation of biomolecules

### Technical data

- Pore size 300 Å; particle size 5 µm, carbon content 4 % for $C_{18}$, 2.5 % for $C_4$; pH stability 1–9; high reproducibility from lot to lot

### Recommended application

- Biological macromolecules like proteins or peptides

Column selection by analyte characteristics

Tanaka plots of NUCLEODUR® wide pore phases

### Batch-to-batch reproducibility of NUCLEODUR® 300-5 $C_4$ ec and NUCLEODUR® 300-5 $C_{18}$ ec

MN Appl. Nos. 126551 / 126552

| | |
|---|---|
| Columns: | 250 x 4 mm |
| Eluent: | A) 0.1 % TFA in water |
| | B) 0.08 % TFA in acetonitrilel |
| | 20–60 % B in 15 min |
| Flow rate: | 1 mL/min |
| Temperature: | 25 °C |
| Detection: | UV, 280 nm |

Peaks:
1. Ribonuclease A
2. Cytochrome C
3. Lysozyme
4. BSA
5. β-Lactoglobulin
6. β-Lactoglobulin 2

# HPLC columns for biochemical separations

Comparison of narrow and wide pore NUCLEODUR®
for the separation of proteins

MN Appl. No. 126590

Columns: 250 x 4,6 mm NUCLEODUR® 300-5 $C_{18}$ ec
250 x 4,6 mm NUCLEODUR® $C_{18}$ Gravity, 5 µm

Eluent: A) 0.1 % TFA in water
B) 0.08 % TFA in acetonitrile
20–65 % B in 15 min
(3 min 65 % B)

Flow rate: 1.3 mL/min

Temperature: 25 °C

Detection: UV, 280 nm

Peaks:
1. Ribonuclease A
2. Cytochrome C
3. Lysozyme
4. BSA
5. β-Lactoglobulin
6. β-Lactoglobulin 2

Sharper peaks of larger molecules on wide pore material

Tryptic digest of cytochrome C

MN Appl. No. 126600

Columns: 250 x 4.6 mm NUCLEODUR® 300-5 $C_{18}$ ec
250 x 4.6 mm Jupiter® $C_{18}$, 5 µm

Eluent: A) 0.1 % TFA in water
B) 0.08 % TFA in acetonitrile
5–40 % B in 15 min (1 min 40 % B)

Flow rate: 1.3 mL/min

Temperature: 30 °C

Detection: UV, 280 nm

Less tailing and better separation on NUCLEODUR® 300 $C_{18}$ ec

## Ordering information

Eluent in column acetonitrile – water

| | ID | Length → 100 mm | 125 mm | 150 mm | 250 mm | EC guard columns* |
|---|---|---|---|---|---|---|
| **NUCLEODUR® 300-5 $C_{18}$ ec** octadecyl phase, particle size 5 µm, pore size 300 Å, endcapped, 4 % C | | | | | | |
| Analytical EC columns | | | | | | |
| | 2 mm | 760183.20 | 760184.20 | 760185.20 | 760186.20 | 761988.20 |
| | 3 mm | 760183.30 | 760184.30 | 760185.30 | 760186.30 | 761988.30 |
| | 4 mm | 760183.40 | 760184.40 | 760185.40 | 760186.40 | 761988.30 |
| | 4.6 mm | 760183.46 | 760184.46 | 760185.46 | 760186.46 | 761988.30 |
| **NUCLEODUR® 300-5 $C_4$ ec** butyl phase, particle size 5 µm, pore size 300 Å, endcapped, 2.5 % C | | | | | | |
| Analytical EC columns | | | | | | |
| | 2 mm | 760193.20 | 760194.20 | 760195.20 | 760196.20 | 761989.20 |
| | 3 mm | 760193.30 | 760194.30 | 760195.30 | 760196.30 | 761989.30 |
| | 4 mm | 760193.40 | 760194.40 | 760195.40 | 760196.40 | 761989.30 |
| | 4.6 mm | 760193.46 | 760194.46 | 760195.46 | 760196.46 | 761989.30 |

* EC guard columns require the Column Protection System guard column holder (REF 718966, see page 251).
EC columns in packs of 1, guard columns in packs of 3.

## NUCLEOSIL® MPN RP chromatography of biological macromolecules

### NUCLEOSIL® 100-5 $C_{18}$ MPN · USP L1

**Key feature**

- Octadecyl phase, particle size 5 µm; pore size 100 Å
- Dynamic protein binding capacity per g packing: 6 mg BSA, 110 mg cytochrome C
- pH working range 2–8, max. working pressure 250 bar

**Technical data**

- Silica-based reversed phase materials with monomerically bonded alkyl chains, brush type structure predominantly hydrophobic forces with a small portion of hydrophilic interactions
- Maximum separation efficiency can be achieved when the injected protein mass does not exceed 1–2 % of the maximum protein loading capacity.

### NUCLEOSIL® 300-5 $C_4$ MPN · USP L26

**Key feature**

- Butyl phase, particle size 5 µm, pore size 300 Å
- Dynamic protein binding capacity per g packing: 14 mg BSA, 27 mg cytochrome C especially suited for the purification of larger, hydrophobic peptides and very different proteins
- pH working range 2–8, max. working pressure 250 bar

**Technical data**

- Silica-based reversed phase materials with monomerically bonded alkyl chains, brush type structure predominantly hydrophobic forces with a small portion of hydrophilic interactions
- Maximum separation efficiency can be achieved when the injected protein mass does not exceed 1–2 % of the maximum protein loading capacity.

Separation of haemoglobin chains

MN Appl. No. 108240

Column: 250 x 4 mm NUCLEOSIL® 300-5 $C_4$ MPN
Eluent: A) 20 % acetonitrile, 80 % water, 0.1 % TFA
B) 60 % acetonitrile, 40 % water, 0.1 % TFA
40–60 % B in 60 min
Flow rate: 1 mL/min
Detection: UV, 220 nm

Peaks:
1. Hem
2. β-globin
3. α-globin
4. $^{A}\gamma^{T}$-globin
5. $^{G}\gamma$-globin
6. $^{A}\gamma^{I}$-globin

## Ordering information

Eluent in column methanol

| | ID | Length → 250 mm | EC guard columns* |
|---|---|---|---|
| **NUCLEOSIL® 100-5 $C_{18}$ MPN** | | | |
| Analytical EC columns | | | |
| | 4 mm | 720231.40 | |
| **NUCLEOSIL® 300-5 $C_4$ MPN** | | | |
| Analytical EC columns | | | |
| | 4 mm | 720245.40 | 721119.30 |

* EC guard columns require the Column Protection System guard column holder (REF 718966, see page 251). Columns in packs of 1, guard columns in packs of 2.

## NUCLEOSIL® PPN RP chromatography of biological macromolecules

### NUCLEOSIL® 100-5 $C_{18}$ PPN · USP L1

**Key feature**

- Octadecyl phase, particle size 5 µm, pore size 100 Å, dynamic protein binding capacity per g packing: 8 mg BSA, 64 mg cytochrome C; suited for the separation of peptides and proteins up to about 40 kD, also suited for basic peptides

**Technical data**

- Silica-based reversed phase materials with polymerically bonded alkyl chains; exclusively hydrophobic interactions
- pH working range 1–9, max. working pressure 250 bar

### NUCLEOSIL® 500-5 $C_{18}$ PPN · USP L1

**Key feature**

- Octadecyl phase, particle size 5 µm, pore size 500 Å, dynamic protein binding capacity per g packing: 22 mg BSA, 40 mg cytochrome C; especially suited for large peptides and medium-size hydrophilic proteins

**Technical data**

- Silica-based reversed phase materials with polymerically bonded alkyl chains; exclusively hydrophobic interactions
- pH working range 1–9, max. working pressure 250 bar

**Separation of a protein standard**

MN Appl. No. 108220

Column: 125 x 4 mm NUCLEOSIL® 100-5 $C_{18}$ PPN
Eluent: A) 0.1 % TFA in $H_2O$
B) 0.08 % TFA in $CH_3CN$
20–60 % B in 10 min
Flow rate: 1.0 mL/min
Detection: UV, 280 nm

Peaks:
1. Ribonuclease
2. Cytochrome C
3. Lysozyme
4. β-Lactoglobulin
5. Ovalbumin

**Separation of pancreatic secretion of piglets**

MN Appl. No. 108280

Column: 125 x 4 mm NUCLEOSIL® 500-5 $C_{18}$ PPN
Eluent: A) 0.1 % TFA in $H_2O$
B) 0.08 % TFA in $CH_3CN$
30–50 % B in 14 min, then 50–65 % B in 6 min
Flow rate: 1 mL/min
Detection: UV, 215 nm

Peaks:
1. Trypsin + trypsinogen
2. Proelastase
3. Lipase + α-Chymotrypsin
4. Chymotrypsinogen
5. α-Amylase
6., 7. Procarboxypeptidase

## Ordering information

Eluent in column methanol

| ID | Length → 250 mm | EC guard columns* |
|---|---|---|
| **NUCLEOSIL® 100-5 $C_{18}$ PPN** particle size 5 µm, pore size 100 Å | | |
| Analytical EC columns | | |
| 4 mm | 720252.40 | 721567.30 |
| **NUCLEOSIL® 500-5 $C_{18}$ PPN** particle size 5 µm, pore size 500 Å | | |
| Analytical EC columns | | |
| 4 mm | 720258.40 | 721924.30 |

* EC guard columns require the Column Protection System guard column holder (REF 718966, see page 251).
Columns in packs of 1, guard columns in packs of 2.

## NUCLEOGEL® RP columns RP columns for biochemical applications · USP L21

### Technical data

- Polystyrene resin cross-linked with divinylbenzene, available particle sizes 5 µm and 8 µm, available pore sizes 100 Å and 300 Å
- pH working range 1–13, max. working pressure 180 bar
- Small pore columns for reversed phase separation of small molecules such as pharmaceuticals with basic properties, e.g., organic heterocycles; also suited for separation of nucleosides and nucleotides up to 5000 Da; allow gradient as well as isocratic elution
- Wide pore columns are especially recommended for large biomolecules higher background hydrophobicity compared to silica phases

Analysis of the synthetic acyl carrier protein ACP(65-74)

MN Appl. No. 108500

| | |
|---|---|
| Column: | 150 x 4.6 mm NUCLEOGEL® RP 100-8 |
| Eluant: | A) 0.1 % TFA in acetonitrile – water (1:99, v/v) |
| | B) 0.1 % TFA in acetonitrile – water (99:1, v/v) |
| | 10–60 % B in 20 min |
| Flow rate: | 1 mL/min |
| Detection: | UV, 220 nm |

Peaks:
1. ACP(66-74)(H-Gln)
2. ACP(65-74)
3. ACP(66-74)(Glp)
4. Thioanisole

### Ordering information

Eluent in column acetonitrile – water

| ID | Length → 50 mm | 150 mm | 250 mm | Guard columns* |
|---|---|---|---|---|
| **NUCLEOGEL® RP 100-5** particle size 5 µm, pore size 100 Å | | | | |
| Analytical Valco type columns | | | | |
| 4.6 mm | | 719454 | 719455 | 719542 |
| **NUCLEOGEL® RP 100-8** particle size 8 µm, pore size 100 Å | | | | |
| Analytical Valco type columns | | | | |
| 4.6 mm | | 719456 | 719520 | 719542 |
| **NUCLEOGEL® RP 300-5** particle size 5 µm, pore size 300 Å | | | | |
| Analytical Valco type columns | | | | |
| 4.6 mm | 719459 | | | 719542 |
| **NUCLEOGEL® RP 300-8** particle size 8 µm, pore size 300 Å | | | | |
| Analytical Valco type columns | | | | |
| 4.6 mm | 719460 | | | 719542 |

* Valco type guard columns measure 5 x 3 mm and require Guard column holder B, REF 719539, see page 250.
Columns in packs of 1, guard columns in packs of 2.

# HPLC columns for sugar analyses

## NUCLEOSIL® Carbohydrate separation of mono- and disaccharides · USP L8

### Technical data

- Matrix: NUCLEOSIL® silica with amino modification, particle size 10 µm

### Recommended application

- RP separation of mono- and disaccharides

Separation of sugars

MN Appl. No. 102480

| | |
|---|---|
| Column: | 250 x 4 mm NUCLEOSIL® Carbohydrate |
| Eluent: | acetonitrile – water (79:21, v/v) |
| Flow rate: | 2 mL/min |
| Temperature: | 25 °C |
| Detection: | RI |
| Injection: | 10 µL |

Peaks:
1. Fructose
2. Glucose
3. Saccharose
4. Maltose
5. Lactose

## Ordering information

Eluent in column acetonitrile – water (79:21, v/v)

| ID | Length → 250 mm | EC guard columns* |
|---|---|---|
| **NUCLEOSIL® Carbohydrate** | | |
| Analytical EC columns | | |
| 4 mm | 720905.40 | 721170.30 |

* EC 4/3 guard columns for EC columns with 4 mm ID require the Column Protection System guard column holder (REF 718966, see page 251). Columns and guard columns in packs of 1.

## NUCLEOGEL® SUGAR 810 separation of sugars · USP L17 (H-Form) · USP L19 (Ca form)

### Technical data

- Sulfonated polystyrene - divinylbenzene resins in different ionic forms; due to a different selectivity pattern compared to NUCLEOGEL® SUGAR columns, the range of application is considerably enlarged
- Separation mechanism: ion exclusion, ion exchange, size exclusion, ligand exchange, NP and RP chromatography

### Recommended application

- $H^+$ form:
  Separation of sugars, sugar alcohols and organic acids; eluent in column 5 mmol/L $H_2SO_4$
- $Ca^{2+}$ form:
  Separation of mono-, di- and oligosaccharides; eluent in column water

Organic acids and alcohols

MN Appl. No. 113870

| | |
|---|---|
| Column: | 300 x 7.8 mm NUCLEOGEL® SUGAR 810 H |
| Eluent: | 5 mmol/L $H_2SO_4$ |
| Flow rate: | 0.6 mL/min |
| Temperature: | 35 °C |
| Detection: | RI |
| Injection: | 5 µL |

Sugars and sugar alcohols

MN Appl. No. 114160

| | |
|---|---|
| Column: | 300 x 7.8 mm NUCLEOGEL® SUGAR 810 Ca |
| Eluent: | water |
| Flow rate: | 0.6 mL/min |
| Temperature: | 85 °C |
| Detection: | RI |

### Ordering information

| ID | Length → 300 mm | Guard columns* |
|---|---|---|
| **NUCLEOGEL® SUGAR 810 H** eluent in column 5 mmol/L $H_2SO_4$ | | |
| Analytical Valco type columns | | |
| 7.8 mm | 719574 | 719575 |
| **NUCLEOGEL® SUGAR 810 Ca** eluent in column water | | |
| Analytical Valco type columns | | |
| 7.8 mm | 719570 | 719571 |

* NUCLEOGEL® SUGAR 810 guard columns measure 30 x 4 mm and require the CC column holder 30 mm (REF 721823)
Columns in packs of 1, guard columns in packs of 2.

# HPLC columns for sugar analyses

## NUCLEOGEL® ION 300 OA / SUGAR

separation of sugars · USP L17 (H form) · USP L19 (Ca form) · USP L34 (Pb form) · USP L58 (Na form)

### Technical data

- Sulfonated spherical PS/DVB resins in different ionic forms; mean particle size 10 µm, pore size 100 Å
- Separation mechanism includes steric exclusion, ligand exchange and partition effects, ligand exchange being the predominant force, since the hydrated metal ions form strong interactions with the hydroxyl groups of the sample molecules. The intensity of these interactions decreases in the sequence Pb > Ca > Na
- Recommended operating temperatures: 60–95 °C; maximum pressure 70 bar

### Recommended application

NUCLEOGEL® ION 300 OA:
$H^+$ form for separation of sugars, alcohols and organic acids

NUCLEOGEL® SUGAR:
$Ca^{2+}$ form: separation of mono- and oligosaccharides, sugar alcohols

$Pb^{2+}$ form: separation of mono- and disaccharides from food and biological samples

$Na^+$ form: separation of oligosaccharides from starch hydrolysates and food

Separation of carbohydrates

MN Appl. No. 102430

| | |
|---|---|
| Column: | 300 x 7.8 mm NUCLEOGEL® SUGAR Pb |
| Eluent: | deionized water |
| Flow rate: | 0.4 mL/min |
| Temperature: | 80 °C |
| Detection: | RI |

Peaks:
1. Sucrose
2. Maltose
3. Glucose
4. Xylose
5. Galactose
6. Arabinose
7. Mannose

### Ordering information

| ID | Length → 300 mm | Guard columns* |
|---|---|---|
| **NUCLEOGEL® ION 300 OA** eluent in column 5 mmol/L $H_2SO_4$ 5 mmol/L $H_2SO_4$ | | |
| Analytical Valco type columns | | |
| 7.8 mm | 719501 | 719537 |
| **NUCLEOGEL® SUGAR Ca** eluent in column water + 0.02 % azide | | |
| Analytical Valco type columns | | |
| 6.5 mm | 719531 | 719535 |
| **NUCLEOGEL® SUGAR Pb** eluent in column water + 0.02 % azide | | |
| Analytical Valco type columns | | |
| 7.8 mm | 719530 | 719534 |
| **NUCLEOGEL® SUGAR Na** eluent in column water + 0.02 % azide | | |
| Analytical Valco type columns | | |
| 7.8 mm | 719532 | 719536 |

* Valco Type guard columns measure 21 x 4 mm and require the guard column holder C, REF 719538, see page 250.
Columns in packs of 1, guard columns in packs of 2.

## NUCLEOGEL® GPC for GPC of water-insoluble substances

### Technical data

- Highly crosslinked macroporous, spherical polystyrene – divinylbenzene polymer matrix with good mechanical stability

### Chromatogram of styrene oligomers

### Working ranges for polystyrene

### Ordering information

Eluent in column toluene

| Phase | Exclusion limit [kDalton] | Application | Column 300 x 7.7 mm |
|---|---|---|---|
| **5 µm particle size** | | | |
| Analytical Valco type columns | | | |
| NUCLEOGEL GPC 50 | 2 | low molecular weight organics | 719402 |
| NUCLEOGEL GPC 100 | 4 | oligomers, oils | 719403 |
| NUCLEOGEL GPC 500 | 25 | low molecular weight polymers | 719404 |
| NUCLEOGEL GPC 103 | 60 | low molecular weight polymers | 719405 |
| NUCLEOGEL GPC 104 | 500 | polymers up to 500 kDa | 719406 |
| | | guard columns 50 x 7.7 mm | 719409 |
| **10 µm particle size** | | | |
| Analytical Valco type columns | | | |
| NUCLEOGEL GPC 50 | 2 | low molecular weight organics | 719410 |
| NUCLEOGEL GPC 100 | 4 | oligomers, oils | 719411 |
| NUCLEOGEL GPC 500 | 25 | low molecular weight polymers | 719412 |
| NUCLEOGEL GPC 103 | 60 | low molecular weight polymers | 719413 |
| NUCLEOGEL GPC 104 | 500 | polymers up to 500 kDa | 719414 |
| | | guard columns 50 x 7.7 mm | 719418 |

Columns and guard columns in packs of 1.

## EC standard columns for analytical HPLC / UHPLC

- Analytical column system manufactured from stainless steel M8 outer threads on both ends combination of sealing element and very fine-meshed stainless steel screen, PTFE ring and fitting adaptor column heads SW 12, with inner threads M8 x 0.75 and UNF 10-32 (= 1/16“ connection)
- EC column hardware guarantees pressure stability of 1200 bar - hereby EC columns are suitable for UHPLC applications (ultra fast HPLC) and all modern HPLC systems.
- As screw-on guard column system we recommend the Column Protection System used with EC guard column cartridges with 4 mm length.
- EC guard columns supplied with NUCLEODUR®, NUCLEOSIL® spherical silicas and NUCLEOSHELL® spherical core shell silica particles

### Available standard dimensions of EC columns

| ID | Length → 20 mm | 30 mm | 50 mm | 75 mm | 100 mm | 125 mm | 150 mm | 200 mm | 250 mm | 300 mm |
|---|---|---|---|---|---|---|---|---|---|---|
| 2 mm | + | + | + | + | + | + | + | + | + | + |
| 3 mm | + | + | + | + | + | + | + | + | + | + |
| 4 mm | + | + | + | + | + | + | + | + | + | + |
| 4.6 mm | + | + | + | + | + | + | + | + | + | + |

Please ask for availability of certain phases.

Note: NUCLEODUR® and NUCLEOSHELL® column head must not be removed!

### Guard columns for EC columns

| EC column with ID | EC guard column* |
|---|---|
| 2 mm | 4/2 |
| 3 mm | 4/3 |
| 3 mm | 4/3 |
| 3 mm | 4/3 |

Packs of 3 cartridges

* Information about the Column Protection System on page 251.

For preparative applications MN offers the so-called VarioPrep® hardware system, which is described from page 252 on.

## Valco type columns

- Analytical column system manufactured from stainless steel
- Available inner diameters: 4.6 mm ID (1/4“ OD) and 7.7 mm (3/8“ OD)
- Mainly used for NUCLEOGEN® and NUCLEOGEL® (see page 226)

### Ordering information

| Description | Pack of | REF |
|---|---|---|
| **Accessories for Valco type columns** | | |
| Guard column holder B for VA columns 5 x 3 mm | 1 | 719539 |
| Guard column holder C for VA guard columns 21 x 4 mm | 1 | 719538 |

## Column Protection System

### Innovative and universal guard column holder system

- Suitable for all analytical HPLC columns with 1/16” fittings
- Cartridges filled with special NUCLEODUR®, NUCLEOSIL® and NUCLEOSHELL® HPLC adsorbents
- Ideal protection for your analytical main column → significant increase in column lifetime
- Minimized dead volume → suitable also for ultra-fast HPLC
- Special ferrules → pressure stability up to 1300 bar (18 850 psi)
- Visual contamination check → in-time changing of the guard column
- Suitable guard columns with 4 mm length, 2 mm ID (for main columns with 2 mm ID); 3 mm ID (for main columns with 3, 4 and 4.6 mm), respectively
- UNIVERSAL RP guard columns suitable for all HPLC columns under RP conditions

### Content of the Column Protection System

| Description | Pack of | REF |
|---|---|---|
| Guard column holder | 1 | 718966 |
| Capillaries (0.12 mm ID) | 2 | |
| Ferrules | 3 | |
| Wrenches | 2 | |
| Manual | 1 | |

### Ordering information

| Description | Pack of | REF |
|---|---|---|
| **Replacement parts for the Column Protection System** | | |
| Special ferrules made of PEEK | 5 | 718967 |
| Replacement connector including O-ring | 1 | 718968 |
| Stainless steel capillaries 0.12 mm ID, nuts and metal ferrules | 3 | 718969 |
| Stainless steel capillaries 0.18 mm ID (for higher flow rates), nuts and metal ferrules | 3 | 718971 |
| Wrench (size 12 and 14 mm) | 1 | 718970 |
| EC 4/2 UNIVERSAL RP guard column (for main columns with 2 mm ID) | 3 | 728777.20 |
| EC 4/2 UNIVERSAL RP guard column (for main columns with 2 mm ID), value pack | 9 | 728778.20 |
| EC 4/3 UNIVERSAL RP guard column (for main columns with 3, 4 and 4.6 mm ID) | 3 | 728777.30 |
| EC 4/3 UNIVERSAL RP guard column (for main columns with 3, 4 and 4.6 mm ID), value pack | 9 | 728778.30 |

### Visual contamination check

The cartridge is fitted with a special filter membrane:

- If this silver membrane is contaminated (bright or dark discoloration), it is advisable to replace the cartridge.
- If the contaminants are colorless, replace the cartridge if the pressure rises or the chromatographic performance decreases.

## VarioPrep (VP) columns for preparative HPLC

- Column system for preparative HPLC, manufactured from stainless steel with two adjustable end fittings, suitable for frequent use of back-flushing techniques
- Allows compensation of a dead volume, which could occur at the column inlet after some time of operation, without need for opening the column
- Can be packed with all NUCLEODUR® and NUCLEOSIL® spherical silicas

### Available standard dimensions of VarioPrep columns with axially adjustable end fittings

| End fitting design | ID | Length → 10* mm | 15* mm | Length → 50 mm | 75 mm | 100 mm | 125 mm | 150 mm | 250 mm | 500 mm |
|---|---|---|---|---|---|---|---|---|---|---|
| | 8 | + | | + | | + | + | + | + | |
| | 10 | | | + | | + | + | + | + | |
| | 16 | + | | + | | + | + | + | + | |
| | 21 | | | + | + | + | + | + | + | |
| | 32 | | + | | | + | | + | + | |
| | 40 | | | + | | + | + | + | + | + |
| | 50 | | + | | | + | | + | + | |
| | 80 | | | | | | | | + | + |

* 10 x 8, 10 x 16, 15 x 32 and 15 x 50 mm ID columns are used as guard columns and require the respective holders, see page 253.

### The VarioPrep principle

1

2

3

Readjustment of fitting

4

VarioPrep columns are produced with highest packing quality and bed density (1). Due to intensive chemical and/or mechanical exposure of the column adsorbent, shrinking of the column bed can occur (2; orange gap). in this even unlikely case readjustment of the VarioPrep column fitting (3; turning the nut at the column inlet clockwise) will eliminate the emerged dead volume (4). The performance of the VarioPrep column is completely reconstituted and column lifetime is significantly extended.

### Column reconstitution

### Reconstitution of VarioPrep column performance

- Slight peak broadening and deformation after 800 injections under strongly demanding conditions (pH 11; 50 °C; sample in DMSO)
- Readjustment of the column fitting restores column performance and prolongs column lifetime noticeably.

## The improved guard column system for (semi-) preparative HPLC

① VP 15/32 for 32 and 40 mm ID columns
② VP 10/16 for 16 and 21 mm ID columns
③ VP 10/8 for 8 and 10 mm ID columns
④ VP 15/50 for ≥ 50 mm ID columns

- Easy handling and cartridge exchange
- Robust hardware
- Free rotary plunger fittings – low O-ring abrasion
- Cost-efficient cartridges
- Minimally invasive / no disturbance of the separation efficiency of main column
- Low back pressure
- Designed for pressures up to 400 bar

### Column performance without and with guard column

Columns: 125 x 16 mm NUCLEODUR® $C_{18}$ HTec, 5 µm
125 x 16 mm NUCLEODUR® $C_{18}$ HTec, 5 µm + 10 x 16 mm NUCLEODUR® $C_{18}$ HTec guard column
Eluent: acetonitrile – water (80:20, v/v)
Flow rate: 16 mL/min
Temperature: 22 °C

Peaks:
1. Phenol
2. Naphthalene
3. Anthracene

Using VarioPrep guard columns provides ideal protection of your main column – symmetry, pressure and retention stay almost constant.

## Technical data

· 1/16“ thread · free rotary plunger fittings – low O-ring abrasion · stainless steel

| Guard cartridge | Holder REF | Holder ID | Recommended for column ID | Preferred capillary ID | Typical flow rate |
|---|---|---|---|---|---|
| VP 10/8 | 718251 | 8 mm | 8 and 10 mm ID | 0.17 and 0.25 mm | 1–12 mL/min |
| VP 10/16 | 718256 | 16 mm | 16 and 21 mm ID | 0.17, 0.25 and 0.5 mm | 2–32 mL/min |
| VP 15/32 | 718253 | 32 mm | 32 and 40 mm ID | 0.25, 0.5 and 1.0 mm | 5–150 mL/min |
| VP 15/50 | 718255 | 50 mm | ≥ 50 mm ID | 0.5 and 1.0 mm | 20–250 mL/min |

## Ordering information

### Guard column holders for VarioPrep columns

| | VP Guard columns for VarioPrep columns with ID → | | | | Pack of | Replacement O-ring | Holder | |
|---|---|---|---|---|---|---|---|---|
| | 8, 10 mm | 16, 21 mm | 32, 40 mm | ≥ 50 mm | guard columns | (pack of 2) | ID | REF |
| VP | 10/8 | | | | 2 | 718975 | 8 mm | 718251 |
| VP | | 10/16 | | | 2 | 718976 | 16 mm | 718256 |
| VP | | | 15/32 | | 1 | 718977 | 32 mm | 718253 |
| VP | | | | 15/50 | 1 | 718978 | 50 mm | 718255 |

For REF numbers of individual VP guard column cartridges see respective NUCLEODUR® and NUCLEOSIL® phases.

## Accessories for stainless steel HPLC columns

- Stainless steel columns are most frequently used in HPLC.
- The material is corrosion resistant, pressure stable and easy to work mechanically.

### Ordering information

| Description | Pack of | REF |
|---|---|---|
| **Capillary accessories** | | |
| 1/16“ column end caps (plastic) | 4 | 718582 |
| 1/16“ nut for connecting 1/16“ capillaries | 5 | 718583 |
| 1/16“ ferrule | 5 | 718584 |
| **Capillary unions** | | |
| Typ 1: 100 mm x 1/16“ x 0.25 mm | 1 | 718637 |
| Typ 2: 100 mm x 1/16“ x 0.12 mm | 1 | 719489 |
| Cutter for 1/16“ capillary tubing | 1 | 706290 |

For accessories and replacement parts for EC columns see page 251, for accessories and replacement parts for VarioPrep columns see page 253.

SPE accessories for sample preparation, like e.g., CHROMABOND® vacuum manifolds can be found on page 65.

## PEEK accessories

- PEEK (= polyether ether ketone) is a high performance polymer belonging to the group of polyarylether ketones (PAEK), which meets all requirements of HPLC columns with respect to chemical resistance and mechanical stability. In some fields of application in HPLC like, e.g., in ion chromatography and chromatography of biopolymers, PEEK fulfils the requirements for a nonmetallic material.
- All fittings can be tightened by hand.

### Ordering information

| Description | Pack of | REF |
|---|---|---|
| **PEEK fittings** | | |
| 1/16“ PEEK fingertight fitting, 1-part combination nut + ferrule | 1 | 718770 |
| 1/16“ PEEK fingertight Nut | 1 | 718771 |
| 1/16“ PEEK ferrule for REF 718771 | 1 | 718772 |
| 1/16“ PEEK double ferrule | 1 | 718775 |

| | | |
|---|---|---|
| 1/16“ PEEK union, both sides inner threads, equipped with 2 fingertight nuts and double ferrules | 1 | 718766 |

| | | |
|---|---|---|
| 1/16“ PEEK union, both sides inner threads, however without nuts and without ferrules | 1 | 718767 |

| | | |
|---|---|---|
| 1/16“ PEEK union, both sides outer threads | 1 | 718768 |

| AD | ID [mm] | Length | Pack of | REF |
|---|---|---|---|---|
| **PEEK standard capillaries** | | | | |
| 1/16“ | 0.13 | 1 m | 1 | 718765 |
| 1/16“ | 0.17 | 1 m | 1 | 718760 |
| 1/16“ | 0.25 | 1 m | 1 | 718761 |
| 1/16“ | 0.5 | 1 m | 1 | 718762 |
| 1/16“ | 0.75 | 1 m | 1 | 718763 |

| Description | Pack of | REF |
|---|---|---|
| **Tools for PEEK capillaries** | | |
| Guillotine cutter for PEEK and PTFE capillaries | 1 | 718769 |

| | | |
|---|---|---|
| Clean-Cut cutter for different capillary outer diameters | 1 | 718755 |

# NUCLEODUR® high purity silica for HPLC

## Basics of preparative HPLC

In principal for preparative HPLC the same rules apply than for analytic HPLC. However both differ significantly in their aim. The aim of analytic HPLC is a preferably complete separation of the single components of a mixture with subsequent peak identification. In contrast the goal of preparative HPLC is isolation of the desired product in defined purity, maximum amount while having a cost effective method of operating.

### Demand of a preparative separation

- Throughput
- Purity
- Yield

### Upscaling table for current MN column dimensions

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ID x Length [mm] | 4 x 250 | 8 x 250 | 10 x 250 | 16 x 250 | 21 x 250 | 32 x 250 | 40 x 250 | 50 x 250 | 80 x 250 |
| Linear scale-up factor | 1 | 4 | 6.25 | 16 | 27.6 | 64 | 100 | 156.3 | 400 |
| Typical amount of sample* [mg] | 0.02–2 | 0.08–8 | 0.13–13 | 0.3–35 | 0.6–60 | 1.3–130 | 2–210 | 3–350 | 10–850 |
| Typical flow rate [mL/min] | 0.5–1.5 | 2–6 | 3–9 | 8–24 | 14–40 | 32–96 | 50–150 | 80–250 | 200–600 |

* based on RP material; the herein stated maximum amounts of sample are dependent on the separation problem and the sample. In some cases half the maximum amount of sample can already lead to a drastic overload of the column, in other cases the maximum amount of sample still leads to an acceptable separation.

## NUCLEODUR® bulk packings

- Fully spherical high purity silica
- Pore size 110 Å; pore volume 0.9 mL/g; surface (BET) 340 $m^2/g$; density 0.47 g/mL; pressure stable up to 600 bar
- Bigger particles for preparative application

### Ordering information

| Phase | Endcapped | Carbon content | Particle size | Pack of 100 g | Pack of 1000 g |
|---|---|---|---|---|---|
| **NUCLEODUR® $C_{18}$ HTec premium octadecyl phase (see page 178)** | | | | | |
| NUCLEODUR® $C_{18}$ HTec, 7 µm | yes | 18 % C | 7 µm | 713831.0100 | 713831.1 |
| NUCLEODUR® $C_{18}$ HTec, 10 µm | yes | 18 % C | 10 µm | 713832.0100 | 713832.1 |
| **NUCLEODUR® $C_{18}$ ec standard octadecyl phase (see page 181)** | | | | | |
| NUCLEODUR® 100-10 $C_{18}$ ec | yes | 17.5 % C | 10 µm | 713611.0100 | 713611.1 |
| NUCLEODUR® 100-12 $C_{18}$ ec | yes | 17.5 % C | 12 µm | 713618.0100 | 713618.1 |
| NUCLEODUR® 100-16 $C_{18}$ ec | yes | 17.5 % C | 16 µm | 713621.0100 | 713621.1 |
| NUCLEODUR® 100-20 $C_{18}$ ec | yes | 17.5 % C | 20 µm | 713601.0100 | 713601.1 |
| NUCLEODUR® 100-30 $C_{18}$ ec | yes | 17.5 % C | 30 µm | 713631.0100 | 713631.1 |
| NUCLEODUR® 100-50 $C_{18}$ ec | yes | 17.5 % C | 50 µm | 713550.0100 | 713550.1 |
| **Unmodifiziertes NUCLEODUR® SiOH silica (see page 190)** | | | | | |
| NUCLEODUR® 100-10 | | | 10 µm | 713610.0100 | 713610.1 |
| NUCLEODUR® 100-12 | | | 12 µm | 713615.0100 | 713615.1 |
| NUCLEODUR® 100-16 | | | 16 µm | 713620.0100 | 713620.1 |
| NUCLEODUR® 100-20 | | | 20 µm | 713600.0100 | 713600.1 |
| NUCLEODUR® 100-30 | | | 30 µm | 713630.0100 | 713630.1 |
| NUCLEODUR® 100-50 | | | 50 µm | 713551.0100 | 713551.1 |

## POLYGOSIL® bulk packings

- Irregular silica for analytical applications
- pH stability 2–8

### Physical properties of unmodified POLYGOSIL® materials

| Phase | Pore size | Pore volume | Surface (BET) | Density | Pressure stability |
|---|---|---|---|---|---|
| POLYGOSIL® 60 | 60 Å | 0.75 mL/g | 350 $m^2/g$ | 0.45 g/mL | 600 bar |
| POLYGOSIL® 100 | 100 Å | 1 mL/g | 280 $m^2/g$ | 0.35 g/mL | 400 bar |
| POLYGOSIL® 300 | 300 Å | 0.8 mL/g | 100 $m^2/g$ | 0.45 g/mL | 400 bar |
| POLYGOSIL® 1000 | 1000 Å | 0.8 mL/g | 25 $m^2/g$ | 0.45 g/mL | 300 bar |

Modification of POLYGOSIL® follows the same processes as for NUCLEOSIL® silica.

### Ordering information

| Phase | Endcapped | Carbon content | Pore size | Particle size | Pack of 10 g | Pack of 100 g |
|---|---|---|---|---|---|---|
| **Octadecyl phases** $-(CH_2)_{17}-CH_3$ | | | | | | |
| POLYGOSIL® 60-5 $C_{18}$ | yes | 12 % C | 60 Å | 5 µm | 711330.10 | 711330.100 |
| POLYGOSIL® 60-7 $C_{18}$ | yes | 12 % C | 60 Å | 7 µm | 711340.10 | 711340.100 |
| POLYGOSIL® 60-10 $C_{18}$ | yes | 12 % C | 60 Å | 10 µm | 711350.10 | 711350.100 |
| POLYGOSIL® 100-5 $C_{18}$ | yes | 14 % C | 100 Å | 5 µm | 711560.10 | 711560.100 |
| POLYGOSIL® 100-7 $C_{18}$ | yes | 14 % C | 100 Å | 7 µm | 711570.10 | 711570.100 |
| POLYGOSIL® 100-10 $C_{18}$ | yes | 14 % C | 100 Å | 10 µm | 711580.10 | 711580.100 |
| POLYGOSIL® 300-7 $C_{18}$ | yes | 4 % C | 300 Å | 7 µm | 711710.10 | 711710.100 |
| POLYGOSIL® 1000-7 $C_{18}$ | yes | ~ 1 % C | 1000 Å | 7 µm | 711992.10 | 711992.100 |
| **Octyl phases** $-(CH_2)_7-CH_3$ | | | | | | |
| POLYGOSIL® 60-5 $C_8$ | no | 7 % C | 60 Å | 5 µm | 711300.10 | 711300.100 |
| POLYGOSIL® 60-7 $C_8$ | no | 7 % C | 60 Å | 7 µm | 711310.10 | 711310.100 |
| POLYGOSIL® 60-10 $C_8$ | no | 7 % C | 60 Å | 10 µm | 711320.10 | 711320.100 |
| **Butyl phases** $-(CH_2)_3-CH_3$ | | | | | | |
| POLYGOSIL® 300-7 $C_4$ | yes | ~ 1 % C | 300 Å | 7 µm | 711680.10 | 711680.100 |
| POLYGOSIL® 1000-7 $C_4$ | yes | < 1 % C | 1000 Å | 7 µm | 711991.10 | 711991.100 |
| **Cyano phases (nitrile)** $-(CH_2)_3-CN$ | | | | | | |
| POLYGOSIL® 60-5 CN | | ~ 5 % C | 60 Å | 5 µm | 711380.10 | 711380.100 |
| POLYGOSIL® 60-10 CN | | ~ 5 % C | 60 Å | 10 µm | 711390.10 | 711390.100 |
| **Amino phases** $-(CH_2)_3-NH_2$ | | | | | | |
| POLYGOSIL® 60-5 $NH_2$ | | ~ 3 % C | 60 Å | 5 µm | 711360.10 | 711360.100 |
| POLYGOSIL® 60-10 $NH_2$ | | ~ 3 % C | 60 Å | 10 µm | 711370.10 | 711370.100 |
| **Dimethylamino phases** $-(CH_2)_3-N(CH_3)_2$ | | | | | | |
| POLYGOSIL® 60-5 $N(CH_3)_2$ | | ~ 3.5 % C | 60 Å | 5 µm | 711420.10 | 711420.100 |
| POLYGOSIL® 60-10 $N(CH_3)_2$ | | ~ 3.5 % C | 60 Å | 10 µm | 711430.10 | 711430.100 |
| **Unmodified silica** SiOH | | | | | | |
| POLYGOSIL® 60-5 | | | 60 Å | 5 µm | 711010.10 | 711010.100 |
| POLYGOSIL® 60-7 | | | 60 Å | 7 µm | 711280.10 | 711280.100 |
| POLYGOSIL® 60-10 | | | 60 Å | 10 µm | 711020.10 | 711020.100 |
| POLYGOSIL® 100-5 | | | 100 Å | 5 µm | 711510.10 | 711510.100 |
| POLYGOSIL® 100-7 | | | 100 Å | 7 µm | 711520.10 | 711520.100 |
| POLYGOSIL® 100-10 | | | 100 Å | 10 µm | 711530.10 | 711530.100 |
| POLYGOSIL® 300-7 | | | 300 Å | 7 µm | 711600.10 | 711600.100 |
| POLYGOSIL® 1000-7 | | | 1000 Å | 7 µm | 711890.10 | 711890.100 |

## POLYGOPREP bulk packings

- Irregular silica for preparative applications
- pH stability 2–8

### Physical properties of unmodified POLYGOPREP materials

| Phase | Pore size | Pore volume | Surface (BET) | Density | Pressure stability |
|---|---|---|---|---|---|
| POLYGOPREP 60 | 60 Å | 0.75 mL/g | 350 $m^2/g$ | 0.45 g/mL | 600 bar |
| POLYGOPREP 100 | 100 Å | 1 mL/g | 280 $m^2/g$ | 0.35 g/mL | 400 bar |
| POLYGOPREP 300 | 300 Å | 0.8 mL/g | 100 $m^2/g$ | 0.45 g/mL | 400 bar |
| POLYGOPREP 1000 | 1000 Å | 0.8 mL/g | 35 $m^2/g$ | 0.45 g/mL | 300 bar |

Modification of POLYGOPREP follows the same processes as for NUCLEOSIL® silica.

### Ordering information

| Phase | Endcapped | Carbon content | Pore size | Particle size | Pack of 100 g | Pack of 1 kg |
|---|---|---|---|---|---|---|
| **Octadecyl phases** $-(CH_2)_{17}-CH_3$ | | | | | | |
| POLYGOPREP 60-12 $C_{18}$ | no* | 12 % C | 60 Å | 10–15 µm | 711009.100 | 711009.1000 |
| POLYGOPREP 60-20 $C_{18}$ | no* | 12 % C | 60 Å | 15–25 µm | 711031.100 | 711031.1000 |
| POLYGOPREP 60-30 $C_{18}$ | no* | 12 % C | 60 Å | 25–40 µm | 711480.100 | 711480.1000 |
| POLYGOPREP 60-50 $C_{18}$ | no* | 12 % C | 60 Å | 40–63 µm | 711500.100 | 711500.1000 |
| POLYGOPREP 60-80 $C_{18}$ | no* | 12 % C | 60 Å | 63–100 µm | 711011.100 | 711011.1000 |
| POLYGOPREP 60-130 $C_{18}$ | no* | 12 % C | 60 Å | 63–200 µm | 711590.100 | 711590.1000 |
| POLYGOPREP 100-12 $C_{18}$ | no* | 14 % C | 100 Å | 10–15 µm | 711018.100 | 711018.1000 |
| POLYGOPREP 100-20 $C_{18}$ | no* | 14 % C | 100 Å | 15–25 µm | 711019.100 | 711019.1000 |
| POLYGOPREP 100-30 $C_{18}$ | no* | 14 % C | 100 Å | 25–40 µm | 711032.100 | 711032.1000 |
| POLYGOPREP 100-50 $C_{18}$ | no* | 14 % C | 100 Å | 40–63 µm | 711021.100 | 711021.1000 |
| POLYGOPREP 300-12 $C_{18}$ | yes | 4 % C | 300 Å | 10–15 µm | 711024.100 | 711024.1000 |
| POLYGOPREP 300-20 $C_{18}$ | yes | 4 % C | 300 Å | 15–25 µm | 711025.100 | 711025.1000 |
| POLYGOPREP 300-30 $C_{18}$ | yes | 4 % C | 300 Å | 25–40 µm | 711720.100 | 711720.1000 |
| POLYGOPREP 300-50 $C_{18}$ | yes | 4 % C | 300 Å | 40–63 µm | 711730.100 | 711730.1000 |
| POLYGOPREP 1000-30 $C_{18}$ | yes | ~ 1 % C | 1000 Å | 25–40 µm | 711028.100 | 711028.1000 |
| POLYGOPREP 1000-50 $C_{18}$ | yes | ~ 1 % C | 1000 Å | 40–63 µm | 711029.100 | 711029.1000 |
| **Octyl phases** $-(CH_2)_7-CH_3$ | | | | | | |
| POLYGOPREP 60-12 $C_8$ | no* | 7 % C | 60 Å | 10–15 µm | 711007.100 | 711007.1000 |
| POLYGOPREP 60-20 $C_8$ | no* | 7 % C | 60 Å | 15–25 µm | 711008.100 | 711008.1000 |
| POLYGOPREP 60-30 $C_8$ | no* | 7 % C | 60 Å | 25–40 µm | 711470.100 | 711470.1000 |
| POLYGOPREP 60-50 $C_8$ | no* | 7 % C | 60 Å | 40–63 µm | 711490.100 | 711490.1000 |
| * On request, these POLYGOPREP RP phases can be endcapped at surcharge. | | | | | | |
| **Butyl phases** $-(CH_2)_3-CH_3$ | | | | | | |
| POLYGOPREP 300-12 $C_4$ | yes | ~ 1 % C | 300 Å | 10–15 µm | 711022.100 | 711022.1000 |
| POLYGOPREP 300-20 $C_4$ | yes | ~ 1 % C | 300 Å | 15–25 µm | 711023.100 | 711023.1000 |
| POLYGOPREP 300-30 $C_4$ | yes | ~ 1 % C | 300 Å | 25–40 µm | 711690.100 | 711690.1000 |
| POLYGOPREP 300-50 $C_4$ | yes | ~ 1 % C | 300 Å | 40–63 µm | 711700.100 | 711700.1000 |
| POLYGOPREP 1000-30 $C_4$ | yes | < 1 % C | 1000 Å | 25–40 µm | 711026.100 | 711026.1000 |
| POLYGOPREP 1000-50 $C_4$ | yes | < 1 % C | 1000 Å | 40–63 µm | 711027.100 | 711027.1000 |
| **Cyano phases (nitrile)** $-(CH_2)_3-CN$ | | | | | | |
| POLYGOPREP 60-12 CN | | ~ 4.5 % C | 60 Å | 10–15 µm | 711015.100 | 711015.1000 |
| POLYGOPREP 60-20 CN | | ~ 4.5 % C | 60 Å | 15–25 µm | 711016.100 | 711016.1000 |
| POLYGOPREP 60-30 CN | | ~ 4.5 % C | 60 Å | 25–40 µm | 711017.100 | 711017.1000 |
| **Amino phases** $-(CH_2)_3-NH_2$ | | | | | | |
| POLYGOPREP 60-12 $NH_2$ | | ~ 3 % C | 60 Å | 10–15 µm | 711012.100 | 711012.1000 |
| POLYGOPREP 60-20 $NH_2$ | | ~ 3 % C | 60 Å | 15–25 µm | 711013.100 | 711013.1000 |
| POLYGOPREP 60-30 $NH_2$ | | ~ 3 % C | 60 Å | 25–40 µm | 711014.100 | 711014.1000 |

## Ordering information

| Phase | Pore size | Particle size | Pack of 100 g | Pack of 1 kg | Pack of 5 kg |
|---|---|---|---|---|---|
| **Unmodified POLYGOPREP silica** SiOH | | | | | |
| POLYGOPREP 60-12 | 60 Å | 10–15 µm | | 711001.1000 | 711001.5000 |
| POLYGOPREP 60-20 | 60 Å | 15–25 µm | | 711240.1000 | 711240.5000 |
| POLYGOPREP 60-30 | 60 Å | 25–40 µm | | 711250.1000 | 711250.5000 |
| POLYGOPREP 60-50 | 60 Å | 40–63 µm | | 711260.1000 | 711260.5000 |
| POLYGOPREP 60-80 | 60 Å | 63–100 µm | | 711270.1000 | 711270.5000 |
| POLYGOPREP 60-130 | 60 Å | 63–200 µm | | 711037.1000 | 711037.5000 |
| POLYGOPREP 100-12 | 100 Å | 10–15 µm | | 711002.1000 | 711002.5000 |
| POLYGOPREP 100-20 | 100 Å | 15–25 µm | | 711003.1000 | 711003.5000 |
| POLYGOPREP 100-30 | 100 Å | 25–40 µm | | 711540.1000 | 711540.5000 |
| POLYGOPREP 100-50 | 100 Å | 40–63 µm | | 711550.1000 | 711550.5000 |
| POLYGOPREP 100-80 | 100 Å | 63–100 µm | | 711033.1000 | 711033.5000 |
| POLYGOPREP 100-130 | 100 Å | 63–200 µm | | 711034.1000 | 711034.5000 |
| POLYGOPREP 300-12 | 300 Å | 10–15 µm | 711004.100 | 711004.1000 | |
| POLYGOPREP 300-20 | 300 Å | 15–25 µm | 711610.100 | 711610.1000 | |
| POLYGOPREP 300-30 | 300 Å | 25–40 µm | 711620.100 | 711620.1000 | |
| POLYGOPREP 300-50 | 300 Å | 40–63 µm | 711630.100 | 711630.1000 | |
| POLYGOPREP 1000-12 | 1000 Å | 10–15 µm | 711035.100 | 711035.1000 | |
| POLYGOPREP 1000-20 | 1000 Å | 15–25 µm | 711036.100 | 711036.1000 | |
| POLYGOPREP 1000-30 | 1000 Å | 25–40 µm | 711005.100 | 711005.1000 | |
| POLYGOPREP 1000-50 | 1000 Å | 40–63 µm | 711006.100 | 711006.1000 | |

# Adsorbents for column chromatography

## Silica adsorbents for low pressure column chromatography

- Silica 60; pore size ~ 60 Å; pore volume ~ 0.75 mL/g; spec. surface BET ~ 500 $m^2/g$ highly porous, amorphous silicic acid in the form of hard, opalescent particles, prepared by precipitation of water glass with sulfuric acid
- For higher demands on the performance of column packings we recommend our high-purity irregular POLYGOPREP silicas (see before).
- Silica FIA for the fluorescence indicator adsorption procedure for the determination of hydrocarbon groups in the testing of liquid fuels in accordance with DIN 51791 and ASTM D 1319-58T
- The FIA method determines saturated hydrocarbons, olefins and aromatic hydrocarbons of a sample chromatographically by adsorption and desorption in a column filled with FIA silica, in the presence of a fluorescent dye mixture.

### Ordering information

| Description | Particle size | 1 kg | 5 kg | 25 kg |
|---|---|---|---|---|
| Silica 60, 0.015–0.04 mm | – | 815650.1 | 815650.5 | 815650.25 |
| Silica 60, 0.025–0.04 mm | – | 815300.1 | 815300.5 | 815300.25 |
| Silica 60, 0.04–0.063 mm | 230–400 mesh | 815380.1 | 815380.5 | 815380.25 |
| Silica 60 M, 0.04–0.063 mm | 230–400 mesh | 815381.1 | 815381.5 | 815381.25 |
| Silica 60, 0.05–0.1 mm | 130–270 mesh | 815390.1 | 815390.5 | 815390.25 |
| Silica 60, 0.05–0.2 mm | 70–270 mesh | 815320.1 | 815320.5 | 815320.25 |
| Silica 60, 0.063–0.2 mm | 70–230 mesh | 815330.1 | 815330.5 | 815330.25 |
| Silica 60, < 0.063 mm | +230 mesh | 815400.1 | 815400.5 | 815400.25 |
| Silica 60, < 0.08 mm | +190 mesh | 815310.1 | 815310.5 | 815310.25 |
| Silica 60, 0.1–0.2 mm | 70–130 mesh | 815340.1 | 815340.5 | 815340.25 |
| Silica 60, 0.2–0.5 mm | 35–70 mesh | 815350.1 | 815350.5 | 815350.25 |
| Silica 60, 0.5–1.0 mm | 18–35 mesh | 815360.1 | 815360.5 | 815360.25 |
| Silica FIA fine | 0.071–0.16 mm | 815410.1 | | |
| Silica FIA coarse | 0.071–0.63 mm | 815430.1 | | |

## Aluminum oxide

- Aluminum oxides produced by dehydration of different aluminum hydroxides, e.g., hydrargillite between 400 and 500 °C.
- Activity grade I, particle size 50–200 µm, specific surface (BET) ~ 130 $m^2/g$

### Ordering information

| Description | pH | 1 kg | 5 kg | 25 kg |
|---|---|---|---|---|
| Aluminum oxide 90 basic | pH 9.5 ± 0.3 | 815010.1 | 815010.5 | 815010.25 |
| Aluminum oxide 90 neutral | pH 7 ± 0.5 | 815020.1 | 815020.5 | 815020.25 |
| Aluminum oxide 90 acidic | pH 4 ± 0.3 | 815030.1 | 815030.5 | 815030.25 |

## Kieselguhr

- Naturally occurring amorphous silicic acids of fossil origin, also known as diatomaceous earth or diatomite purified for chromatographic applications
- Compared to silica, kieselguhr has a small surface of low activity → application in partition chromatography; impregnated with various substances (paraffin, silicone oil, undecane) it can be used for reversed phase chromatography
- The following grades of kieselguhr are manufactured by Johns-Manville. They are narrowly classified with homogeneous particle size distributions and high purity.
- For columns packed with kieselguhr please see CHROMABOND® XTR for liquid-liquid extraction, page 63.

### Ordering information

| Description | Rel. purification factor | Rel. flow rate | 1 kg | 5 kg |
|---|---|---|---|---|
| Filter-Cel® | 100 | 100 | 815510.1 | 815510.5 |
| Hyflo® Super-Cel® | 58 | 534 | 815530.1 | 815530.5 |
| Celite® 503 | 42 | 910 | 815540.1 | 815540.5 |
| Celite® 535 | 35 | 1269 | 815550.1 | 815550.5 |
| Celite® 545 | 32 | 1830 | 815560.1 | 815560.5 |

## Florisil®

- Hard granular magnesia silica gel:
  MgO 15.5 ± 0.5 % · $SiO_2$ 84.0 ± 0.5 % · $Na_2SO_4$ ≤ 1.0 %;
  60/100 mesh
- Recommended application
  Sample preparation (see chapter “Solid phase extraction”, page 16)
- Clean-up of pesticide residues, separation of chlorinated pesticides, extraction of steroids, sex hormones, antibiotics, lipids etc.

### Ordering information

| Description | Particle size | 1 kg | 5 kg |
|---|---|---|---|
| Florisil standard 60/100 mesh | 0.15/0.25 mm | 815710.1 | 815710.5 |

## Polyamide

- Polyamide 6 = ε-polycaprolactam
- The separation mechanism mainly based on hydrogen bonds
- Recommended application
  Separation of phenolic compounds (e.g., isolation of natural products) carboxylic acids, aromatic nitro compounds
- For SPE columns packed with polyamide see CHROMABOND® PA page 44.

### Ordering information

| Description | Particle size | 1 kg | 5 kg |
|---|---|---|---|
| Polyamide SC 6, < 0.07 mm | < 0,07 mm | 815610.1 | 815610.5 |
| Polyamide SC 6, 0.05–0.16 mm | 0.05–0.16 mm | 815620.1 | 815620.5 |
| Polyamide SC 6, 0.10–0.30 mm | 0.10–0.30 mm | 815600.1 | 815600.5 |

## Unmodified cellulose

- Cellulose MN 100:
  native fibrous cellulose, standard grade average degree of polymerization 620–680, fiber length (85 %) 20–100 µm, specific surface acc. to Blaine ~ 6500 $cm^2/g$; residue on ignition at 850 °C < 10000 ppm, < 20 ppm Fe, < 5 ppm Cu, < 7 ppm P, $CH_2Cl_2$ extract < 0.20 %
- Cellulose MN 2100:
  native fibrous cellulose, purified grade (washed with different eluents) average degree of polymerization 620–680, fiber length (85 %) 20–75 µm, specific surface acc. to Blaine ~ 5500 $cm^2/g$ residue on ignition at 850 °C < 1000 ppm, < 2 ppm Fe, < 1 ppm Cu, < 2 ppm P, $CH_2Cl_2$ extract < 0.15 %
- Grade MN 2100ff is a defatted cellulose MN 2100 with a $CH_2Cl_2$ extract < 0.02 %

### Ordering information

| Description | 1 kg | 5 kg | 25 kg |
|---|---|---|---|
| Cellulose MN 100 | 815050.1 | 815050.5 | 815050.25 |
| Cellulose MN 2100 | 815060.1 | 815060.5 | 815060.25 |
| Cellulose MN 2100ff (Cellulose MN 2100 defatted) | 815070.1 | | |

# MACHEREY-NAGEL
## optimal autosampler vials for your sample

### Vials and closures

For reliable and reproducible analysis the correct storage of sample solutions is important. MACHEREY-NAGEL offers diverse vials and suitable closures.

### Our product range includes

- Different vial types from N 8 to N 24
  - Crimp neck
  - Screw neck
  - Snap ring
- Clear glass, amber glass and polypropylene vials, with or without scale and label
- Diverse inserts for small sample volumes
- Variety of closures and septa of different material
- Suitable accessories like crimping tools and vial containers
- Compatibility with different autosamplers from page 136 onwards

Our broad range of vials and closures can be found from page 97 onwards.

Also use our VialFinder on *www.mn-net.com/VialFinder*

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Glass plates

ALUGRAM® Xtra aluminum sheets
ALUGRAM® aluminum sheets



POLYGRAM® polyester sheets

Thin layer chromatography (TLC) and high performance thin layer chromatography (HPTLC), also called planar chromatography, are, like all chromatographic techniques, based on a multi-stage distribution process involving

- Suitable adsorbents (the stationary phase) coated as a thin layer onto a suitable support (e.g., glass plate, polyester or aluminum sheet; also see page 272)
- Solvents or solvent mixtures (the mobile phase or eluent)
- Sample molecules

The principle of TLC is known for more than 100 years [11]. The real break-through as an analytical method, however, came about 50 years ago as a consequence of the pioneering work of Egon Stahl [12].

Today TLC has gained increasing importance as an analytical separation technique, which is probably due to effects of instrumentation and automation [13]. At the same time the applicability of thin layer chromatography was enhanced by development of new adsorbents and supports.

Today MACHEREY-NAGEL offers a versatile range of ready-to-use layers, which are the result of 50 years of continuous research and development.

## Features of modern TLC / HPTLC

The success of thin layer chromatography as a highly efficient microanalytical separation method is based on a large number of advantageous properties:

- High sample throughput in a short time
- Suitable for screening tests
- Pilot procedure for HPLC and Flash chromatography
- After separation the analytical information can be stored for a longer period of time (the TLC ready-to-use layer acts as storage medium for data)
- Separated substances can be subjected to subsequent analytical procedures (e.g., IR, MS) at a later date
- Rapid and cost-efficient optimization of the separation due to easy change of mobile and stationary phase

## Principle steps of a TLC separation

### Sample preparation

For separation the sample must meet several requirements to obtain good results. Since the TLC plate is a disposable product, sample preparation in general is not as demanding as for other chromatographic methods. However, eventually several steps for sample pretreatment may be necessary. These include sampling, mechanical crushing, extraction steps, filtration and sometimes enrichment of interesting components or clean-up, i.e. removal of undesired impurities.

Our TLC micro-sets introduce some simple methods of sample pretreatment. The dyes or dye mixtures of the beginner's set do not require complicated procedures. The advanced sets require the user to carry out some additional steps for preparing a sample, thus introducing the user to techniques often performed in industrial laboratories.

Thorough preparation of samples is an important prerequisite for the success of a TLC separation. For our range of products for more demanding sample pretreatment please see the chapter "SPE" from page 10.

### Sample application

The most frequent technique is application with a glass capillary as spot or short streak.

Application as streak will yield better results especially for instrumental quantification. For both types of application some manual skill is required to obtain reproducible results. Substance zones which are too large from the beginning will cause poor separation since during chromatography they will become even larger and more diffuse.

A valuable aid for manual application especially of large volumes of very dilute samples is the concentrating zone (e.g., SILGUR-25 $UV_{254}$), which consists of a chromatographically inactive adsorbent (kieselguhr). The substances to be separated are concentrated to a small band in the concentrating zone and the separation starts at the beginning of the chromatographically active adsorbent silica.

Arbitrary application in the concentrating zone

Developed chromatogram

Another method for sample concentration is a short pre-elution (few mm) with a solvent, in which all substances have a high $R_f$ value.

If a quantitative evaluation with a TLC scanner is to follow the separation we recommend to use commercially available sample applicators for spotting. These range from simple spotting guides via nanoapplicators to completely automated spotting devices. Application as streak can be performed automatically by spraying of the sample without touching the layer of the TLC plate. Application as band over the whole width of the TLC plate is especially important for preparative TLC. After application allow the solvent of the samples to evaporate completely (about 10 min) or blow with cold or hot air. Development of a chromatogram should never start before the solvent of the applied samples is evaporated completely.

## Developing a chromatogram – separation techniques

The most frequently used separation technique is ascending TLC in a trough chamber (standard method, linear development). Usually it is applied as single development. However, multiple development, with or without change of eluent (step technique) can improve separation results. For 2-dimensional development only 1 spot of the sample is applied in one edge of a plate. After chromatography in the first direction the plate is dried, turned by 90° and developed in the 2nd dimension with another eluent. Thus complicated mixtures give 2-dimensional chromatograms taking advantage of the different separating properties of two eluents.

For selection and optimization of the eluent numerous publications are available. A generally applicable standardized optimization method is described by H. Keuker et al. [14].

It is important to pay attention to the atmosphere in the developing chamber. If reproducible migration distances are required, saturation of the chamber atmosphere with eluent vapor is necessary. For this purpose the developing chamber is lined with well absorbing chromatography paper (e.g., MN 260) and charged with a correspondingly larger volume of eluent.

A) Normal saturation, arrows show evaporation of the eluent from the layer

B) Chamber lined with filter paper, saturated with eluent vapor

## Evaluation of a thin layer chromatogram

Evaluation depends on the purpose of the chromatographic analysis. For qualitative determination often localization of substances is sufficient. This can be easily achieved by parallel runs with reference substances.

A parameter often used for qualitative evaluation is the $R_f$ value (retention factor) or the 100-fold value h$R_f$. The $R_f$ value is defined as follows:

$$R_f = \frac{\text{distance starting line – middle of spot}}{\text{distance starting line – solvent front}} = \frac{b}{a}$$

i.e. the $R_f$ values are between 0 and 1, best between 0.1 and 0.8 (i.e. 10–80 for h$R_f$). If reproducible $R_f$ values are to be obtained, it is essential that several parameters such as chamber saturation, composition of solvent mixtures, temperature etc. are strictly controlled.

Quantitative evaluation is possible by suitable calibration measurements. For this purpose either the area of a substance spot is measured or a photometric evaluation is performed directly on the layer. The latter procedure, however, requires a higher instrumental expense.

The following paragraphs describe the most frequently used methods for evaluation in TLC.

## Qualitative detection

Qualitative evaluation is generally made directly on the TLC plate via characteristic $R_f$ values of substances, i.e. the ratio of distance start – substance zone to distance start – solvent front and specific chemical reactions.

## Visualization of separated substances

First of all it is necessary to recognize the position of a substance spot. Only in very few cases the sample is a dye which can be seen with the naked eye. Much more often for unspecific visualization substances can be viewed under UV light, since many substances show a UV absorption. If a fluorescent indicator is added to the layer, all substances absorbing in the respective region of wave length cause a quenching of the fluorescence, i.e. they appear as dark spots on the fluorescent layer. Customary fluorescent indicators are excited at 254 nm or (less frequently) at 366 nm with a mercury lamp. For our program of fluorescent indicators for TLC please see page 296.

Quenching of the fluorescence

Identification of separated substances is possible via the $R_f$ value compared to the pure compound, which is often applied simultaneously on the same plate.

For a number of compounds their native fluorescence can be used for visualization, which is excited by UV light (mostly long-wave UV) (e.g., aflatoxins). This allows not only determination of the $R_f$ value, but often enables a further qualitative assignment.

If these methods do not allow localization or characterization of a substance, post-chromatographic detection methods can be applied, chemical reactions on the TLC plate [15]. Quite unspecific reactions are iodine adsorption and the charring technique (spraying with sulfuric acid and heat treatment).

More reliable results are possible with specific reagents for spraying or dipping, which form colored or fluorescent compounds with the substances to be detected. Depending on the sensitivity of these reactions they are not only used for group or substance specific characterization (in addition to the $R_f$ value) but also for quantification down to trace levels. As example take the ninhydrin reaction. Formation of a (usually red) zone with this detection method yields the information, that a certain group of substances, e.g., α-amino acids, are present. The $R_f$ value allows further assignment to one or several single compounds.

For identification of a substance a combination of different detection methods can be useful. Thus almost all lipids can be converted to products with light green fluorescence by reaction with 2',7'-dichlorofluorescein. Adsorption of iodine vapor enables a differentiation between saturated and unsaturated lipids or lipids containing nitrogen. And finally the $R_f$ value is a third means of identification.

Here are some general remarks concerning spraying: use all spray reagents under a fume hood. The developed, dried TLC plate or sheet is placed on a sheet of filter paper for spraying. Usually it is sufficient to fill the sprayer with about 5–10 mL solution. Spray from a distance of about 15 cm with the aid of a rubber ball or – if available – with pressurized air. It is always better to spray a layer twice very thinly and evenly (with intermediate drying), than to saturate the layer with excessive spray reagent. In the latter case spots tend to become diffuse. After visualization mark outlines of zones with a lead pencil, because some spots tend to fade after a while.

Especially for quantitative evaluation short dipping of the layer in the respective reagent solution is recommended. For this purpose automatic instruments are commercially available, which allow reproducible dipping.

When a substance is localized on the TLC plate (e.g., under UV), but not yet identified, TLC scanners allow recording of UV spectra of individual substance zones directly on the layer, or the zone is removed by scratching or cutting (for sheets), eluted and further analyzed, e.g., by FT-IR, RAMAN, NMR or mass spectroscopy.

### Quantitative evaluation

Often TLC is considered to be only a semiquantitative analytical procedure. This is true for visual evaluation of spots, since the eye can only compare but not measure absolute values. If, however, a direct optical evaluation ("in situ" measurement) is performed on the TLC plate with a thin layer scanner, after measurement of calibration functions, exact quantitative results are possible. Commercial scanners offer many features such as evaluation in absorption and fluorescence, unattended programmed scanning of lanes, multi-wave length measurement, background correction, selectable base line for integration, recording of spectra, evaluation of circular or anti-circular chromatograms with very high ease of operation. In addition to manual operation control by a computer is possible with respective data collection and storage. Usually wavelengths from 200 to 700 nm are available (visible and UV), e.g., all post-chromatographic (and of course all pre-chromatographic) visualization procedures are evaluated with the proper wavelength, which is determined with the instrument. Time requirements for all these possibilities are extremely low. Interlaboratory experiments with standard deviations of 2 % show how excellent results are obtainable [16].

## TLC micro-sets introductory kits for science education

### Beginner's set

- Features separations with simple developing solvents; samples are colored thus eliminating the need for visualization.
- All equipment needed is contained in the set.

### Advanced sets F1, F2 and F3

- Require some experience and skill from the user: some of the samples have to be pretreated before separation, and for identification of substances spray reagents have to be used

### TLC micro-set A for beginners

This kit contains all chemicals and accessories for the following separations:

- Separation of the fat-soluble (lipophilic)
  Test dye mixture 1: butter yellow, indophenol, sudan blue II, sudan red G
- Separation of a mixture of anthraquinone dyes
  Test dye mixture 2: blue 1, blue 3, green, green blue, red, violet 1, violet 2
- Separation of a mixture of food dyes
  Test dye mixture 3: brilliant black BN (E151), fast red E, erythrosine (E127), yellow orange S (sunset yellow CFC, E110), naphthol red S, ponceau 4 R (E124), tartrazine (E102)
- Separation of dyes from felt tip pens

### Contents of TLC micro-set A for beginners

1 manual

3 developing chambers

50 glass capillaries 1 µL

1 spotting guide

2 felt tip pens

1 measuring cylinder 10 mL

50 polyester sheets 4 x 8 cm each of POLYGRAM®: SIL G/$UV_{254}$, Alox N/$UV_{254}$ and CEL 300

8 mL each of test dye mixture 1 (4 lipophilic dyes), test dyes sudan red G, and sudan blue II

8 mL each of test dye mixture 2 (7 anthraquinone dyes), test dyes blue 1 and violet 2

8 mL each of test dye mixture 3 (7 food dyes), test dyes yellow orange S, and brilliant black BN

100 mL each of toluene, toluene – cyclohexane (2:1, v/v), ethanol, 2.5 % sodium citrate solution, 25 % ammonia solution – 2-propanol (5:3, v/v)

### Ordering information

| Designation | Pack of | REF |
|---|---|---|
| **TLC micro-set A for beginners*** | 1 kit | 814000 |
| Replacement parts for TLC micro-set A | | |
| Test dye mixture 1*, solution of 4 lipophilic dyes in toluene (components see above) | 8 mL | 814001 |
| Test dye mixture 2*, solution of 7 anthraquinone dyes in toluene – cyclohexane (2:1, v/v) (components see above) | 8 mL | 814002 |
| Test dye mixture 3, aqueous solution of 7 food dyes (components see above) | 8 mL | 814003 |
| Collection of 4 individual components of test dye mixture 1* | 4 x 8 mL | 814011 |
| Collection of 7 individual components of test dye mixture 2* | 7 x 8 mL | 814012 |
| Collection of 7 individual components of test dye mixture 3 | 7 x 8 mL | 814013 |
| Sodium citrate, 2.5 g in 100 mL bottle to fill up with distilled water | 2.5 g | 814029 |

* These products contain harmful substances which must be specially labeled as hazardous. For detailed information please see SDS.

Information about the advanced sets F1, F2 and F3 can be found on page 270 and page 271.

## TLC micro-set F1

This kit contains all chemicals required for the separation of

- Amino acids (test mixture, consisting of alanine, arginine, tryptophan and valine)
- Amino acids in urine
- The heavy metal cations copper(II) and manganese(II)

**Contents of TLC micro-set F1**

1 manual, 50 glass capillaries 1 µL

50 polyester sheets 4 x 8 cm each of POLYGRAM®: SIL G/$UV_{254}$ and CEL 300

100 mL each of *n*-butanol, ninhydrin spray reagent (0.2 % in ethanol), acetone, 25 % ammonia solution, rubeanic acid spray reagent

50 mL each of 50 % acetic acid, 18 % hydrochloric acid

8 mL each of the amino acid test mixture (see left), tryptophan and arginine reference solutions

8 mL each of the heavy metal cation test mixture (see left), $Cu^{2+}$ and $Mn^{2+}$ reference solutions

## TLC micro-set F2

This kit contains all chemicals required

- For analysis of edible fats
- For analysis of fats and cholesterol in blood

**Contents of TLC micro-set F2**

1 manual, 50 glass capillaries 1 µL

50 polyester sheets 4 x 8 cm POLYGRAM®: SIL G/$UV_{254}$

5 disposable pipettes 25 µL

5 sample vials N 11 (1.5 mL) with PE caps and seals

3 sample vials 30 mL (for butter, margarine and edible oil)

100 mL each of cyclohexane and molybdatophosphoric acid spray reagent

2 x 50 mL acetone with calibrated pipette

25 mL butan-2-one

8 mL cholesterol reference solution

## TLC micro-set F3

This kit contains all chemicals required

- For separation of analgetics (pain relievers)
- For drug analysis as shown for cinchona bark

**Contents of TLC micro-set F3**

1 manual, 50 glass capillaries 1 µL

50 polyester sheets 4 x 8 cm POLYGRAM®: SIL G/$UV_{254}$

5 Aspirin® tablets, 5 Thomapyrin® tablets

20 folded filters MN 615 1/4, 11 cm diameter

3 sample vials 8 mL (for Aspirin® sample, Thomapyrin® sample, cinchona bark extract), 5 g cinchona bark

100 mL each of ethanol, 2-propanol, toluene – diethyl ether je 100 mL Ethanol, 2-Propanol, Toluol – Diethylether (61:39, v/v), spray reagent for caffeine and spray reagent according to Dragendorff-Munier

50 mL each of iron(III) chloride solution and potassium hexacyanoferrate(III) solution, 30 mL ethyl acetate

25 mL each of 12.5 % ammonia solution and diethylamine

8 mL each of caffeine, paracetamol, quinine reference solutions

All experiments with TLC micro-sets F1–F3 require the materials kit (see TLC micro-set M on page 271).

## Ordering information

| Designation | Pack of | REF |
|---|---|---|
| **TLC micro-set F1*** | 1 kit | 814200 |
| Refill reagents for TLC micro-set F1 | | |
| Amino acid test mixtures (components see previous page) | 8 mL | 814201 |
| Collection of 4 individual components of the amino acid test mixture | 4 x 8 mL | 814202 |
| Cation test mixture (components see previous page) | 8 mL | 814204 |
| Collection of 2 individual components of the cation test mixture ($Cu^{2+}$, $Mn^{2+}$) | 2 x 8 mL | 814205 |
| **TLC micro-set F2*** | 1 kit | 814300 |
| Refill reagents for TLC micro-set F2 | | |
| Cholesterol reference solution* | 8 mL | 814301 |
| **TLC micro-set F3*** | 1 kit | 814400 |
| Refill reagents for TLC micro-set F3 | | |
| Quinine reference solution* | 8 mL | 814405 |
| Paracetamol reference solution* | 8 mL | 814406 |
| Caffeine reference solution* | 8 mL | 814407 |
| **Refill packs TLC sheets for all TLC micro-sets** | | |
| TLC polyester sheets POLYGRAM® SIL G/$UV_{254}$, 4 x 8 cm | 4 x 50 | 814025 |
| TLC polyester sheets POLYGRAM® Alox N/$UV_{254}$, 4 x 8 cm | 4 x 50 | 814026 |
| TLC polyester sheets POLYGRAM® CEL 300, 4 x 8 cm | 4 x 50 | 814027 |
| TLC polyester sheets POLYGRAM® 4 x 8 cm: 100 x SIL G/$UV_{254}$; 50 x Alox N/$UV_{254}$; 50 x CEL 300 | 1 kit | 814028 |

* These products contain harmful substances which must be specially labeled as hazardous. For detailed information please see SDS.
Accessories for TLC micro-sets can be found under TLC accessories on page 295.
Spray reagents can be found on page 296.

### TLC micro-set M

This kit is prerequisite for the separations with kits F1 to F3. In addition, it serves as basic equipment for the individual study of further thin layer chromatographic experiments.

**Contents of TLC micro-set M (materials kit)**

2 x 50 glass capillaries 1 µL, 2 spotting guides
1 rubber cap for capillaries
1 measuring cylinder 10 mL
1 beaker 25 mL
2 developing chambers
1 glass laboratory sprayer with rubber bulb
1 plastic syringe 1 mL
20 sheets filter paper MN 713 (15 x 21 cm)
50 polyester sheets 4 x 8 cm each of POLYGRAM®: SIL G/$UV_{254}$, Alox N/$UV_{254}$ and CEL 300

## Ordering information

| Designation | Pack of | REF |
|---|---|---|
| TLC micro-set M (materials kit) | 1 kit | 814100 |

# Summary of MN ready-to-use layers

## Advantages of MN plates and sheets for TLC

### Continuous high quality

- Guaranteed by stringent production control including standardized lot tests, surface checks for roughness or cracks as well as hardness and adherence checks

### Comprehensive range of phases for TLC / HPTLC

- There is no universal TLC plate which meets all possible types of analyses
- Our versatile range of TLC ready-to-use layers covers many different types of applications

### Immediately ready for chromatographic separation

- Coatings or impregnations are not necessary

### Homogeneous, smooth, well adhering layers

- An important criterion especially for reproducible quantitative evaluation

## Adsorbents for MN plates and sheets for TLC

### Classical adsorbents

- For ~ 80 % of all TLC separations silica 60 (mean pore diameter 60 Å = 6 nm) is used
- Other classical adsorbents are aluminum oxide, cellulose, kieselguhr, ion exchangers and polyamide

### Special phases

- Modified silica, like $C_{18}$ (octadecyl-) cyano-, amino-, diol-, RP-2
- Special layers for specific separations, like PAH- or enantiomer separation

### Particle size distribution and thickness of layer

- Are chosen to fit the given type of application (e.g., HPTLC, standard or preparative separations)
- Most MN ready-to-use layers are available with or without fluorescent indicator

Electron microscope photograph of a cross section through a glass plate with silica layer (magnification x 500)

Electron microscope photograph of a cross section through an aluminum sheet with silica layer (magnification x 500)

### Supports for ready-to-use layers for TLC

| | Glass plates G | POLYGRAM® P | ALUGRAM® A / ALUGRAM® Xtra Ax |
|---|---|---|---|
| Physical properties of support materials | | | |
| Material | glass | polyester | aluminum |
| Thickness (approx.) | 1.3 mm | 0.2 mm | 0.15 mm |
| Weight, packaging and storage requirements | high | low | low |
| Torsional strength | ideal | low | relatively high |
| Temperature stability | high | max. 185 °C | high |
| Susceptible to breakage | yes | no | no |
| Can be cut with scissors | no | yes | yes |
| Chemical resistance of support materials | | | |
| Against solvents | high | high | high |
| Against mineral acids and conc. ammonia | high | high | low |
| Stability of the binder system of NP plates in water | | | |
| Suitability for aqueous detection reagents | depending on phase | very suitable | ALUGRAM®: limited suitability; ALUGRAM® Xtra: very suitable |

# Summary of MN ready-to-use layers

## Summary

| Phase | Support* | | | | Layer | Page |
|---|---|---|---|---|---|---|
| **Standard silica** particle size 5–17 µm | | | | | | |
| ADAMANT | G | | | | silica 60, improved binder system, optimized particle size distribution | 274 |
| SIL G | G | P | A | Ax | silica 60, standard grade | 276 |
| DURASIL | G | | | | silica 60, special binder system | 277 |
| SILGUR | G | | | Ax | silica 60 with kieselguhr concentrating zone | 279 |
| **Unmodified silica for HPTLC** particle size 2–10 µm | | | | | | |
| Nano-SILGUR | G | | | Ax | nano silica 60 with kieselguhr concentrating zone | 279 |
| Nano-ADAMANT | G | | | | nano silica 60, improved binder system, optimized particle size distribution | 281 |
| Nano-SIL | G | | A | Ax | nano silica 60, standard grade | 281 |
| Nano-DURASIL | G | | | | nano silica 60, special binder system | 282 |
| **Modified silica for HPTLC** particle size 2–10 µm | | | | | | |
| Nano-SIL C18-50 / Nano-SIL C18-100 | G | | | | nano silica with partial or complete $C_{18}$ modification | 283 |
| RP-18 W/$UV_{254}$ | G | | A | | nano silica with partial octadecyl modification, wettable with water | 284 |
| RP-2/$UV_{254}$ | G | | A | | silanized silica = dimethyl-modified nano silica 60 | 284 |
| Nano-SIL CN | G | | A | | cyano-modified nano silica | 285 |
| Nano-SIL $NH_2$ | G | | A | | amino-modified nano silica | 286 |
| Nano-SIL DIOL | G | | | | diol-modified nano silica | 287 |
| **Aluminum oxide** | | | | | | |
| Alox-25 / Alox N | G | P | A | | aluminum oxide | 288 |
| **Cellulose, unmodified and modified** | | | | | | |
| CEL 300 | G | P | A | | native fibrous cellulose MN 300 | 289 |
| CEL 400 | G | P | | | microcrystalline cellulose MN 400 (AVICEL®) | 289 |
| CEL 300 PEI | | P | | | polyethyleneimine-impregnated cellulose ion exchanger | 290 |
| CEL 300 AC | | P | | | acetylated cellulose MN 300 | 290 |
| **POLYAMID-6** | | | | | | |
| POLYAMID-6 | | P | | | perlon = ε-polycaprolactame | 290 |
| **Layers for special separations** | | | | | | |
| CHIRALPLATE | G | | | | RP silica with $Cu^{2+}$ ions and chiral reagent, for enantiomer separation of amino acids | 291 |
| SIL N-HR | | P | | | high purity silica 60, special binder system, higher gypsum content | 291 |
| SIL G-25 HR | G | | | | high purity silica 60 with gypsum, recommended for aflatoxin analysis | 292 |
| SIL G-25 Tenside | G | | | | silica G with ammonium sulfate for separation of surfactants | 292 |
| Nano-SIL PAH | G | | | | nano silica with special impregnation for PAH analysis | 292 |
| IONEX-25 SA-Na | | P | | | mixed layer of strongly acidic cation exchanger and silica | 293 |
| IONEX-25 SB-AC | | P | | | mixed layer of strongly basic anion exchanger and silica | 293 |
| Alox / CEL-AC-Mix | G | | | | mixed layer of aluminum oxide and acetylated cellulose | 293 |
| SILCEL-Mix | G | | | | mixed layer of cellulose and silica | 293 |

* G = Glass plates  P = POLYGRAM® polyester sheets  A = ALUGRAM® aluminum sheets  Ax = ALUGRAM® Xtra aluminum sheets

# Unmodified TLC silica layers

## ADAMANT G unmodified standard silica layers

### Key features

- Outstanding hardness and abrasion resistance due to an optimized binder system
- Increased separation efficiency due to an optimized particle size distribution
- High suitability for trace analysis resulting from a UV indicator with increased brilliance and a lownoise background of the layer

### Technical characteristics

- Silica 60, mean pore size 60 Å, specific surface (BET) ~ 500 $m^2/g$, specific pore volume 0.75 mL/g, particle size 5–17 µm

### Separation of steroids

MN Appl. No. 402930

Layers: ADAMANT $UV_{254}$, SIL G/$UV_{254}$
Sample: 0.1 % solution in $CHCl_3$
Eluent: chloroform – methanol (97:3, v/v)
Migration distance: ADAMANT 50 mm in 10 min, SIL G 57 mm in 10 min
Detection: UV

ADAMANT $UV_{254}$ SIL G/$UV_{254}$

| Substance | $R_f$ ADAMANT | $R_f$ SIL G |
|---|---|---|
| Cortisone | 0.37 | 0.27 |
| Corticosterone | 0.43 | 0.30 |
| Testosterone | 0.50 | 0.39 |
| Deoxycorticosterone | 0.55 | 0.46 |
| Progesterone | 0.73 | 0.62 |

### Separation of barbiturates

MN Appl. No. 402950

Layer: ADAMANT $UV_{254}$
Sample volume: 1 µL
Eluent: chloroform – acetone (95:5, v/v)
Migration distance: 70 mm in 20 min
Detection: UV

ADAMANT $UV_{254}$

| Substance | $R_f$ |
|---|---|
| Thiamylal (0.5 %) | 0.69 |
| Thiopental (1.0 %) | 0.65 |
| Hexobarbital (5.0 %) | 0.41 |
| Pentobarbital (1.0 %) | 0.26 |
| Phenobarbital (1.0 %) | 0.18 |

## Ordering information

| Plate size [cm] | 2.5 x 7.5 | 5 x 10 | 5 x 10 | 5 x 20 | 10 x 10 | 10 x 20 | 20 x 20 | Thickness of layer | Fluorescent indicator |
|---|---|---|---|---|---|---|---|---|---|
| Pack of [plates] | 100 | 50 | 200 | 100 | 25 | 50 | 25 | | |
| **Glass plates** | | | | | | | | | |
| ADAMANT | | 821040 | 821040.200 | | 821050 | | 821060 | 0.25 mm | – |
| ADAMANT $UV_{254}$ | 821005 | 821010 | 821010.200 | 821015 | 821020 | 821025 | 821030 | 0.25 mm | $UV_{254}$ |

## ALUGRAM® Xtra SIL G Ax unmodified standard silica layers on aluminum

### Key features

- Outstanding wettability for precise colorization results, even with 100 % aqueous detection reagents
- Excellent separation efficiency and reproducibility from lot to lot
- Easy and reliable cutting due to an optimized binder system, no flaking of silica

### Technical characteristics

- Silica 60, mean pore size 60 Å, specific surface (BET) ~ 500 $m^2$/g, specific pore volume 0.75 mL/g, particle size 5–17 µm
- Binder: highly polymeric product, which is stable in almost all organic solvents and resistant towards aggressive visualization reagents, also completely stable in purely aqueous eluents

### Separation of nutmeg ingredients

MN Appl. No. 403590

| | |
|---|---|
| Layer: | ALUGRAM® Xtra SIL G $UV_{254}$ |
| Sample: | shake 1.0 g freshly powdered drug for 3 min with 4 mL methanol and filter; apply 10 µL |
| Eluent: | toluene – ethyl acetate (95:5, v/v) |
| Migration distance: | 15 cm |
| Detection: | 254 nm: underivatized<br>daylight and 366 nm: spray with 5 % ethanolic sulfuric acid, 1 % vanillic acid and heat to 105 °C |

The chromatograms show the following zones with increasing $R_f$ values: linalool (bluish grey), eugenol (yellowish brown), myristicin (reddish brown), and anethole (pink-violet). Other colored zones may appear.

Daylight 254 nm 366 nm

### Ordering information

| Plate size [cm] | 2.5 x 7.5 | 4 x 8 | 5 x 7.5 | 5 x 10 | 5 x 20 | 10 x 20 | 20 x 20 | Thickness of layer | Fluorescent indicator |
|---|---|---|---|---|---|---|---|---|---|
| Pack of [plates] | 200 | 50 | 20 | 50 | 50 | 20 | 25 | | |
| **ALUGRAM® Xtra aluminum sheets** | | | | | | | | | |
| SIL G | | | 818230.20 | 818261 | 818232 | | 818233 | 0.20 mm | – |
| SIL G/$UV_{254}$ | 818329 | 818331 | 818330.20 | 818360 | 818332 | 818362 | 818333 | 0.20 mm | $UV_{254}$ |

Further application examples can be found online in our application database at *www.mn-net.com/apps*

# Unmodified TLC silica layers

## SIL G G P A unmodified standard silica layers

### Technical characteristics

- Silica 60, mean pore size 60 Å, specific surface (BET) ~ 500 $m^2/g$, specific pore volume 0.75 mL/g, particle size 5–17 µm
- Thickness of layer for analytical plates 0.25 mm, for preparative plates 0.5 and 1 mm; for 2 mm preparative layers a slightly coarser material is used
- Indicators: manganese activated zinc silicate with green fluorescence for short-wave UV (254 nm); special inorganic fluorescent pigment with blue fluorescence for long-wave UV (366 nm)
- Binders: highly polymeric products, which are stable in almost all organic solvents and resistant towards aggressive visualization reagents; binder system for POLYGRAM® sheets is also completely stable in purely aqueous eluents

### Ordering information

#### Glass plates

| Plate size [cm] | 2.5 x 7.5 | 5 x 10 | 5 x 10 | 5 x 20 | 10 x 10 | 10 x 20 | 20 x 20 | Thickness of layer |
|---|---|---|---|---|---|---|---|---|
| Pack of [plates] | 100 | 50 | 200 | 100 | 25 | 50 | 25 | |
| SIL G-25 | | 809017 | 809017.200 | 809011 | | 809012 | 809013 | 0.25 mm |
| SIL G-25 $UV_{254}$ | 809028.100 | 809027 | 809027.200 | 809021 | 809020 | 809022 | 809023 | 0.25 mm |
| SIL G-25 $UV_{254+366}$ | | | | 809121 | | 809122 | 809123 | 0.25 mm |

#### Glass plates

| Pack of [plates] | (preparative TLC) | 20 | |
|---|---|---|---|
| SIL G-50 | | 809051 | 0.50 mm |
| SIL G-50 $UV_{254}$ | | 809053 | 0.50 mm |

#### Glass plates

| Pack of [plates] | (preparative TLC) | 15 | |
|---|---|---|---|
| SIL G-100 | | 809061 | 1.00 mm |
| SIL G-100 $UV_{254}$ | | 809063 | 1.00 mm |

#### Glass plates

| Pack of [plates] | (preparative TLC) | 12 | |
|---|---|---|---|
| SIL G-200 | | 809073 | 2.00 mm |
| SIL G-200 $UV_{254}$ | | 809083 | 2.00 mm |

#### POLYGRAM® polyester sheets

| Plate size [cm] | 2.5 x 7.5 | 4 x 8 | 5 x 20 | 20 x 20 | 40 x 20 | |
|---|---|---|---|---|---|---|
| Pack of [plates] | 200 | 50 | 50 | 25 | 25 | |
| SIL G | 805902 | 805032 | 805012 | 805013 | 805014 | 0.20 mm |
| SIL G/$UV_{254}$ | 805901 | 805021 | 805022 | 805023 | 805024 | 0.20 mm |
| SIL G/$UV_{254}$ | | | | roll 500 x 20 cm 805017 | | 0.20 mm |

#### ALUGRAM® aluminum sheets

| Plate size [cm] | 2.5 x 7.5 | 4 x 8 | 5 x 7.5 | 5 x 10 | 5 x 20 | 10 x 20 | 20 x 20 | |
|---|---|---|---|---|---|---|---|---|
| Pack of [plates] | 200 | 50 | 20 | 50 | 50 | 20 | 25 | |
| SIL G | | | 818030.20 | 818161 | 818032 | 818163 | 818033 | 0.20 mm |
| SIL G/$UV_{254}$ | 818129 | 818131 | 818130.20 | 818160 | 818132 | 818162 | 818133 | 0.20 mm |

Further application examples can be found online in our application database at *www.mn-net.com/apps*

## DURASIL G unmodified standard silica layers

### Technical characteristics

- Silica 60, mean pore size 60 Å, specific surface (BET) ~ 500 $m^2/g$, specific pore volume 0.75 mL/g, particle size 5–17 µm
- Hard, water-resistant and wettable layers due to a special binder system

### Ordering information

| Plate size [cm] | 5 x 10 | 5 x 10 | 5 x 20 | 10 x 20 | 20 x 20 | Thickness of layer | Fluorescent indicator |
|---|---|---|---|---|---|---|---|
| Pack of [plates] | 50 | 200 | 100 | 50 | 25 | | |
| **Glass plates** | | | | | | | |
| DURASIL-25 | | | | 812003 | 812004 | 0.25 mm | – |
| DURASIL-25 $UV_{254}$ | 812005 | 812005.200 | 812006 | 812007 | 812008 | 0.25 mm | $UV_{254}$ |

The most TLC layers are available as glass plate, polyester- or aluminum sheet (also see page 272 and 273).

## MN TLC pre-coated layers – qualitative and individual tailored

### Kieselguhr zone

- For rapid sample application
- Because kieselguhr is completely inert towards a large number of compounds, the samples always form a narrow band at the interface of the two adsorbents, irrespective of shape, size or position of the spots in the concentrating zone. Separation then takes place in the silica layer.

Arbitrary application in the concentrating zone | Applied substances are concentrated | Applied substances at the phase boundary | Developed chromatogram

## SILGUR G Ax unmodified standard silica layers with concentrating zone

### Technical characteristics

- Silica 60, mean pore size 60 Å, specific surface (BET) ~ 500 $m^2/g$, specific pore volume 0.75 mL/g, particle size 5–17 µm
- Kieselguhr zone for rapid sample application (see page 278)
- Channel-plate with 19 channels help to prevent cross contamination by separating several samples
- More samples can be separated on a plate, and spot areas can be more easily determined

### Ordering information

| Plate size [cm] | 10 x 20 | 20 x 20 | Thickness of layer | Fluorescent indicator |
|---|---|---|---|---|
| **Glass plates** | | | | |
| Pack of [plates] | 50 | 25 | | |
| SILGUR-25 | 810012 | 810013 | 0.25 mm | – |
| SILGUR-25 $UV_{254}$ | 810022 | 810023 | 0.25 mm | $UV_{254}$ |
| **Channel-Plates** | | | | |
| Pack of [plates] | | 25 | | |
| SILGUR-25-C $UV_{254}$ | | 810123 | 0.25 mm | $UV_{254}$ |
| **ALUGRAM® Xtra aluminum sheets** | | | | |
| Pack of [plates] | 20 | 25 | | |
| SILGUR | 818412 | 818413 | 0.20 mm | – |
| SILGUR $UV_{254}$ | 818422 | 818423 | 0.20 mm | $UV_{254}$ |

## Nano-SILGUR G Ax unmodified HPTLC silica layers with concentrating zone

### Technical characteristics

- Nano silica 60, pore size 60 Å, specific surface (BET) ~ 500 $m^2/g$, mean specific pore volume 0.75 mL/g, particle size 2–10 µm
- Kieselguhr zone for rapid sample application (see page 278)

### Ordering information

| Plate size [cm] | 10 x 10 | Thickness of layer | Fluorescent indicator |
|---|---|---|---|
| Pack of [plates] | 25 | | |
| **Glass plates** | | | |
| Nano-SILGUR-20 | 811032 | 0.20 mm | – |
| Nano-SILGUR-20 $UV_{254}$ | 811042 | 0.20 mm | $UV_{254}$ |
| **ALUGRAM® Xtra aluminum sheets** | | | |
| Nano-SILGUR | 818432 | 0.20 mm | – |
| Nano-SILGUR $UV_{254}$ | 818442 | 0.20 mm | $UV_{254}$ |

## Sharper separation by nano silica

### Nano silica for HPTLC

- Narrow fractionation of the silica particles allows theoretical plate heights, which are one order of magnitude smaller than on standard silica layers.

### Advantages

- Shorter migration distances
- Lower amount of samples required
- Increased detection sensitivity with equal selectivity
- Less developing time

Nano silica

Standard silica

Comparison of ADAMANT and Nano-ADAMANT plates for separation of anthraquinone dyes

Layers: A) ADAMANT
B) Nano-ADAMANT
Sample: 1 µL, about 0.1 %
Eluent: toluene – cyclohexane (4:3, v/v)
Migration time: A) 30 min, B) 15 min

Peaks:
1. Blue 3
2. Violet 2
3. Red
4. Green
5. Blue 1
6. Greenish blue
7. Violet 1

A)

B)

## Nano-ADAMANT G unmodified HPTLC silica layers

### Key features

- Outstanding hardness and abrasion resistance due to an optimized binder system
- Increased separation efficiency due to an optimized particle size distribution
- High suitability for trace analyses resulting from a UV indicator with increased brilliance and a lownoise background of the layer

### Technical characteristics

- Nano silica 60, mean pore size 60 Å, specific surface (BET) ~ 500 $m^2$/g, specific pore volume 0.75 mL/g, particle size 2–10 µm

### Ordering information

| Plate size [cm] | 10 x 10 | 10 x 20 | Thickness of layer | Fluorescent indicator |
|---|---|---|---|---|
| Pack of [plates] | 25 | 50 | | |
| **Glass plates** | | | | |
| Nano-ADAMANT | 821140 | 821150 | 0.20 mm | – |
| Nano-ADAMANT $UV_{254}$ | 821110 | 821120 | 0.20 mm | $UV_{254}$ |

## Nano-SIL G Ax A unmodified HPTLC silica layers

### Technical characteristics

- Nano silica 60, mean pore size 60 Å, specific surface (BET) ~ 500 $m^2$/g, specific pore volume 0.75 mL/g, particle size 2–10 µm
- Indicator: manganese activated zinc silicate with green fluorescence for short-wave UV (254 nm)
- Binder: highly polymeric product, which is stable in almost all organic solvents and resistant towards aggressive visualization reagents

### Ordering information

| Plate size [cm] | 5 x 5 | 5 x 20 | 10 x 10 | 10 x 20 | 20 x 20 | Thickness of layer | Fluorescent indicator |
|---|---|---|---|---|---|---|---|
| Pack of [plates] | 100 | 50 | 25 | 50 | 25 | | |
| **Glass plates** | | | | | | | |
| Nano-SIL-20 | 811011 | | 811012 | 811013 | | 0.20 mm | – |
| Nano-SIL-20 $UV_{254}$ | 811021 | | 811022 | 811023 | | 0.20 mm | $UV_{254}$ |
| **ALUGRAM® Xtra aluminum sheets** | | | | | | | |
| Nano-SIL G | | 818240 | | | 818241 | 0.20 mm | – |
| Nano-SIL G/$UV_{254}$ | | 818342 | | | 818343 | 0.20 mm | $UV_{254}$ |
| **ALUGRAM® aluminum sheets** | | | | | | | |
| Nano-SIL G | | | | | 818141 | 0.20 mm | – |
| Nano-SIL G/$UV_{254}$ | | | | | 818143 | 0.20 mm | $UV_{254}$ |

## Nano-DURASIL G unmodified HPTLC silica layers

### Technical characteristics

- Nano silica 60, mean pore size 60 Å, specific surface (BET) ~ 500 $m^2/g$, specific pore volume 0.75 mL/g, particle size 2–10 µm
- Indicator: manganese activated zinc silicate with green fluorescence for short-wave UV (254 nm)
- Hard, water-resistant and wettable layers due to a special binder system
- Different selectivity compared to ADAMANT and SIL-G plates no reversed phase tendency, more polar than Nano-SIL

### Ordering information

| Plate size [cm]<br>Pack of [plates] | 10 x 10<br>25 | 10 x 20<br>50 | Thickness of layer | Fluorescent indicator |
|---|---|---|---|---|
| **Glass plates** | | | | |
| Nano-DURASIL-20 | 812010 | 812011 | 0.20 mm | – |
| Nano-DURASIL-20 $UV_{254}$ | 812013 | 812014 | 0.20 mm | $UV_{254}$ |

## MACHEREY-NAGEL CHROMABOND® SPE and Flash products

### High-performance products for sample preparation

- Comprehensive range of RP- and normal phases as well as ion exchangers
- Polymer and silica based phases
- Phases for special applications like food or environmental analysis
- SPE polypropylene columns and cartridges, MULTI 96 plates and SPE accessories
- High throughput SPE
- Flash chromatography cartridges

More information from page 9 onwards as well as online at *www.mn-net.com/chroma*

## Nano-SIL C18 G octadecyl-modified HPTLC silica layers

### Technical characteristics

- Nano silica 60, mean pore size 60 Å, specific surface (BET) ~ 500 $m^2/g$, specific pore volume 0.75 mL/g, pH stability 2–10, particle size 2–10 µm
- Indicator: acid-resistant product with a pale blue fluorescence for short-wave UV (254 nm), UV-absorbing substances appear as dark-blue to black spots on a light-blue background

### Modification

- Partial (50 %) or complete (100 %) octadecyl modification, carbon content 7.5 and 14 %, respectively
- Order of polarity: silica > DIOL > $NH_2$ > CN > RP-2 > C18-50 > RP-18 W > C18-100

### Recommended application

- Reversed phase separation mode with eluents from anhydrous solvents to mixtures with high concentrations of water (see table and figure below)
- Alkaloids, amino acids, preservatives, optical brighteners, barbiturates, polycyclic aromatic hydrocarbons (PAH), drugs, peptides, flavonoids, phenols, indole derivatives, steroids

### Ordering information

| Plate size [cm] | | 10 x 10 | Thickness of layer | Fluorescent indicator |
|---|---|---|---|---|
| Pack of [plates] | | 25 | | |
| **Glass plates** | | | | |
| Nano-SIL C18-50 | 50 % silanized | 811054 | 0.20 mm | – |
| Nano-SIL C18-50 $UV_{254}$ | 50 % silanized | 811064 | 0.20 mm | $UV_{254}$ |
| Nano-SIL C18-100 | 100 % silanized | 811052 | 0.20 mm | – |
| Nano-SIL C18-100 $UV_{254}$ | 100 % silanized | 811062 | 0.20 mm | $UV_{254}$ |

| Eluent | v/v | Migration distances [mm/15 min] | | |
|---|---|---|---|---|
| | | C18-50 | C18-100 | RP-18 W |
| Methanol – $H_2O$ | 2:1 | 57 | 45 | 44 |
| | 1:1 | 52 | 21 | 40 |
| | 1:2 | 50 | 0 | 43 |
| | 1:3 | 40 | 0 | 45 |
| | 1:4 | 30 | 0 | 46 |
| | 0:1 | 0 | 0 | 54 |
| Acetonitrile – $H_2O$ | 2:1 | 62 | 46 | 66 |
| | 1:1 | 52 | 30 | 54 |
| | 1:2 | 51 | 27 | 46 |
| | 1:3 | 48 | 15 | 44 |
| | 1:9 | 20 | 0 | 42 |
| Trichloromethane | | 68 | 64 | 71 |

Migration of C18-50 and C18-100 silica layers as compared to RP-18 W plates

a) RP-18 W, b) Nano-SIL C18-50, c) Nano-SIL C18-100
all plates with UV indicator
methanol – water; acetonitrile – water

Elution properties of MN RP plates in mixtures of methanol – water and acetonitrile – water

Further application examples can be found online in our application database at *www.mn-net.com/apps*

# Modified silica layers

## RP-18 W/$UV_{254}$ G A octadecyl-modified HPTLC silica layers

### Technical characteristics

- Nano silica 60, mean pore size 60 Å, specific surface (BET) ~ 500 $m^2$/g, specific pore volume 0.75 mL/g, particle size 2–10 µm, for preparative plates (1 mm thickness of layer) standard silica 60, pH stability 2–10, particle size 5–17 µm
- Indicator: acid-resistant product with a pale blue fluorescence for short-wave UV (254 nm), UV-absorbing substances appear as dark-blue to black spots on a light-blue background

### Modification

- Partial octadecyl ($C_{18}$) modification, wettable with water, carbon content 14 %
- Order of polarity:
  silica > DIOL > $NH_2$ > CN > RP-2 > C18-50 > RP-18 W > C18-100

### Recommended application

- NP or RP separation with eluents from anhydrous solvents to mixtures with high concentrations of water (see table and figure on previous page), relative polarity of the eluent determines the polarity of the layer
- Aminophenols, barbiturates, preservatives, nucleobases, polycyclic aromatic hydrocarbons, steroids, tetracyclines, plasticizers (phthalates)

### Ordering information

| Plate size [cm] | 4 x 8 | 5 x 10 | 5 x 20 | 10 x 10 | 10 x 20 | 20 x 20 | Thickness of layer | Fluorescent indicator |
|---|---|---|---|---|---|---|---|---|
| **Glass plates** | | | | | | | | |
| Pack of [plates] | | | 50 | 25 | 50 | 25 | | |
| RP-18 W/$UV_{254}$ | | | 811073 | 811075 | 811072 | 811071 | 0.25 mm | $UV_{254}$ |
| Pack of [plates] (preparative TLC) | | | | | | 15 | | |
| RP-18 W/$UV_{254}$ | | | | | | 811074 | 1.00 mm | $UV_{254}$ |
| **ALUGRAM® aluminum sheets** | | | | | | | | |
| Pack of [plates] | 50 | 50 | 50 | 25 | | 25 | | |
| RP-18 W/$UV_{254}$ | 818144 | 818152 | 818145 | 818147 | | 818146 | 0.15 mm | $UV_{254}$ |

## RP-2/$UV_{254}$ G A "silanized silica" = dimethyl-modified standard silica layers

### Technical characteristics

- Silica 60, mean pore size 60 Å, specific surface (BET) ~ 500 $m^2$/g, specific pore volume 0.75 mL/g, pH stability 2–10, particle size 5–17 µm
- Indicator: acid-resistant product with a pale blue fluorescence for short-wave UV (254 nm), UV-absorbing substances appear as dark-blue to black spots on a light-blue background

### Modification

- Silanized silica with dimethyl modification, carbon content 4 %
- Order of polarity:
  silica > DIOL > $NH_2$ > CN > RP-2 > C18-50 > RP-18 W > C18-100

### Recommended application

- Normal phase or reversed phase separation modes with purely organic, organic - aqueous or purely aqueous eluents
- Active plant constituents, steroids

### Ordering information

| Plate size [cm] | 10 x 20 | 20 x 20 | Thickness of layer | Fluorescent indicator |
|---|---|---|---|---|
| Pack of [plates] | 50 | 25 | | |
| **Glass plates** | | | | |
| RP-2/$UV_{254}$ | 811081 | 811082 | 0.25 mm | $UV_{254}$ |
| **ALUGRAM® aluminum sheets** | | | | |
| RP-2/$UV_{254}$ | | 818171 | 0.15 mm | $UV_{254}$ |

## Nano-SIL CN G A cyano-modified HPTLC silica layers

### Technical characteristics

- Nano silica 60, mean pore size 60 Å, specific surface (BET) ~ 500 $m^2/g$, specific pore volume 0.75 mL/g, pH stability 2–8, particle size 2–10 µm
- Indicator: acid-resistant product with a pale blue fluorescence for short-wave UV (254 nm), UV-absorbing substances appear as dark-blue to black spots on a light-blue background

### Modification

- Cyanopropyl modification, carbon content 5.5 %
- Order of polarity: silica > DIOL > $NH_2$ > CN > RP-2 > C18-50 > RP-18 W > C18-100

### Recommended application

- NP or RP separation modes depending on the polarity of the developing solvent (see figure below)
- Steroid hormones, phenols, preservatives

$R_f$ values of different steroids as a function of eluent composition

Layer: Nano-SIL CN/UV

Polarity of the eluent governs the type of separation mechanism:

Eluent system petroleum ether (PE) – acetone (NP mode)

the higher the concentration of PE, the stronger are the adsorptive interactions of the steroids with the stationary phase

Eluent system acetone – water (RP mode)

the sequence of elution of the steroids is reversed, the most nonpolar compounds are most strongly retained

Separation of preservatives

MN Appl. No. 401440

| | |
|---|---|
| Layer: | Nano-SIL CN/UV |
| Sample volume: | 400 nL |
| Eluent: | ethanol – water – glacial acetic acid (20:80:0.2) with 0.1 mol/L tetraethylammonium chloride |
| Migration distance: | 73 mm in 30 min |
| Detection: | TLC scanner, UV 254 nm |

Peaks:
1. Propyl p-hydroxybenzoate
2. Ethyl p-hydroxybenzoate
3. Methyl p-hydroxybenzoate
4. Benzoic acid
5. Sorbic acid

### Ordering information

| Plate size [cm] | 4 x 8 | 10 x 10 | 10 x 20 | Thickness of layer | Fluorescent indicator |
|---|---|---|---|---|---|
| Pack of [plates] | 50 | 25 | 25 | | |
| **Glass plates** | | | | | |
| Nano-SIL CN/UV | | 811115 | 811116 | 0.20 mm | $UV_{254}$ |
| **ALUGRAM® aluminum sheets** | | | | | |
| Nano-SIL CN/UV | 818184 | | | 0.15 mm | $UV_{254}$ |

# Modified silica layers

## Nano-SIL $NH_2$ G A amino-modified HPTLC silica layers

### Technical characteristics

- Nano silica 60, mean pore size 60 Å, specific surface (BET) ~ 500 $m^2/g$, specific pore volume 0.75 mL/g, pH stability 2–8, particle size 2–10 µm
- Indicator: acid-resistant product with a pale blue fluorescence for short-wave UV (254 nm), UV-absorbing substances appear as dark-blue to black spots on a light-blue background

### Modification

- Aminopropyl modification, carbon content 3.5 %
- Order of polarity: silica > DIOL > $NH_2$ > CN > RP-2 > C18-50 > RP-18 W > C18-100
- Layer can be wetted equally well with pure water as with organic solvents

### Recommended application

- Vitamins, sugars, steroids, purine derivatives, xanthines, phenols, nucleotides and pesticides

Influence of eluent composition on the separation of nucleotides

| | |
|---|---|
| Layer: | Nano-SIL $NH_2$/UV |
| Eluent: | MeOH – $H_2O$ according to fig. + 0.18 mol/L NaCl |
| Migration distance: | 7 cm |
| c-AMP, AMP: | adenosine monophosphate |
| ADP: | adenosine diphosphate |
| ATP: | adenosine triphosphate |

Separation of sugars

MN Appl. No. 401590

| | |
|---|---|
| Layer: | Nano-SIL $NH_2$/UV |
| Sample volume: | 0.5 µL |
| Eluent: | ethyl acetate – pyridine – water – glacial acetic acid (60:30:10:5, v/v/v/v) |
| Migration distance: | 80 mm in 45 min, double development |
| Detection: | dry layer at 160 °C for 5 min, TLC scanner, UV 254 nm |

Peaks (0.1 % each):
1. Lactose
2. Saccharose
3. Galactose
4. Glucose
5. Fructose
6. Arabinose
7. Xylose
8. Ribose

## Ordering information

| Plate size [cm] | 4 x 8 | 10 x 10 | 10 x 20 | Thickness of layer | Fluorescent indicator |
|---|---|---|---|---|---|
| Pack of [plates] | 50 | 25 | 25 | | |
| **Glass plates** | | | | | |
| Nano-SIL $NH_2$/UV | | 811111 | 811112 | 0.20 mm | $UV_{254}$ |
| **ALUGRAM® aluminum sheets** | | | | | |
| Nano-SIL $NH_2$/UV | 818182 | | | 0.15 mm | $UV_{254}$ |

Further application examples can be found online in our application database at *www.mn-net.com/apps*

## Nano-SIL DIOL G diol-modified HPTLC silica layers

### Technical characteristics

- Nano silica 60, mean pore size 60 Å, specific surface (BET) ~ 500 $m^2/g$, specific pore volume 0.75 mL/g, pH stability 2–8, particle size 2–10 µm
- Indicator: acid-resistant product with a pale blue fluorescence for short-wave UV (254 nm), UV-absorbing substances appear as dark-blue to black spots on a light-blue background

### Modification

- Diol modification, carbon content 5.5 %
- Order of polarity: silica > DIOL > $NH_2$ > CN > RP-2 > C18-50 > RP-18 W > C18-100
- Layer can be wetted equally well with pure water as with organic solvents

### Recommended application

- Steroids, pesticides and plant constituents
- For critical separations an alternative to silica
- Since it is less sensitive to the water content of the environment, leads to more reproducible results compared to silica

Separation of herbicides

MN Appl. No. 401950

| | |
|---|---|
| Layer: | Nano-SIL DIOL/UV |
| Sample volume: | 2 µL |
| Eluent: | petroleum ether (40–60 °C) – acetone (80:20, v/v) |
| Migration distance: | 70 mm |
| Detection: | TLC scanner, 230 nm |

Peaks:
(0.07 % each in methanol)
1. Metoxuron
2. Monuron
3. Metobromuron

### Ordering information

| Plate size [cm] | 10 x 10 | Thickness of layer | Fluorescent indicator |
|---|---|---|---|
| Pack of [plates] | 25 | | |
| **Glass plates** | | | |
| Nano-SIL DIOL/UV | 811120 | 0.20 mm | $UV_{254}$ |

## Alox G P A aluminum oxide layers

### Technical characteristics

- Aluminum oxide, mean pore size 60 Å, specific surface (BET) ~ 200 $m^2/g$
- Inert organic binder
- Indicator: manganese-activated zinc silicate

### Recommended application

- Terpenes, alkaloids, steroids, aliphatic and aromatic compounds
- We recommend to activate aluminum oxide layers before use by heating 10 minutes at 120 °C

#### Separation of bisadducts of fullerenes

MN Appl. No. 401930

F. Djojo, A. Hirsch, Chem. Eur. J. 4 (1998), 344–356

Layer: ALUGRAM® Alox N/$UV_{254}$
Eluent: toluene – ethyl acetate (95:5, v/v)
Detection: UV, 254 nm

| Compound | $R_f$ values |
|---|---|
| Bis[bis(4-phenyloxazolin)methane]fullerene 1 | 0.14 |
| Bis[bis(4-phenyloxazolin)methane]fullerene 2 | 0.26 |

#### Separation of lipophilic dyes

MN Appl. No. 403010

Layer: Alox-25 $UV_{254}$
Sample volume: 1000 nL
Eluent: toluene – cyclohexane (2:1, v/v)
Migration distance: 108 mm in 15 min
Detection: TLC scanner, UV 254 nm

Peaks:
1. Indophenol
2. Sudan red G
3. Sudan blue II
4. Butter yellow

## Ordering information

| Plate size [cm] | 4 x 8 | 5 x 20 | 20 x 20 | Thickness of layer | Fluorescent indicator |
|---|---|---|---|---|---|
| **Glass plates** | | | | | |
| Pack of [plates] | | 100 | 25 | | |
| Alox-25 $UV_{254}$ | | 807021 | 807023 | 0.25 mm | $UV_{254}$ |
| Pack of [plates] (preparative TLC) | | | 15 | | |
| Alox-100 $UV_{254}$ | | | 807033 | 1.00 mm | $UV_{254}$ |
| **POLYGRAM® polyester sheets** | | | | | |
| Pack of [plates] | 50 | 50 | 25 | | |
| Alox N/$UV_{254}$ | 802021 | 802022 | 802023 | 0.20 mm | $UV_{254}$ |
| **ALUGRAM® aluminum sheets** | | | | | |
| Pack of [plates] | | 50 | 25 | | |
| Alox N/$UV_{254}$ | | 818024 | 818023 | 0.20 mm | $UV_{254}$ |

Further application examples can be found online in our application database at *www.mn-net.com/apps*

## Cellulose MN 300 G P A native fibrous cellulose layers

### Technical characteristics

- Fiber length (95 %) 2–20 µm, average degree of polymerization 400–500, specific surface acc. to Blaine 15 000 $cm^2/g$, ≤ 20 ppm Fe, 6 ppm Cu, 7 ppm P; $CH_2Cl_2$- extract ≤ 0.25 %; residue on ignition at 850 °C ≤ 1500 ppm

### Recommended application

- Partition chromatography of polar substances such as amino acids, carboxylic acids or carbohydrates

### Ordering information

| Plate size [cm] | 4 x 8 | 5 x 20 | 20 x 20 | Thickness of layer | Fluorescent indicator |
|---|---|---|---|---|---|
| **Glass plates** | | | | | |
| Pack of [plates] | | | 25 | | |
| CEL 300-10 | | | 808013 | 0.10 mm | – |
| CEL 300-10 $UV_{254}$ | | | 808023 | 0.10 mm | $UV_{254}$ |
| CEL 300-25 | | | 808033 | 0.25 mm | – |
| CEL 300-25 $UV_{254}$ | | | 808043 | 0.25 mm | $UV_{254}$ |
| Pack of [plates] (preparative TLC) | | | 20 | | |
| CEL 300-50 | | | 808053 | 0.50 mm | – |
| CEL 300-50 $UV_{254}$ | | | 808063 | 0.50 mm | $UV_{254}$ |
| **POLYGRAM® polyester sheets** | | | | | |
| Pack of [plates] | 50 | 50 | 25 | | |
| CEL 300 | 801011 | | 801013 | 0.10 mm | – |
| CEL 300 $UV_{254}$ | | 801022 | 801023 | 0.10 mm | $UV_{254}$ |
| **ALUGRAM® aluminum sheets** | | | | | |
| Pack of [plates] | 50 | 50 | 25 | | |
| CEL 300 | 818155 | | 818153 | 0.10 mm | – |
| CEL 300 $UV_{254}$ | | 818157 | 818156 | 0.10 mm | $UV_{254}$ |

## Cellulose MN 400 (AVICEL®) G P microcrystalline cellulose layers

### Technical characteristics

- Prepared by hydrolysis of high purity cellulose with HCl, average degree of polymerization 40–200

### Recommended application

- Carboxylic acids, lower alcohols, urea and purine derivatives

### Ordering information

| Plate size [cm] | 10 x 20 | 20 x 20 | Thickness of layer | Fluorescent indicator |
|---|---|---|---|---|
| Pack of [plates] | 50 | 25 | | |
| **Glass plates** | | | | |
| CEL 400-10 | 808072 | 808073 | 0.10 mm | – |
| **POLYGRAM® polyester sheets** | | | | |
| CEL 400 | | 801113 | 0.10 mm | – |
| CEL 400 $UV_{254}$ | | 801123 | 0.10 mm | $UV_{254}$ |

## Cellulose MN 300 PEI P PEI-impregnated cellulose ion exchange layers

### Technical characteristics

- Fibrous cellulose impregnated with polyethyleneimine

### Recommended application

- Analysis of nucleic acids, and of mutagenic substances with the $^{32}P$ postlabelling procedure

### Ordering information

| Plate size [cm]<br>Pack of [plates] | 20 x 20<br>25 | Thickness of layer | Fluorescent indicator |
|---|---|---|---|
| **POLYGRAM® polyester sheets** | | | |
| CEL 300 PEI | 801053 | 0.10 mm | – |
| CEL 300 PEI/$UV_{254}$ | 801063 | 0.10 mm | $UV_{254}$ |

## Cellulose MN 300 AC P acetylated cellulose layers

### Technical characteristics

- Fibrous cellulose with 10 % content of acetylated cellulose for reversed phase chromatography

### Recommended application

- Reversed phase chromatography

### Ordering information

| Plate size [cm]<br>Pack of [plates] | Acetyl content | 20 x 20<br>25 | Thickness of layer | Fluorescent indicator |
|---|---|---|---|---|
| **POLYGRAM® polyester sheets** | | | | |
| CEL 300 AC-10 % | 10 % | 801033 | 0.10 mm | – |

## Polyamid-6 P ε-polycaprolactame layers

### Technical characteristics

- Polyamide 6 = nylon 6 = perlon = ε-aminopolycaprolactame
- Separation mechanism based on hydrogen bonds to amide groups of the polymer matrix as well as on ionic, dipole and electron donor-acceptor interactions

### Recommended application

- Natural compounds, phenols, carboxylic acids, aromatic nitro compounds and especially amino acids

### Ordering information

| Plate size [cm]<br>Pack of [plates] | 5 x 20<br>50 | 20 x 20<br>25 | Thickness of layer | Fluorescent indicator |
|---|---|---|---|---|
| **POLYGRAM® polyester sheets** | | | | |
| POLYAMID-6 | 803012 | 803013 | 0.10 mm | – |
| POLYAMID-6 $UV_{254}$ | 803022 | 803023 | 0.10 mm | $UV_{254}$ |

Further application examples can be found online in our application database at *www.mn-net.com/apps*

## CHIRALPLATE G special layer enantiomer separation

### Technical characteristics

- Reversed phase nano silica impregnated with $Cu^{2+}$ ions and a chiral selector (proline derivative)
- Separation based on ligand exchange, i.e. formation of ternary mixed-ligand complexes with the Cu(II) ions, differences in the stability of the diastereomeric complexes cause chromatographic separation

### Recommended application

- Enantiomer separation of amino acids, *N*-methylamino acids, *N*-formylamino acids, α-alkylamino acids, thiazolidine derivatives, dipeptides, lactones, α-hydroxycarboxylic acids

Enantiomer separation of amino acids

MN Appl. No. 400520

Quantitative determination (remission location curves) of TLC-separated enantiomers of *tert*.-leucine:

Layer: CHIRALPLATE
Eluent: methanol – water (10:80, v/v)
Detection: dip in 0.3 % ninhydrin solution
quantification with scanner, 520 nm

a) L-*tert*.-leucine
b) L-*tert*.-leucine + 0.1 % D-*tert*.-leucine
c) L-*tert*.-leucine + 1 % D-*tert*.-leucine
d) external reference sample

### Ordering information

| Plate size [cm] | 5 x 20 | 10 x 10 | 10 x 20 | 20 x 20 | Thickness of layer | Fluorescent indicator |
|---|---|---|---|---|---|---|
| **Glass plates** | | | | | | |
| Pack of [plates] | | | 4 | | | |
| CHIRALPLATE | | | 811056 | | 0.25 mm | $UV_{254}$ |
| Pack of [plates] | 50 | 25 | 25 | 25 | | |
| CHIRALPLATE | 811057 | 811059 | 811055 | 811058 | 0.25 mm | $UV_{254}$ |

## SIL N-HR P unmodified standard silica layers

### Technical characteristics

- High purity silica 60, mean pore size 60 Å, specific surface (BET) ~ 500 $m^2/g$, specific pore volume 0.75 mL/g, particle size 5–17 µm, different binder system compared to SIL G results in different separation characteristics
- A special feature of the POLYGRAM® SIL N-HR is a higher gypsum content

### Ordering information

| Plate size [cm] | 5 x 20 | 20 x 20 | Thickness of layer | Fluorescent indicator |
|---|---|---|---|---|
| Pack of [plates] | 50 | 25 | | |
| **POLYGRAM® polyester sheets** | | | | |
| SIL N-HR/$UV_{254}$ | 804022 | 804023 | 0.20 mm | $UV_{254}$ |

## SIL G-25 HR G special layer for aflatoxin separation

### Technical characteristics

- High purity silica 60 with gypsum and a very small quantity of a polymeric organic binder; softer than the standard silica layer, i.e. spots can be scratched and the layer absorbs faster

### Recommended application

- Aflatoxins

### Ordering information

| Plate size [cm]<br>Pack of [plates] | 20 x 20<br>25 | Thickness of layer | Fluorescent indicator |
|---|---|---|---|
| **Glass plates** | | | |
| SIL G-25 HR | 809033 | 0.25 mm | – |
| SIL G-25 HR/$UV_{254}$ | 809043 | 0.25 mm | $UV_{254}$ |

## SIL G-25 Tenside G special layer for separation of surfactants

### Technical characteristics

- Silica G impregnated with ammonium sulfate

### Recommended application

- Detergents, alkanesulfonates, polyglycols

### Ordering information

| Plate size [cm]<br>Pack of [plates] | 20 x 20<br>25 | Thickness of layer | Fluorescent indicator |
|---|---|---|---|
| **Glass plates** | | | |
| SIL G-25 Tenside | 810063 | 0.25 mm | – |

## Nano-SIL PAH G special HPTLC silica layer for PAH analysis

### Technical characteristics

- Nano silica 60, mean pore size 60 Å, specific surface (BET) ~ 500 $m^2/g$, specific pore volume 0.75 mL/g, particle size 2–10 µm
- Impregnated with caffeine, an electron acceptor for PAH analysis based on charge-transfer complexes

### Recommended application

- 6 PAHs according to German drinking water specifications (TVO) in accordance with German standard DIN 38407 part 7

### Ordering information

| Plate size [cm]<br>Pack of [plates] | 10 x 20<br>50 | Thickness of layer | Fluorescent indicator |
|---|---|---|---|
| **Glass plates** | | | |
| Nano-SIL PAH | 811051 | 0.20 mm | – |

Further application examples can be found online in our application database at *www.mn-net.com/apps*

## IONEX P special mixed layers of silica with ion exchange resins

IONEX-25 SA-Na:

- Mixture of silica and a strongly acidic cation exchanger coated to polyester sheets

IONEX-25 SB-AC:

- Mixture of silica and a strongly basic anion exchanger coated to polyester sheets
- Both layers contain an inert organic binder

✓ Recommended application

- Amino acids, e.g., in protein and peptide hydrolyzates, in seeds and fodder, in biological fluids; for racemate separation in peptide syntheses, for the separation of nucleic acid hydrolyzates, aminosugars, amino acids, antibiotics, inorganic phosphates, cations and other compounds with ionic groups

### Ordering information

| Plate size [cm]<br>Pack of [plates] | | 20 x 20<br>25 | Thickness of layer | Fluorescent indicator |
|---|---|---|---|---|
| **POLYGRAM® polyester sheets** | | | | |
| IONEX-25 SA-Na | strongly acidic cation exchanger | 806013 | 0.20 mm | – |
| IONEX-25 SB-AC | strongly basic anion exchanger | 806023 | 0.20 mm | – |

## Mixed layers for TLC G

Alox/CEL-AC-Mix-25:

- Mixed layer of aluminum oxide G and acetylated cellulose, recommended for separation of PAH

SILCEL-Mix-25:

- Mixed layer of cellulose and silica, recommended for separation of preservatives and other antimicrobial compounds

### Ordering information

| Plate size [cm]<br>Pack of [plates] | 20 x 20<br>25 | Thickness of layer | Fluorescent indicator |
|---|---|---|---|
| **Glass plates** | | | |
| Alox/CEL-AC-Mix-25 | 810053 | 0.25 mm | – |
| SILCEL-Mix-25 $UV_{254}$ | 810043 | 0.25 mm | $UV_{254}$ |

Further application examples can be found online in our application database at *www.mn-net.com/apps*

## Chromatography papers

### Chromatography papers

- Paper chromatography is the oldest chromatographic technique separation due to partition of the analytes between special paper grades and the mobile phase, which penetrates the paper by capillary action ascending.
- Descending and circular techniques are possible

### Please note

- Always treat chromatography papers with care
- Never touch them with fingers, because this will contaminate the surface
- Do not bend them sharply, because this will decrease the capillary action (preferably store them flat)

### Direction

- Chromatography papers possess a preferred direction of the fibers with higher absorption properties (with our sheets 58 x 60 cm, the longer edge)
- We recommend to use them in the direction of higher absorption

### Ordering information

| Code | Weight [g/m$^2$] | Thickness [mm] | Description | Flow rate | Size [cm] | Pack of | REF |
|---|---|---|---|---|---|---|---|
| MN 214 | 140 | 0.28 | smooth | 90–100 mm/30 min | 58 x 60 | 100 sheets | 817001 |
| MN 218 | 180 | 0.36 | smooth | 90–100 mm/30 min | 58 x 60 | 100 sheets | 817002 |
| MN 260 | 90 | 0.20 | smooth | 120–130 mm/30 min | 58 x 60 | 100 sheets | 817003 |
| MN 261 | 90 | 0.18 | smooth | 90–100 mm/30 min | 58 x 60 | 100 sheets | 817004 |
| MN 827 | 270 | 0.70 | soft carton | 130–140 mm/10 min | 58 x 60 | 100 sheets | 817005 |
| MN 866 | 650 | 1.70 | soft carton | 100–120 mm/10 min | 38 x 38 | 100 sheets | 817006 |
| MN 866 | 650 | 1.70 | soft carton | 100–120 mm/10 min | 80 x 80 | 100 sheets | 817007 |
| MN 214 ff | 140 | 0.28 | MN 214 defatted * | 90–100 mm/30 min | 56 x 58 | 100 sheets | 817008 |

* This paper is extracted with organic solvents.

For further papers, filters and membranes, feel free to ask for our catalog “Filtration”.

## Accessories

- Beside ready-to-use layers for thin layer chromatography also accessories are required
- Selection of accessories for reliable separation in TLC

### Ordering information

| Designation | Pack of | REF |
|---|---|---|
| Simultaneous developing chamber for TLC, 20 x 20 cm | 1 | 814019 |
| Simultaneous developing chamber for TLC, 10 x 10 cm | 1 | 814018 |
| Developing chambers for TLC micro-sets | 4 | 814021 |
| Glass laboratory sprayer with rubber bulb | 1 | 814101 |
| Glass capillaries 1 µL | 3 x 50 | 814022 |
| Rubber caps for capillaries | 2 | 814102 |
| Plastic syringe, 1 mL content with graduation | 1 | 814104 |
| Spotting guides | 2 | 814023 |
| Measuring cylinders, glass, 10 mL content | 2 | 814024 |
| MN ALUGRAM® scissors, ground blade, black handle | 1 | 818666 |
| Filter paper MN 713, 15 x 21 cm | 100 | 814103 |
| Folded filters MN 615 1/4, 11 cm diameter | 100 | 531011 |
| Chromatography paper MN 260, 7.5 x 17 cm (for chamber saturation) | 100 | 814030 |

## Visualization reagents

- Small selection of frequently used spray reagents for post chromatographic detection reactions in TLC suited for spraying or dipping TLC plates
- A detailed description of many more detection procedures for TLC is available on request

### Ordering information

| Spray reagent | Solvent | Detection of | Pack of | REF |
|---|---|---|---|---|
| Aniline phthalate | 2-propanol – ethanol (1:1) | reducing sugars, oxohalic acids | 100 mL | 814919 |
| Bromocresol green | 2-propanol | organic acids | 100 mL | 814920 |
| Reagent for caffeine detection | water – acetone | caffeine | 100 mL | 814401 |
| 2',7'-Dichlorofluorescein | 2-propanol | lipids (saturated, unsaturated) | 100 mL | 814921 |
| 4-(Dimethylamino)-benzaldehyde | 2-propanol | terpenes, sugars, steroids | 100 mL | 814922 |
| Reagent according to Dragendorff-Munier | water | alkaloids and other nitrogen compounds | 100 mL | 814402 |
| Iron(III) chloride | water | phenolic compounds e.g., acetylsalicylic acid, paracetamol | 100 mL | 814403 |
| Potassium hexacyanoferrate(III) | water | | 100 mL | 814404 |
| Molybdatophosphoric acid | ethanol | lipids, sterols, steroids, reducing compounds | 100 mL | 814302 |
| Ninhydrin | ethanol | amino acids, amines and amino sugars | 100 mL | 814203 |
| Rhodamine B | ethanol | lipids | 100 mL | 814923 |
| Rubeanic acid | ethanol | heavy metal cations | 100 mL | 814206 |

These products contain harmful substances which must be specially labeled as hazardous. For detailed information please see SDS.

## Fluorescent indicators

UV indicators with efficient radiation for short-wave as well as long-wave UV ranges

- $UV_{254}$: manganese-activated zinc silicate with absorption maximum at 254 nm, green fluorescence, relatively susceptible towards acids: its fluorescence can be completely quenched by acidic solvents
- $UV_{366}$: inorganic fluorescent pigment with absorption maximum at 366 nm, blue fluorescence

### Ordering information

| | Composition | Absorption maximum | Color of fluorescence | Pack of 100 g |
|---|---|---|---|---|
| Fluorescent indicator $UV_{254}$ | manganese-activated zinc silicate | 254 nm | green | 816710.01 |
| Fluorescent indicator $UV_{366}$ | inorganic fluorescent pigment | 366 nm | blue | 816720.01 |

## Silica adsorbent for TLC

Pore size 60 Å, pore volume 0.75 mL/g, specific surface (BET) ~ 500 $m^2/g$, pH 7 for a 10 % aqueous suspension

- Silica G: standard grade, particle size 2–20 µm, Fe < 0.02 %, Cl < 0.02 %, 13 % gypsum as binder
- Silica N: standard grade, particle size 2–20 µm, Fe < 0.02 %, Cl < 0.02 %, no binder
- Silica G-HR: high purity grade, particle size 3–20 µm, Fe < 0.002 %, Cl < 0.008 %, gypsum as binder
- Silica P: preparative grade, particle size 5–50 µm, Fe < 0.02 %, Cl < 0.02 %, organic binder
- Silica P with gypsum: preparative grade, particle size 5–50 µm, Fe < 0.02 %, Cl < 0.02 %, gypsum as binder

### Ordering information

| Designation | Fluorescent indicator | 1 kg | 5 kg |
|---|---|---|---|
| Silica G | – | 816310.1 | 816310.5 |
| Silica G/$UV_{254}$ | $UV_{254}$ | 816320.1 | 816320.5 |
| Silica N | – | 816330.1 | 816330.5 |
| Silica N/$UV_{254}$ | $UV_{254}$ | 816340.1 | 816340.5 |
| Silica G-HR | – | 816410.1 | 816410.5 |
| Silica P/$UV_{254}$ | $UV_{254}$ | 816380.1 | 816380.5 |
| Silica P/$UV_{254}$ with gypsums | $UV_{254}$ | 816400.1 | 816400.5 |

## Polyamid adsorbent for TLC

Polyamide 6 = nylon 6 = perlon = ε-polycaprolactame

### Ordering information

| Designation | Fluorescent indicator | 1 kg |
|---|---|---|
| Polyamid-DC 6 | – | 816610.1 |
| Polyamid-DC 6 $UV_{254}$ | $UV_{254}$ | 816620.1 |

## Cellulose MN 301 native fibrous cellulose

- Standard grade, fiber length (95 %) 2–20 µm
- Average degree of polymerization 400–500, specific surface acc. to Blaine 15 000 $cm^2/g$
- ≤ 20 ppm Fe, 6 ppm Cu, 7 ppm P, $CH_2Cl_2$ extract ≤ 0.25 %, residue on ignition at 850 °C ≤ 1500 ppm

### Ordering information

| Designation | 1 kg | 5 kg |
|---|---|---|
| Cellulose MN 301 | 816250.1 | 816250.5 |

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## The GC system

### Configuration of a gas chromatograph

① Gas supply: carrier gas and - if necessary - detector gases e.g., for FID detector

② Sample injector: During direct injection, the sample is applied to the column without touching any other parts made from glass or metal (on-column injection). During indirect injection, the sample is brought into an evaporator and is then transferred onto the column either completely, or partially (split technique). Both techniques allow working at low temperatures, high temperatures and the use of temperature programming.

③ Capillary column: the heart of the GC system

④ Temperature-controlled oven

⑤ Detector: indicates a substance by generating an electrical signal (response). Some detectors are specific for certain classes of substances or for certain elements (e.g., P, N).

⑥ Data station for configuration of a gas chromatograph

## The separation process

Chromatographic separation is achieved through continuous distribution of each sample component between the mobile and the stationary phase:

In GC, the mobile phase is always a gas, mostly either He, $N_2$ or $H_2$.

The stationary phase is often a viscous, gum-like liquid adhered to the inner wall of a capillary column (WCOT = Wall Coated Open Tubular).

Transport of the components occurs exclusively in the mobile phase, while separation only takes place in the stationary phase. The quality of a separation (resolution) depends on the residence time of the components within the stationary phase and on the rate of interactions. The type of interaction between component and phase (selectivity) is determined by the functional groups of the stationary phase. The polarity of the phase is a function of its substituents.

## The chromatogram

A chromatogram consists of a base line and a number of peaks. The area of a peak allows quantitative determinations:

A: starting point of a chromatogram = time of injection of a dissolved solute

A component can be identified by its retention time (qualitative determination):

$$t_{Ri} = t_0 + t'_{Ri}$$

$t_0$: dead time = residence time of a solute in the mobile phase (time required by a component to migrate through the chromatographic system without any interaction with the stationary phase)

$t_{Ri}$: retention time = time interval between peak i and the point of injection

$t'_{Ri}$: net retention time = difference between total retention time and dead time $t_0$. It indicates how long a substance stays in the stationary phase.

Other terms characterizing a separation:

k': retention factor: a measure for the position of a sample peak in the chromatogram. The retention factor is specific for a given compound and constant under constant conditions.

$$k'_i = \frac{t_{Ri} - t_0}{t_0}$$

α: relative retention, also called separation factor or selectivity coefficient, is the ratio of two capacity factors. The reference substance is always in the denominator.

$$\alpha = \frac{k'_2}{k'_1}$$

The relative retention does not provide any information on the quality of a separation. For equal values of α two very broad peaks may overlap (as shown in a), or may be completely resolved (as in b), if they are accordingly narrow.

R: resolution: a measure for the quality of a separation, taking ($w_{1/2}$) into account according to:

$$R = 1.18 \cdot \frac{t_{R2} - t_{R1}}{(w_{1/2})_2 + (w_{1/2})_1}$$

N: number of theoretical plates: characterizes the quality of a column (should be determined for k' > 5). The height equivalent to a theoretical plate (h, HETP) is calculated by dividing the length L of the column by the number of theoretical plates Nth. The smaller this value the more efficient the column.

$$N = 5.54 \cdot \frac{(t_{Ri})}{(w_{1/2})} \qquad h = HETP = \frac{L}{N}$$

The Golay equation shows how the plate height h depends on the flow velocity u:

B: molecular axial diffusion; B is a function of the diffusion coefficient of the component in the respective carrier gas

C: resistance to mass transfer

In practice often higher velocities than $u_{opt.}$ are chosen, if separation efficiency is sufficient. Higher carrier velocities mean shorter retention times.

## Parameters characterizing a capillary column

| OPTIMA® 5 | 1.0 µm film | 30 m x | 0.32 mm ID |
|---|---|---|---|
| A | B | C | D |

### A. Stationary phase

Different chemical structures of stationary phases are responsible for the type of interaction (selectivity) between the phase and the analytes. The stationary phase also limits the temperature range for chromatography. For a detailed summary of MN phases for GC please see the following chapter.

### B. Film thickness

MACHEREY-NAGEL offers ranges from 0.1 to 5.0 µm. The standard film thickness is 0.25 µm. Thin films (0.1–0.2 µm) are very well suited for high-boiling, temperature-sensitive or almost contemporaneously eluting substances.

Increasing the film thickness will increase the capacity, the retention for low-boiling substances and the inertness of the column. This is especially helpful for samples with a broad range of concentrations, or the separation of volatile polar substances.

A better coverage of the column wall by a thicker film and a reduced column surface due to a shorter column have a positive impact on the separation of very active substrates, that may cause noticeable tailing when they come in contact with non-coated spots of the column wall.

Thick films, however, always mean more stationary phase in the column, hence increased column bleeding. Therefore, maximum operating temperatures for thick-film columns are reduced. In addition, thick-film columns may have a lesser separating capacity.

### C. Column length

The separating efficiency (better the number of plates N) of a column is directly proportional to its length. Most routine separations are carried out on 25 or 30 m columns, while more complex samples may require 50 or 60 m. 10 m columns are common for Fast GC (see page 340).

### D. Inner diameter (ID)

The lower the ID, the higher is the theoretically possible number of plates per meter.

0.1–0.2 mm ID:
for high resolution and short retention times at low carrier gas flow

0.25 mm ID:
for analysis of complex mixtures

0.32 mm ID:
for routine analysis with short retention times, but increased capacity

0.53 mm ID:
for rapid separations with inert surface and highest capacity

## USP listing of MN GC phases

| Code | Specifications | MN GC phases | Page |
|---|---|---|---|
| USP G1 / G2 | dimethylpolysiloxane oil | OPTIMA® 1 | 310 |
| | | OPTIMA® 1 MS | 312 |
| | | OPTIMA® 1 MS Accent | 312 |
| | | OPTIMA® 1-TG | 348 |
| | | PERMABOND® SE-30 | 336 |
| | | PERMABOND® P-100 | 352 |
| USP G3 | 50 % phenyl - 50 % methylpolysiloxane | OPTIMA® 17 | 327 |
| | | OPTIMA® 17 MS | 328 |
| | | OPTIMA® 17-TG | 348 |
| USP G6 | trifluoropropylmethylpolysiloxane | OPTIMA® 210 | 329 |
| USP G7 | 50 % 3-cyanopropyl - 50 % phenylmethylpolysiloxane | OPTIMA® 225 | 330 |
| USP G16 | polyethylene glycol (average molecular weight ~ 15 000); high molecular weight compound of polyethylene glycol and diepoxide | OPTIMA® WAX | 332 |
| | | OPTIMA WAXplus® | 333 |
| | | PERMABOND® CW 20 M | 337 |
| | | PERMABOND® CW 20 M-DEG | 354 |
| | | FS-CW 20 M-AM | 351 |
| USP G19 | 25 % phenyl – 25 % cyanopropyl – 50 % methylsiloxane | OPTIMA® 225 | 330 |
| USP G25 | high molecular weight compound of polyethylene glycol and diepoxide, which is esterified with terephthalic acid | OPTIMA® FFAP | 334 |
| | | OPTIMA® FFAPplus | 335 |
| | | PERMABOND® FFAP | 338 |
| USP G27 | 5 % phenyl – 95 % methylpolysiloxane | OPTIMA® 5 | 314 |
| | | OPTIMA® 5 Amine | 350 |
| | | OPTIMA® 5 HT | 349 |
| | | OPTIMA® 5 MS | 315 |
| | | OPTIMA® 5 MS Accent | 316 |
| | | PERMABOND® SE-52 | 336 |
| USP G28 | 25 % phenyl – 75 % methylpolysiloxane | OPTIMA® 35 MS | 326 |
| USP G32 | 20 % phenylmethyl – 80 % dimethylpolysiloxane | OPTIMA® 35 MS | 326 |
| USP G35 | high molecular weight compound of polyethylene glycol and diepoxide, which is esterified with nitroterephthalic acid | OPTIMA® FFAP | 334 |
| | | OPTIMA® FFAPplus | 335 |
| | | PERMABOND® FFAP | 338 |
| USP G36 | 1 % vinyl – 5 % phenylmethylpolysiloxane | OPTIMA® 5 | 314 |
| | | OPTIMA® 5 Amine | 350 |
| | | OPTIMA® 5 HT | 349 |
| | | OPTIMA® 5 MS | 315 |
| | | OPTIMA® 5 MS Accent | 316 |
| | | PERMABOND® SE-54 HKW | 352 |
| USP G38 | dimethylpolysiloxane oil | OPTIMA® 1 | 310 |
| | | OPTIMA® 1 MS | 312 |
| | | OPTIMA® 1 MS Accent | 312 |
| | | OPTIMA® 1-TG | 348 |
| | | PERMABOND® SE-30 | 336 |
| | | PERMABOND® P-100 | 352 |
| USP G42 | 35 % phenyl – 65 % dimethylpolysiloxane | OPTIMA® 35 MS | 326 |
| USP G43 | 6 % cyanopropylphenyl – 94 % dimethylpolysiloxane | OPTIMA® 1301 | 321 |
| | | OPTIMA® 1301 MS | 322 |
| | | OPTIMA® 624 | 323 |
| | | OPTIMA® 624 LB | 323 |
| USP G46 | 14 % cyanopropylphenyl – 86 % methylpolysiloxane | OPTIMA® 1701 | 324 |
| | | OPTIMA® 1701 MS | 325 |
| USP G49 | proprietary derivatized phenyl groups on a polysiloxane backbone | OPTIMA® δ-3 | 319 |

# Additional information for GC columns

## Scope of delivery

Each column is individually tested and supplied with test certificate and test chromatogram, but without fittings or ferrules. Columns have fused ends or are sealed with septa, to protect them from atmospheric oxygen. Further more an instruction leaflet is enclosed.

## GC cages

The standard size of a GC cage is 7 inches. On request, all columns can be supplied on a 5 inch (13 cm) cage e.g., for the Agilent GC 6850. To order, please add an E at the end of the REF number (e.g., 726470.30E)

7 inches standard size e.g., REF 726600.30

5 inches special cage e.g., REF 726600.30E

## Integrated guard column

To prolong column life, even at highly contaminated or matrix-containing samples, MN offers the option to add an integrated guard column. All capillary columns are available with a 10 m guard column with respective deactivation. To order, please add V1 at the end of the REF number (e.g., 726600.30V1). Guard column combinations with other lengths, IDs or different deactivation are available on request.

Without integrated guard column e.g., REF 726600.30

With integrated guard column e.g., REF 726600.30V1

# MACHEREY-NAGEL derivatization reagents

## Purpose of derivatization

- Improved volatility, better thermal stability or a lower limit of detection in gas chromatography
- Prerequisite: quantitative, rapid and reproducible formation of only one derivative
- Halogen atoms inserted by derivatization (e.g., trifluoroacetates) for specific detection (ECD) with the advantage of high sensitivity
- Influence of elution orders and fragmentation patterns in MS by a specific derivatization
- We provide reagents for
  - Silylation
  - Alkylation (methylation)
  - Acylaction
- For 1 x 10 mL, 1 x 50 mL and 6 x 50 mL also as screw neck vial
- Product range from page 357 onwards

# Separation properties of OPTIMA® phases

Peaks:
1. Undecane
2. Dodecane
3. Octanol
4. Dimethylaniline
5. Decylamine
6. Methyl decanoate
7. Methyl undecanoate
8. Henicosane
9. Docosane
10. Tricosane

| | |
|---|---|
| All columns: | 0.25 µm film, 30 m x 0.25 mm ID |
| Sample: | MN OPTIMA® test mixture (REF 722316) |
| Injection: | 1.0 µL, split 15 mL/min |
| Carrier gas: | 0.80 bar He |
| Temperature: | 80 °C $T_{max}$ (isothermal), 8 °C/min (20 min $T_{max}$) |
| Detector: | FID 260–280 °C |

# Summary of MN phases for GC

## Overview of OPTIMA® MN phases

| Phase | Composition | Page | Relative polarity ① | Maximum temperature ② |
|---|---|---|---|---|
| OPTIMA® 1 | 100 % dimethylpolysiloxane | 310 | | 340 / 360 °C |
| OPTIMA® 1 MS | | 312 | | |
| OPTIMA® 1 MS Accent | | 312 | | |
| OPTIMA® 5 | 5 % phenyl – 95 % methylpolysiloxane | 314 | | 340 / 360 °C |
| OPTIMA® 5 MS | 5 % diphenyl – 95 % dimethylpolysiloxane | 315 | | 340 / 360 °C |
| OPTIMA® 5 MS Accent | silarylene phase with selectivity similar to 5 % diphenyl – 95 % dimethylpolysiloxane | 316 | | 340 / 360 °C |
| OPTIMA® XLB | silarylene phase like above, optimized silarylene content for low bleeding | 317 | | 340 / 360 °C |
| OPTIMA® δ-3 | phase with autoselectivity ④ | 319 | | 340 / 360 °C |
| OPTIMA® δ-6 | phase with autoselectivity ④ | 320 | | 340 / 360 °C |
| OPTIMA® 1301 | 6 % cyanopropylphenyl – 94 % dimethylpolysiloxane | 321 | | 300 / 320 °C |
| OPTIMA® 1301 MS | silarylene phase with low bleeding: polarity similar to 6 % cyanopropylphenyl – 94 % dimethylpolysiloxane | 322 | | 300 / 320 °C |
| OPTIMA® 624 | 6 % cyanopropylphenyl – 94 % dimethylpolysiloxane | 323 | | 280 / 300 °C |
| OPTIMA® 624 LB | like above, phase with low bleeding | 323 | | |
| OPTIMA® 1701 | 14 % cyanopropylphenyl – 86 % dimethylpolysiloxane | 324 | | 280 / 300 °C |
| OPTIMA® 1701 MS | silarylene phase with low bleeding: polarity similar to 14 % cyanopropylphenyl – 86 % dimethylpolysiloxane | 325 | | 280 / 300 °C |

① = nonpolar, = polar

② First temperature (long term temperature) for isothermal operation, second value for the max. temperature (short term temperature) in a temperature program. Please note th
For details refer to the description of individual phases.

③ Phases which provide a similar selectivity based on chemical and physical properties

④ See description on page 318

GC columns for special separations can be found from page 339 onwards.

| Structure | USP | Similar phases ③ |
|---|---|---|
| | G1 / G2 / G38 | PERMABOND® SE-30, OV-1, DB-1, SE-30, HP-1, SPB™-1, CP-Sil 5 CB, Rtx®-1, 007-1, BP1, MDN-1, AT™-1, ZB-1, OV-101 |
| | | 5 % diphenyl – 95 % dimethylpolysiloxane |
| | G27 / G36 | PERMABOND® SE-52, SE-54, SE-52, HP-5, SPB™-5, CP-Sil 8, Rtx®-5, 007-5, BP5, MDN-5, AT™-5, ZB-5 |
| | G27 / G36 | DB-5, DB-5MS, HP-5MS, Ultra-2, Equity™-5, CP-Sil 8CB low bleed/MS, Rxi®-5MS, Rtx®-5SIL-MS, Rtx®-5MS, 007-5MS, BPX™5, MDN-5S, AT™-5MS, VF-5MS |
| | G27 / G36 | |
| | – | DB-XLB, Rxi®-XLB, Rtx®-XLB, MDN-12, VF-XMS |
| see description page 318 | G49 | no similar phases |
| see description page 318 | – | no similar phases |
| | G43 | HP-1301, DB-1301, SPB™-1301, Rtx®-1301, CP-1301, 007-1301 |
| | G43 | VF-1301ms, Rxi®-1301Sil MS, TG-1301MS |
| | G43 | HP-624, HP-VOC, DB-624, DB-VRX, SPB™-624, CP-624, Rtx®-624, Rtx®-Volatiles, 007-624, BP624, VOCOL |
| | G46 | OV-1701, DB-1701, CP-Sil 19 CB, HP-1701, Rtx®-1701, SPB™-1701, 007-1701, BP10, ZB-1701 |
| | G46 | VF-1701ms, TG-1701MS, OV-1701, DB-1701, HP-1701, Rtx®-1701, SPB™-1701, CP Sil 19 CB, 007-1701, BP10, ZB-1701 |

at for columns with 0.53 mm ID and for columns with thicker films temperature limits are generally lower.

# Summary of MN phases for GC

| Phase | Composition | Page | Relative polarity ① | Maximum temperature ② |
|---|---|---|---|---|
| OPTIMA® 35 MS | silarylene phase with selectivity similar to 35 % diphenyl – 65 % dimethylpolysiloxane | 326 | | 360 / 370 °C |
| OPTIMA® 17 | phenylmethylpolysiloxane, 50 % phenyl | 327 | | 320 / 340 °C |
| OPTIMA® 17 MS | silarylene phase with selectivity similar to 50 % phenyl – 50 % methylpolysiloxane | 328 | | 340 / 360 °C |
| OPTIMA® 210 | trifluoropropylmethylpolysiloxane (50 % trifluoropropyl) | 329 | | 260 / 280 °C |
| OPTIMA® 225 | 50 % cyanopropylmethyl – 50 % phenylmethylpolysiloxane | 330 | | 260 / 280 °C |
| OPTIMA® 240 | 33 % cyanopropylmethyl – 67 % dimethylpolysiloxan | 331 | | 260 / 280 °C |
| OPTIMA® WAX | polyethylene glycol 20 000 Da | 332 | | 240 / 250 °C |
| OPTIMA WAXplus® | polyethylene glycol with optimized cross-linking | 333 | | 260 / 270 °C |
| OPTIMA® FFAP | polyethylene glycol 2-nitroterephthalate | 334 | | 250 / 260 °C |
| OPTIMA® FFAPplus | polyethylene glycol 2-nitroterephthalate with optimized cross-linking | 335 | | 250 / 260 °C |

① = nonpolar, = polar
② First temperature (long term temperature) for isothermal operation, second value for the max. temperature (short term temperature) in a temperature program. Please note t
For details refer to the description of individual phases.
③ Phases which provide a similar selectivity based on chemical and physical properties

GC columns for special separations can be found from page 339 onwards.

| Structure | USP | Similar phases ③ |
|---|---|---|
| | G28 / G32 / G42 | DB-35 MS, HP-35, SPB™-35, Rxi®-35SIL MS, Rtx-35, 007-35, BPX™-35, MDN-35, AT™-35 MS, ZB-35, OV-11, VF-35 MS |
| | G3 | OV-17, DB-17, HP-50+, HP-17, SPB™-50, SP-2250, Rxi®-17, Rtx®-50, CP-Sil 24 CB, 007-17, ZB-50 |
| | G3 | OV-17, AT™-50, BPX™-50, DB-17, DB-17ms, HP-50+, HP-17, SPB™-50, SPB™-17, SP-2250, Rtx®-50, CP-Sil 24 CB, 007-17, VF-17ms, ZB-50 |
| | G6 | OV-210, DB-210, Rtx®-200, 007-210 |
| | G7 / G19 | DB-225, HP-225, OV-225, Rtx®-225, CP-Sil 43, 007-225, BP225 |
| | – | no similar phases |
| | G16 | PERMABOND® CW 20 M, DB-Wax, Supelcowax, HP-Wax, HP-INNOWAX, Rtx-Wax, CP-Wax 52 CB, Stabilwax, 007-CW, BP20, AT-Wax, ZB-Wax<br>DB-Wax, Supelcowax, HP-Wax, HP-INNOWAX, Rtx-Wax, CP-Wax 52 CB, Stabilwax, 007-CW, BP20, AT-Wax, ZB-Wax |
| | G35 / G25 | PERMABOND® FFAP, DB-FFAP, HP-FFAP, CP-Wax 58 FFAP CB, 007-FFAP, CP-FFAP CB, Nukol™, AT-1000, SPB-1000, BP21, OV-351<br>DB-FFAP, HP-FFAP, CP-SIL 58 CB, 007-FFAP, CP-FFAP CB, Nukol™ |

hat for columns with 0.53 mm ID and for columns with thicker films temperature limits are generally lower.

## OPTIMA® 1 100 % dimethylpolysiloxane · USP G1 / G2 / G38

### Key features

- Nonpolar phase
- Structure see page 307

### Recommended application

- Separation of components according to boiling points
- Thick film columns ≥ 3 µm film are especially recommended for solvent analysis.

### Temperature

- Columns with 0.1–0.32 mm ID and films < 3 µm: $T_{max}$ 340 °C (long-term temperature), $T_{max}$ 360 °C (short-term max. temperature in a temperature program)
- 0.53 mm ID, films < 3 µm: $T_{max}$ 320 and 340 °C, resp.
- Thick film columns with films ≥ 3 µm: max. temperatures 300 and 320 °C, resp.

### Similar phases

- PERMABOND® SE-30 (see page 336), OV-1, DB-1, SE-30, HP-1, SPB™-1, CP-Sil 5 CB, Rtx®-1, 007-1, BP1, MDN-1, AT™-1, ZB-1, OV-101

### Ordering information

#### OPTIMA® 1

| | Length → 10 m | 12 m | 15 m | 20 m | 25 m | 30 m | 50 m | 60 m |
|---|---|---|---|---|---|---|---|---|
| 0.1 mm ID (0.4 mm OD) | | | | | | | | |
| 0.10 µm film | 726024.10 | | | 726024.20 | | | | |
| 0.40 µm film | | | | 726025.20 | | | | |
| 0.2 mm ID (0.4 mm OD) | | | | | | | | |
| 0.10 µm film | | | | | 726832.25 | | | |
| 0.20 µm film | | 726834.12 | | | 726834.25 | | 726834.50 | |
| 0.35 µm film | | 726837.12 | | | 726837.25 | | 726837.50 | |
| 0.50 µm film | | | | | | | 726839.50 | |
| 0.25 mm ID (0.4 mm OD) | | | | | | | | |
| 0.10 µm film | 726038.10 | | 726038.15 | | 726038.25 | 726038.30 | | 726038.60 |
| 0.25 µm film | 726050.10 | | 726050.15 | | 726050.25 | 726050.30 | 726050.50 | 726050.60 |
| 0.50 µm film | 726081.10 | | | | 726081.25 | 726081.30 | 726081.50 | 726081.60 |
| 1.00 µm film | | | | | 726802.25 | 726802.30 | 726802.50 | 726802.60 |
| 0.32 mm ID (0.5 mm OD) | | | | | | | | |
| 0.10 µm film | 726301.10 | | | | 726301.25 | 726301.30 | 726301.50 | 726301.60 |
| 0.25 µm film | 726302.10 | | 726302.15 | | 726302.25 | 726302.30 | 726302.50 | 726302.60 |
| 0.35 µm film | | | | | 726821.25 | 726821.30 | 726821.50 | 726821.60 |
| 0.50 µm film | 726304.10 | | | | 726304.25 | 726304.30 | 726304.50 | 726304.60 |
| 1.00 µm film | 726323.10 | | 726323.15 | | 726323.25 | 726323.30 | 726323.50 | 726323.60 |
| 3.00 µm film | | | | | 726805.25 | 726805.30 | 726805.50 | 726805.60 |
| 5.00 µm film | 726931.10 | | | | 726931.25 | 726931.30 | 726931.50 | |
| 0.53 mm ID (0.8 mm OD) | | | | | | | | |
| 0.50 µm film | | | 726519.15 | | 726519.25 | 726519.30 | | |
| 1.00 µm film | 726529.10 | | 726529.15 | | 726529.25 | 726529.30 | | |
| 2.00 µm film | 726521.10 | | | | 726521.25 | 726521.30 | 726521.50 | |
| 5.00 µm film | 726926.10 | | | | 726926.25 | 726926.30 | 726926.50 | |

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 303.

## Solvent analysis

MN Appl. No. 201390

| | |
|---|---|
| Column: | OPTIMA® 1, 60 m x 0.32 mm ID, 1.0 µm film |
| Sample: | solvent mixture, courtesy of J. Lutz, Alcan Rorschach, Switzerland |
| Injection: | 0.4 µL, split 1:60 |
| Carrier gas: | $H_2$, 120 kPa |
| Temperature: | 50 °C (9 min) → 90 °C, 4 °C/min → 280 °C (2 min), 14 °C/min |
| Detector: | FID 300 °C |

Peaks:

1. Methanol
2. Ethanol
3. Acetone
4. 2-Propanol
5. Methyl acetate
6. *n*-Propanol
7. Methyl ethyl ketone
8. Ethyl acetate
9. Isobutanol
10. *n*-Butanol
11. 1-Methoxy-2-propanol
12. Isooctane
13. Ethyl glycol
14. Isoheptane
15. Methyl isobutyl ketone
16. 1-Ethoxy-2-propanol
17. Toluene
18. Isobutyl acetate
19. Butyl acetate
20. 4-Hydroxy-4-methyl-2-pentanone
21. 1-Methoxy-2-propyl acetate
22. Xylene
23. Cyclohexanone
24. Ethyl glycol acetate
25. Butyl glycol
26. Heptanol
27. Ethyl diglycol
28. Butyl diglycol
29. Butyl glycol acetate
30. Butyl diglycol acetate

## OPTIMA® 1 MS 100 % dimethylpolysiloxane · USP G1 / G2 / G38

### Key features
- Selectivity identical to OPTIMA® 1, Phase with low bleeding
- Structure see page 307

### Recommended application
- GC/MS and ECD, general analysis at trace level

### Temperature
- $T_{max}$ 340 °C (long-term temperature), $T_{max}$ 360 °C (short-term max. temperature in a temperature program)

### Similar phases
- Ultra-1, DB-1MS, HP-1MS, Rxi®-1MS, Rtx®-1MS, Equity™-1, AT™-1MS, VF-1MS, CP-Sil 5 CB MS

### Ordering information

OPTIMA® 1 MS

| Length → | 12 m | 15 m | 25 m | 30 m | 50 m | 60 m |
|---|---|---|---|---|---|---|
| 0.2 mm ID (0.4 mm OD) | | | | | | |
| 0.20 µm film | | | 726201.25 | | 726201.50 | |
| 0.35 µm film | 726203.12 | | | | | |
| 0.25 mm ID (0.4 mm OD) | | | | | | |
| 0.25 µm film | | 726205.15 | | 726205.30 | | 726205.60 |
| 0.32 mm ID (0.5 mm OD) | | | | | | |
| 0.25 µm film | | | | 726202.30 | | 726202.60 |

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 303.

## OPTIMA® 1 MS Accent 100 % dimethylpolysiloxane · USP G1 / G2 / G38

### Key features
- Selectivity identical to OPTIMA® 1, nonpolar phase
- Lowest column bleed
- Solvent rinsing for removal of impurities applicable
- Increased sensitivity due to an unmatched low background level
- Structure see page 307

### Recommended application
- Ideal for ion trap and quadrupole MS detectors
- Perfect inertness for basic compounds
- All-round phase for environmental analysis, trace analysis, EPA methods, pesticides, PCB, food and drug analysis

### Temperature
- $T_{max}$ 340 °C (long-term temperature), $T_{max}$ 360 °C (short-term max. temperature in a temperature program)

### Similar phases
- Ultra-1, DB-1MS, HP-1MS, Rxi®-1MS, Rtx®-1MS, Equity™-1, AT™-1MS, VF-1MS, CP-Sil 5 CB MS

EPA 8140 / 8141 / 8141 A Organophosphorus pesticides

MN Appl. No. 213030

| | |
|---|---|
| Column: | OPTIMA® 1 MS Accent, 30 m x 0.32 mm ID, 0.50 µm film |
| Sample: | 0.2 µg/mL in hexane,<br>8140 / 8141 OP pesticides calibration mix A<br>and 8141 OP pesticides calibration mix B;<br>IS triphenyl phosphate and tributyl phosphate |
| Injection: | 250 °C, splitless (hold 1 min) |
| Carrier gas: | He, 1 mL/min, constant pressure |
| Temperature: | 100 °C → 180 °C, 10 °C/min (2 min) → 300 °C, 18 °C/min (3 min) |
| Detector: | FPD (Flame Photometric Detector), 280 °C |

Peaks:

1. Dichlorvos
2. Hexamethylphosphoramide
3. Mevinphos
4. Trichlorfon
5. TEPP
6. Thionazin
7. Demeton-O
8. Ethoprop
9. Tributyl phosphate (IS)
10. Dicrotophos
11. Monocrotophos
12. Naled
13. Sulfotepp
14. Phorate
15. Dimethoate
16. Demeton-S
17. Dioxathion
18. Terbufos
19. Fonophos
20. Phosphamidon isomer
21. Diazinon
22. Disulfoton
23. Phosphamidon
24. Dichlorofenthion
25. Parathion-methyl
26. Chlorpyrifos-methyl
27. Ronnel
28. Fenitrothion
29. Malathion
30. Fenthion
31. Aspon
32. Parathion-ethyl
33. Chlorpyrifos
34. Trichloronate
35. Chlorfenvinphos
36. Merphos
37. Crotoxyphos
38. Stirofos
39. Tokuthion
40. Merphos oxidation product
41. Fensulfothion
42. Famphur
43. Ethion
44. Bolstar
45. Carbophenothion
46. Triphenyl phosphate (IS)
47. Phosmet
48. EPN
49. Azinphos-methyl
50. Leptophos
51. Tri-*o*-cresyl phosphate
52. Azinphos-ethyl
53. Coumaphos

## Ordering information

### OPTIMA® 1 MS Accent

| Length → | 15 m | 25 m | 30 m | 50 m | 60 m |
|---|---|---|---|---|---|
| 0.2 mm ID (0.4 mm OD) | | | | | |
| 0.20 µm film | | 725801.25 | | 725801.50 | |
| 0.25 mm ID (0.4 mm OD) | | | | | |
| 0.25 µm film | 725805.15 | | 725805.30 | | 725805.60 |
| 0.50 µm film | | | 725806.30 | | 725806.60 |
| 0.32 mm ID (0.5 mm OD) | | | | | |
| 0.25 µm film | | | 725802.30 | | 725802.60 |
| 0.50 µm film | | | 725807.30 | | 725807.60 |

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 303.

## OPTIMA® 5 5 % phenyl – 95 % methylpolysiloxane · USP G27 / G36

### Key features
- Nonpolar phase
- Structure see page 307

### Recommended application
- Standard phase with large range of application

### Temperature
- Columns with 0.1–0.32 mm ID and films < 3 µm: $T_{max}$ 340 °C (long-term temperature), $T_{max}$ 360 °C (short-term max. temperature in a temperature program)
- 0.53 mm ID, films < 3 µm: $T_{max}$ 320 and 340 °C, resp.
- Thick film columns with films ≥ 3 µm: max. temperatures 300 and 320 °C, resp.

### Similar phases
- PERMABOND® SE-52 (see page 336), SE-54, SE-52, HP-5, SPB™-5, CP-Sil 8, Rtx®-5, 007-5, BP5, MDN-5, AT™-5, ZB-5

### Ordering information

#### OPTIMA® 5

| | Length → 10 m | 15 m | 25 m | 30 m | 50 m | 60 m |
|---|---|---|---|---|---|---|
| 0.1 mm ID (0.4 mm OD) | | | | | | |
| 0.10 µm film | 726846.10 | | | | | |
| 0.2 mm ID (0.4 mm OD) | | | | | | |
| 0.10 µm film | | | 726854.25 | | | |
| 0.20 µm film | | | 726857.25 | | 726857.50 | |
| 0.35 µm film | | | 726860.25 | | 726860.50 | |
| 0.50 µm film | | | 726863.25 | | 726863.50 | |
| 0.25 mm ID (0.4 mm OD) | | | | | | |
| 0.10 µm film | | | 726911.25 | 726911.30 | 726911.50 | 726911.60 |
| 0.25 µm film | 726056.10 | 726056.15 | 726056.25 | 726056.30 | 726056.50 | 726056.60 |
| 0.35 µm film | | | 726623.25 | 726623.30 | 726623.50 | 726623.60 |
| 0.50 µm film | | | 726099.25 | 726099.30 | 726099.50 | 726099.60 |
| 1.00 µm film | | | 726807.25 | 726807.30 | 726807.50 | 726807.60 |
| 0.32 mm ID (0.5 mm OD) | | | | | | |
| 0.10 µm film | 726313.10 | 726313.15 | 726313.25 | 726313.30 | 726313.50 | 726313.60 |
| 0.25 µm film | | 726314.15 | 726314.25 | 726314.30 | 726314.50 | 726314.60 |
| 0.35 µm film | | | 726628.25 | 726628.30 | 726628.50 | 726628.60 |
| 0.50 µm film | | | 726316.25 | 726316.30 | 726316.50 | 726316.60 |
| 1.00 µm film | | 726325.15 | 726325.25 | 726325.30 | 726325.50 | 726325.60 |
| 3.00 µm film | | | 726809.25 | 726809.30 | 726809.50 | 726809.60 |
| 5.00 µm film | | 726934.15 | 726934.25 | 726934.30 | 726934.50 | |
| 0.53 mm ID (0.8 mm OD) | | | | | | |
| 0.50 µm film | 726523.10 | | 726523.25 | 726523.30 | | |
| 1.00 µm film | 726541.10 | 726541.15 | 726541.25 | 726541.30 | | |
| 2.00 µm film | 726525.10 | | 726525.25 | 726525.30 | 726525.50 | 726525.60 |
| 5.00 µm film | 726916.10 | | 726916.25 | 726916.30 | 726916.50 | |

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 303.

Further applications can be found online in our application database at *www.mn-net.com/apps*

## OPTIMA® 5 MS 5 % diphenyl – 95 % dimethylpolysiloxane · USP G27 / G36

### Key features
- Selectivity identical to OPTIMA® 5
- Phase with low bleeding
- Structure see page 307

### Recommended application
- GC/MS and ECD, applications and general analysis at trace level
- Perfect inertness for basic compounds

### Temperature
- $T_{max}$ 340 °C (long-term temperature), $T_{max}$ 360 °C (short-term max. temperature in a temperature program)

### Similar phases
- DB-5, DB-5MS, HP-5MS, Ultra-2, Equity™-5, CP-Sil 8CB low bleed/MS, Rxi®-5MS, Rtx®-5SIL-MS, Rtx®-5MS, 007-5MS, BPX™5, MDN-5S, AT™-5MS, VF-5MS

Analysis of various phenols

MN Appl. No. 210110

Column: OPTIMA® 5 MS, 30 m x 0.25 mm ID, 0.25 µm film
Sample: 5 ppm of each compound except *N-i*-propylaniline (9.4 ppm)
Methode: SPME
Temperature: 40 °C (2 min) → 240 °C, 6 °C/min → 320 °C, 20 °C/min
Detector: MSD

Peaks:
1. Toluene-$D_8$
2. Phenol
3. 2-Methylphenol (o-Cresol)
4. Nitrobenzene-$D_5$
5. *N-i*-Propylaniline
6. 2,4-Dichlorophenol
7. 4-Chlorophenol
8. 4-Bromo-2-chlorophenol
9. 3-Bromophenol
10. 4-Chloro-3-methylphenol
11. 2,4-Dibromophenol
12. 2-Hydroxybiphenyl
13. 2-Cyclohexylphenol
14. Hexafluorobisphenol A

Courtesy of Riedel-de-Haën, Seelze, Germany

## Ordering information

### OPTIMA® 5 MS

| | Length → 12 m | 15 m | 25 m | 30 m | 50 m | 60 m |
|---|---|---|---|---|---|---|
| 0.2 mm ID (0.4 mm OD) | | | | | | |
| 0.20 µm film | 726210.12 | | 726210.25 | | 726210.50 | |
| 0.35 µm film | 726215.12 | | 726215.25 | | 726215.50 | |
| 0.25 mm ID (0.4 mm OD) | | | | | | |
| 0.25 µm film | | 726220.15 | | 726220.30 | | 726220.60 |
| 0.50 µm film | | | | 726225.30 | | 726225.60 |
| 1.00 µm film | | | | 726226.30 | | 726226.60 |
| 0.32 mm ID (0.5 mm OD) | | | | | | |
| 0.25 µm film | | | | 726211.30 | | |
| 0.50 µm film | | | | 726213.30 | | |
| 1.00 µm film | | | 726212.25 | | 726212.50 | 726212.60 |

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 303.

## OPTIMA® 5 MS Accent silarylene phase · USP G27 / G36

### Key features

- Chemically bonded, cross-linked silarylene phase with polarity similar to a 5 % diphenyl - 95 % dimethylpolysiloxane phase
- Lowest column bleed, nonpolar phase, solvent rinsing for removal of impurities applicable
- Structure see page 307

### Recommended application

- Ideal for ion trap and quadrupole MS detectors
- Perfect inertness for basic compounds
- All-round phase for environmental analysis, trace analysis, EPA methods, pesticides, PCB, food and drug analysis

### Temperature

- $T_{max}$ 340 °C (long-term temperature), $T_{max}$ 360 °C (short-term max. temperature in a temperature program)
- Film thickness > 0.5 µm: $T_{max}$ 320 and 340 °C, resp.

### Similar phases

- DB-5, DB-5MS, HP-5MS, Ultra-2, Equity™-5, CP-Sil 8CB low bleed/MS, Rxi®-5MS, Rtx®-5SIL-MS, Rtx®-5MS, 007-5MS, BPX™5, MDN-5S, AT™-5MS, VF-5MS

### Increased sensitivity due to an unmatched low background level

The bleed comparison test of OPTIMA® 5 MS Accent with a conventional 5 MS phase shows the outstanding performance of the silarylene phase.

The unmatched low background level of the OPTIMA® 5 MS Accent, which is approximately three times lower compared to a 5 MS brand column, provides significantly increased sensitivity and allows its application in trace analysis particularly of high-boiling compounds.

### Background noise at 340 °C

### Ordering information

#### OPTIMA® 5 MS Accent

| Length → | 12 m | 15 m | 25 m | 30 m | 50 m | 60 m |
|---|---|---|---|---|---|---|
| 0.2 mm ID (0.4 mm OD) | | | | | | |
| 0.20 µm film | | | 725810.25 | | 725810.50 | |
| 0.35 µm film | 725815.12 | | | | 725815.50 | |
| 0.25 mm ID (0.4 mm OD) | | | | | | |
| 0.25 µm film | | 725820.15 | | 725820.30 | | 725820.60 |
| 0.50 µm film | | | | 725825.30 | | 725825.60 |
| 1.00 µm film | | | | 725826.30 | | 725826.60 |
| 0.32 mm ID (0.5 mm OD) | | | | | | |
| 0.25 µm film | | | | 725811.30 | | 725811.60 |
| 0.50 µm film | | | | 725813.30 | | |
| 1.00 µm film | | | 725812.25 | | | 725812.60 |

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 303.

## OPTIMA® XLB silarylene phase

### Key features

- Chemically bonded, cross-linked silarylene phase, optimized silarylene content for lowest column bleed, nonpolar phase, perfect inertness for basic compounds, solvent rinsing for removal of impurities applicable
- Structure see page 307

### Recommended application

- Ideal for ion trap and quadrupole MS detectors, ultra low bleed phase, highly selective for environmental and trace analysis, pesticides, recommended phase for PCB separations

### Temperature

- $T_{max}$ 340 °C (long-term temperature), $T_{max}$ 360 °C (short-term max. temperature in a temperature program)

### Similar phases

- DB-XLB, Rxi®-XLB, Rtx®-XLB, MDN-12, VF-XMS

**Rapid separation of PCB and PAH**

MN Appl. No. 212920

| | |
|---|---|
| Column: | OPTIMA® XLB, 30 m x 0.25 mm ID, 0.25 µm film |
| Injection: | 1 µL, Standard 0.005 ng/µL, 250 °C, pulsed, splitless, pulse 1.38 bar in 1 min |
| Carrier gas: | 60 mL/min He |
| Temperature: | 40 °C (2 min) → 240 °C (2 min), 30 °C/min → 340 °C (5 min), 10 °C/min |
| Detektion: | MS source 230 °C, interface 280 °C, quadrupole 150 °C |

Peaks:
1. Naphthalene
2. 2-Methylnaphthalene
3. Acenaphthylene
4. Acenaphthene
5. Fluorene
6. Phenanthrene
7. Anthracene
8. PCB-31
9. PCB-28
10. PCB-52
11. Fluoranthene
12. PCB-101
13. Pyrene
14. PCB-77
15. 2-Methylfluoranthene
16. PCB-118
17. PCB-153
18. PCB-138
19. PCB-126
20. PCB-180
21. Benz[*a*]anthracene
22. Chrysene
23. PCB-169
24. PCB-194
25. Benzo[*b*]fluoranthene
26. Benzo[*k*]fluoranthene
27. Benzo[*a*]pyrene
28. Dibenz[*ah*]anthracene
29. Indeno[1,2,3-*cd*]pyrene
30. Benzo[*ghi*]perylene

Courtesy of Centre d'Analyses de Recherche, Lab. d'Hydrologie, 65400 Illkirch, France

## Ordering information

### OPTIMA® XLB

| | Length → 30 m | 60 m |
|---|---|---|
| 0.25 mm ID (0.4 mm OD) | | |
| 0.25 µm film | 725850.30 | 725850.60 |

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 303.

# OPTIMA® δ · phases with autoselectivity

## Range of polarities covered by OPTIMA® δ phases

All stationary GC phases can be classified by their polarities. While the selectivity of common GC phases is generally determined by permanent dipole-dipole interactions, OPTIMA® δ-3 and OPTIMA® δ-6 show an additional feature. Large, polarizable groups in the polymer chain of the stationary phase enable the analyte to induce a further dipole moment that increases with the polarity of said analyte. We call this phenomenon "Autoselectivity", because the column adjusts itself to the polarity of the analyte. The implemented polymers consist of cross-linked polysiloxanes with a defined composition and an extremely narrow distribution of molecular weight.

OPTIMA® δ phases cover broad ranges of polarities. Compared with conventional phases, OPTIMA® δ-3 polarity ranges from approximately the nonpolar OPTIMA® 5 to the midpolar OPTIMA® 1701, while for OPTIMA® δ-6 the polarity covers a range from about the midpolar OPTIMA® 17 to the polar OPTIMA® 210.

OPTIMA® δ phases show high temperature limits (340 / 360 °C), as well as low bleed levels, which makes them ideal for the use with mass selective (MSD) or phosphorus/nitrogen detectors (PND) in the field of environmental trace analysis.

Isomeric phenols, such as chloro- and nitrophenols, are difficult to analyze with standard GC phases (e.g., OPTIMA® 5 or OPTIMA® 17) because of co-elutions. The autoselective OPTIMA® δ-3 is able to separate all 22 phenols due to stronger interactions occurring with more polar molecules, because polar analytes induce a dipole moment in the phase of the OPTIMA® δ-3 (see chromatogram page 319).

## Separation characteristics of OPTIMA® δ phases

Conditions and peaks (see page 305)

**Key features of OPTIMA® δ phases**

- Wide range of application due to autoselectivity
- Outstanding thermal stability similar to nonpolar phases
- Low bleed levels
- Medium polar without CN groups

Ordering information about OPTIMA® δ phases can be found on page 319 and page 320.

## OPTIMA® δ-3 polysiloxane phase with autoselectivity · USP G49

### Key features

- Medium polar without CN groups
- Autoselectivity resulting in a polarity range from approximately the nonpolar OPTIMA® 5 to the midpolar OPTIMA® 1701 (see page 318)
- Analytes determine the polarity of the phase

### Recommended application

- Ideal for MSD and PND detectors

### Temperature

- 0.1–0.32 mm ID:
  $T_{max}$ 340 °C (long-term temperature),
  $T_{max}$ 360 °C (short-term max. temperature in a temperature program)
- 0.53 mm ID:
  $T_{max}$ 320 and 340 °C, resp.

### Similar phases

- Exclusive from MN

Analysis of isomeric phenols

MN Appl. No. 250060

| | |
|---|---|
| Column: | OPTIMA® δ-3, 60 m x 0.25 mm ID, 0.25 µm film |
| Injection: | 1.0 µL, split 1:80 |
| Carrier gas: | He, 1.3 bar |
| Temperature: | 60 °C (3 min) → 320 °C, 6 °C/min |
| Detector: | MSD HP 5971 |

Peaks:

1. Phenol
2. 2-Chlorophenol
3. 2-Methylphenol
4. 4-Methylphenol
5. 3-Methylphenol
6. 2,4-Dimethylphenol
7. 2-Nitrophenol
8. 2,4-Dichlorophenol
9. 2,6-Dichlorophenol
10. 4-Chloro-3-methylphenol
11. 2,3,5-Trichlorophenol
12. 2,4,6-Trichlorophenol
13. 2,4,5-Trichlorophenol
14. 2,3,4-Trichlorophenol
15. 2,3,6-Trichlorophenol
16. 2,3,5,6-Tetrachlorophenol
17. 2,3,4,5-Tetrachlorophenol
18. 2,3,4,6-Tetrachlorophenol
19. 2,4-Dinitrophenol
20. 3,4,5-Trichlorophenol
21. 2-Methyl-4,6-dinitrophenol
22. 2-Isopropyl-4,6-dinitrophenol

## Ordering information

### OPTIMA® δ-3

| | Length → 10 m | 20 m | 25 m | 30 m | 50 m | 60 m |
|---|---|---|---|---|---|---|
| 0.1 mm ID (0.4 mm OD) | | | | | | |
| 0.10 µm film | 726410.10 | 726410.20 | | | | |
| 0.2 mm ID (0.4 mm OD) | | | | | | |
| 0.20 µm film | | | 726400.25 | | 726400.50 | |
| 0.25 mm ID (0.4 mm OD) | | | | | | |
| 0.25 µm film | | | | 726420.30 | | 726420.60 |
| 0.50 µm film | | | | 726421.30 | | |
| 0.32 mm ID (0.5 mm OD) | | | | | | |
| 0.25 µm film | | | | 726440.30 | | 726440.60 |
| 0.35 µm film | | | | 726441.30 | | 726441.60 |
| 1.00 µm film | | | | 726442.30 | | 726442.60 |
| 0.53 mm ID (0.8 mm OD) | | | | | | |
| 1.00 µm film | | | | 726443.30 | | |

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 303.

# OPTIMA® δ · phases with autoselectivity

## OPTIMA® δ-6 polysiloxane phase with autoselectivity

### Key features

- Medium polar without CN groups Autoselectivity resulting in a polarity range from approximately the midpolar OPTIMA® 17 to the polar OPTIMA® 210 (see page 318)
- Analytes determine the polarity of the phase

### Recommended application

- Ideal for MSD and PND detectors

### Temperature

- 0.1–0.32 mm ID: $T_{max}$ 340 °C (long-term temperature), $T_{max}$ 360 °C (short-term max. temperature in a temperature program)
- 0.53 mm ID: $T_{max}$ 320 and 340 °C, resp.

### Similar phases

- Exclusive from MN

Separation of organophosphorus pesticides (EPA 8140 / 8141)

MN Appl. No. 250420

Column: OPTIMA® δ-6, 50 m x 0.2 mm ID, 0.2 µm film
Sample: EPA 8140 OP pesticide calibration mix (Restek), 200 µg/mL each in hexane – acetone (95:5)
Injection: 1 µL, split 1:30
Carrier gas: 2.0 bar He
Temperature: 150 °C → 300 °C (10 min), 2.5 °C/min
Detector: MSD HP 5971
Peaks:

1. Dichlorvos
2. Mevinphos
3. Demeton-S
4. Ethoprop
5. Naled
6. Phorate
7. Demeton-O
8. Diazinon
9. Disulfoton
10. Ronnel
11. Parathion-methyl
12. Chlorpyrifos
13. Trichloronate
14. Fenthion
15. Merphos
16. Stirofos
17. Tokuthion
18. Merphos oxidation product
19. Fensulfothion
20. Bolstar
21. Azinphos-methyl
22. Coumaphos

## Ordering information

### OPTIMA® δ-6

| | Length → 10 m | 25 m | 30 m | 50 m | 60 m |
|---|---|---|---|---|---|
| 0.1 mm ID (0.4 mm OD) | | | | | |
| 0.10 µm film | 726490.10 | | | | |
| 0.2 mm ID (0.4 mm OD) | | | | | |
| 0.20 µm film | | 726465.25 | | 726465.50 | |
| 0.25 mm ID (0.4 mm OD) | | | | | |
| 0.25 µm film | | | 726470.30 | | 726470.60 |
| 0.32 mm ID (0.5 mm OD) | | | | | |
| 0.25 µm film | | | 726480.30 | | 726480.60 |
| 0.35 µm film | | | 726481.30 | | 726481.60 |
| 1.00 µm film | | | 726482.30 | | 726482.60 |
| 0.53 mm ID (0.8 mm OD) | | | | | |
| 1.00 µm film | | | 726483.30 | | |

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 303.

## OPTIMA® 1301 6 % cyanopropyl-phenyl – 94 % dimethylpolysiloxane · USP G43

### Key features
- Midpolar phase
- Structure see page 307

### Recommended application
- Pesticide analysis
- For corresponding columns with higher film thickness see OPTIMA® 624

### Temperature
- $T_{max}$ 300 °C (long-term temperature), $T_{max}$ 320 °C (short-term max. temperature in a temperature program)

### Similar phases
- HP-1301, DB-1301, SPB™-1301, Rtx®-1301, CP-1301, 007-1301

**Analysis of a pesticide mixture**

MN Appl. No. 210620

| | |
|---|---|
| Column: | OPTIMA® 1301, 60 m x 0.25 mm ID, 0.25 µm film |
| Injection: | 3 µL (0.1 ng/µL), 80 °C (1 min) → 250 °C (1 min) pulsed splitless |
| Carrier gas: | He, 54 mL/min |
| Temperature: | 80 °C (2 min) → 190 °C, 20 °C/min (12 min) → 240 °C, 2 °C/min (23 min) → 260 °C, 10 °C/min (20 min) |
| Detector: | ECD |

Peaks :
1. Propyzamide
2. Vinclozolin
3. Bromophos-ethyl
4. 2,4-DDT
5. Brompropylate

**Analysis of a PCB mixture**

MN Appl. No. 210650

| | |
|---|---|
| Column: | OPTIMA® 1301, 60 m x 0.25 mm ID, 0.25 µm film |
| Injection: | 3 µL (0.1 ng/µL), 80 °C (1 min) → 250 °C (1 min) pulsed splitless |
| Carrier gas: | He, 54 mL/min |
| Temperature: | 80 °C (2 min) → 190 °C, 20 °C/min (12 min) → 240 °C, 2 °C/min (23 min) → 260 °C, 10 °C/min (20 min) |
| Detector: | ECD |

Peaks :
1. PCB-28
2. PCB-52
3. PCB-128
4. PCB-153
5. PCB-138
6. PCB-180

## Ordering information

### OPTIMA® 1301

| | Length → 25 m | 30 m | 50 m | 60 m |
|---|---|---|---|---|
| 0.25 mm ID (0.4 mm OD) | | | | |
| 0.25 µm film | 726771.25 | 726771.30 | 726771.50 | 726771.60 |
| 0.32 mm ID (0.5 mm OD) | | | | |
| 0.25 µm film | 726777.25 | 726777.30 | | 726777.60 |
| 1.00 µm film | | 726780.30 | 726780.50 | 726780.60 |
| 0.53 mm ID (0.8 mm OD) | | | | |
| 1.00 µm film | 726783.25 | | | |

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 303.

Further applications can be found online in our application database at *www.mn-net.com/apps*

## OPTIMA® 1301 MS 6 % cyanopropyl-phenyl – 94 % dimethylpolysiloxane · USP G43

### Key features

- Chemically bonded, cross-linked silarylene phase with selectivity similar to 6 % cyanopropyl-phenyl – 94 % dimethylpolysiloxane, symmetric substituted cyanopropylsilanes and integrated phenyl rings (silarylene)
- Midpolar phase with very low bleed
- Perfect deactivation
- Structure see page 307

### Recommended application

- Specially suitable for sophisticated environmental analysis (e.g., EPA methods for PAHs, PCBs and pesticides)
- 100 % ion trap and quadrupol MS compatibility

### Temperature

- $T_{max}$ 300 °C (long-term temperature), $T_{max}$ 320 °C (short-term max. temperature in a temperature program)

### Similar phases

- VF-1301ms, Rxi®-1301Sil MS, TG-1301MS

### Ordering information

OPTIMA® 1301 MS

| | Length → 30 m | 60 m |
|---|---|---|
| 0.25 mm ID (0.4 mm OD) | | |
| 0.25 µm film | 726640.30 | 726640.60 |
| 0.32 mm ID (0.5 mm OD) | | |
| 0.25 µm film | 726641.30 | 726641.60 |
| 1.00 µm film | 726642.30 | 726642.60 |
| 0.53 mm ID (0.8 mm OD) | | |
| 1.00 µm film | 726643.30 | 726643.60 |

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 303.

## OPTIMA® 624 6 % cyanopropyl-phenyl – 94 % dimethylpolysiloxane · USP G43

### Key features
- Midpolar phase
- Structure see page 307

### Recommended application
- Environmental analysis
- For corresponding columns with lower film thickness see OPTIMA® 1301

### Temperature
- $T_{max}$ 280 °C (long-term temperature), $T_{max}$ 300 °C (short-term max. temperature in a temperature program)

### Similar phases
- HP-624, HP-VOC, DB-624, DB-VRX, SPB™-624, CP-624, Rtx®-624, Rtx®-Volatiles, 007-624, BP624, VOCOL

## OPTIMA® 624 LB 6 % cyanopropyl-phenyl – 94 % dimethylpolysiloxane

### Key features
- Midpolar phase with low bleeding
- Structure see page 307

### Recommended application
- Halogenated hydrocarbons, volatiles, aromatic compounds, solvents etc.

Solvents and semi-volatiles

MN Appl. No. 212520

Column: OPTIMA® 624 LB, 30 m x 0.32 mm ID, 1.8 µm film; retention gap Phe-Sil 0.5 m x 0.53 mm
Injection: 1 µL (10 ppm per substance in acetone), cold on-column
Carrier gas: 1.1 bar He
Temperature: 45 °C (3 min) → 150 °C (6 °C/min) → 300 °C (18 °C/min), 20 min 300 °C
Detector: FID 280 °C

Peaks:
1. Acetone
2. Ethyl acetate
3. Tetrahydrofuran
4. Cyclohexane
5. 2-Methyl-2-butanol
6. 1-Butanol
7. Pyridine
8. Toluene
9. Dimethylformamide
10. Dimethylsulfoxide
11. Decane
12. 1-Octanol
13. Acetophenone
14. Butyrophenone
15. Heptanophenone
16. 5-Methoxyindole
17. Dibenzylamine
18. Methyl eicosanoate
19. Methyl *cis*-13-docosenoate
20. Methyl docosanoate

## Ordering information

| | Length → 25 m | 30 m | 50 m | 60 m |
|---|---|---|---|---|
| **OPTIMA® 624** | | | | |
| 0.2 mm ID (0.4 mm OD) | | | | |
| 1.10 µm film | 726784.25 | | | |
| 0.25 mm ID (0.4 mm OD) | | | | |
| 1.40 µm film | 726785.25 | 726785.30 | 726785.50 | 726785.60 |
| 0.32 mm ID (0.5 mm OD) | | | | |
| 1.80 µm film | 726787.25 | 726787.30 | 726787.50 | 726787.60 |
| 0.53 mm ID (0.8 mm OD) | | | | |
| 3.00 µm film | 726789.25 | 726789.30 | | |
| **OPTIMA® 624 LB** | | | | |
| 0.32 mm ID (0.5 mm OD) | | | | |
| 1.80 µm film | | 726786.30 | 726786.50 | |

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 303.

## OPTIMA® 1701 14 % cyanopropyl-phenyl – 86 % dimethylpolysiloxane · USP G46

### Key features

- Midpolar phase, special selectivity due to high cyanopropyl content
- Structure see page 307

### Recommended application

- Reference column for structure identification, e.g., in combination with OPTIMA® 5
- Film thickness ≥ 1 µm for solvent analysis

### Temperature

- $T_{max}$ 280 °C (long-term temperature), $T_{max}$ 300 °C (short-term max. temperature in a temperature program)
- 0.53 mm ID: $T_{max}$ 280 and 300 °C, resp.

### Similar phases

- OV-1701, DB-1701, CP-Sil 19 CB, HP-1701, Rtx®-1701, SPB™-1701, 007-1701, BP10, ZB-1701

Analysis of aromatic hydrocarbons

MN Appl. No. 200400

Column: OPTIMA® 1701, 25 m x 0.32 mm ID, 0.25 µm film
Injection: 1 µL, split 1:40
Carrier gas: 0.6 bar $N_2$
Temperature: 60 °C → 120 °C, 4 °C/min
Detector: FID 260 °C

Peaks:
1. Benzene
2. Toluene
3. Ethylbenzene
4. *p*-Xylene
5. *o*-Xylene
6. Phenol
7. 2-Methylphenol
8. 2,6-Dimethylphenol
9. 4-Methylphenol
10. 2,4-Dimethylphenol
11. 2,4,6-Trimethylphenol

## Ordering information

### OPTIMA® 1701

| | Length → 10 m | 15 m | 25 m | 30 m | 50 m | 60 m |
|---|---|---|---|---|---|---|
| 0.2 mm ID (0.4 mm OD) | | | | | | |
| 0.20 µm film | | | 726841.25 | | 726841.50 | |
| 0.25 mm ID (0.4 mm OD) | | | | | | |
| 0.25 µm film | 726058.10 | 726058.15 | 726058.25 | 726058.30 | 726058.50 | 726058.60 |
| 0.50 µm film | | | | 726064.30 | | 726064.60 |
| 1.00 µm film | | | | 726965.30 | | |
| 0.32 mm ID (0.5 mm OD) | | | | | | |
| 0.25 µm film | 726318.10 | 726318.15 | 726318.25 | 726318.30 | 726318.50 | 726318.60 |
| 0.35 µm film | | | 726824.25 | 726824.30 | 726824.50 | 726824.60 |
| 0.50 µm film | | | 726320.25 | 726320.30 | 726320.50 | 726320.60 |
| 1.00 µm film | | | 726929.25 | 726929.30 | 726929.50 | 726929.60 |
| 0.53 mm ID (0.8 mm OD) | | | | | | |
| 1.00 µm film | 726545.10 | 726545.15 | 726545.25 | 726545.30 | | |
| 2.00 µm film | | 726735.15 | 726735.25 | 726735.30 | 726735.50 | |

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 303.

Further applications can be found online in our application database at *www.mn-net.com/apps*

## OPTIMA® 1701 MS silarylene phase · USP G46

### Key features

- Chemically bonded, cross-linked silarylene phase with selectivity similar to 14 % cyanopropyl-phenyl – 86 % dimethylpolysiloxane, symmetric substituted cyanopropylsilanes and integrated phenyl rings (silarylene)
- Midpolar phase with very low bleed
- Perfect deactivation
- Structure see page 307

### Recommended application

- Environmental analysis (e.g., PAHs, PCBs, pesticides)
- Reference column for structure identification, e.g., in combination with OPTIMA® 5 MS
- 100 % ion trap and quadrupole MS compatibility

### Temperature

- $T_{max}$ 280 °C (long-term temperature), $T_{max}$ 300 °C (short-term max. temperature in a temperature program)

### Similar phases

- VF-1701ms, TG-1701MS, OV-1701, DB-1701, HP-1701, Rtx®-1701, SPB™-1701, CP Sil 19 CB, 007-1701, BP10, ZB-1701

Separation of triazine pesticides (EPA 619)

MN Appl. No. 215080

Column: OPTIMA® 1701 MS, 30 m x 0.25 mm ID, 0.25 µm film
Injection: 1 µL, 250 °C, split 1:100
Carrier gas: 42 cm/s He
Temperature: 160 °C (1 min) → 180 °C, 15 °C/min → 220 °C, 2 °C/min
Detector: MSD

Peaks:
1. Prometon
2. Atraton
3. Propazine
4. Atrazine
5. Simazine
6. Terbuthylazine
7. Secbumeton
8. Prometryn
9. Ametryn
10. Simetryn
11. Terbutryn

## Ordering information

### OPTIMA® 1701 MS

| | Length → 30 m | 60 m |
|---|---|---|
| 0.25 mm ID (0.4 mm OD) | | |
| 0.25 µm film | 726630.30 | 726630.60 |
| 0.50 µm film | 726631.30 | 726631.60 |
| 1.00 µm film | 726632.30 | 726632.60 |
| 0.32 mm ID (0.5 mm OD) | | |
| 0.25 µm film | 726633.30 | 726633.60 |
| 0.50 µm film | 726634.30 | 726634.60 |
| 1.00 µm film | 726635.30 | 726635.60 |

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 303.

## OPTIMA® 35 MS silarylene phase · USP G42 / close equivalent to USP G28 / G32

### Key features

- Chemically bonded cross-linked silarylene phase with selectivity similar to 35 % phenyl – 65 % methyl polysiloxane, midpolar phase, polymer without CN groups
- Very low column bleeding
- Structure see page 309

### Recommended application

- Ideal for ion trap detectors
- Optimum column for confirmation of analytical results in combination with a 1 MS or 5 MS
- All-round phase for environmental analysis, ultra trace analysis, EPA methods, pesticides, PCB, food and drug analysis

### Temperature

- $T_{max}$ 360 °C (long-term temperature), $T_{max}$ 370 °C (short-term max. temperature in a temperature program)

### Similar phases

- DB-35 MS, HP-35, SPB™-35, Rxi®-35SIL MS, Rtx-35, 007-35, BPX™-35, MDN-35, AT™-35 MS, ZB-35, OV-11, VF-35 MS

PAH in accordance with EPA 610

MN Appl. No. 213190

Column: OPTIMA® 35 MS, 30 m x 0.25 mm ID, 0.25 µm film
Injection: 1 µL, split 1:10
Carrier gas: 0.6 bar $H_2$
Temperature: 100 °C (3 min) → 300 °C (10 min), 6 °C/min
Detector: MSD

Peaks
1. Naphthalene
2. Acenaphthylene
3. Acenaphthene
4. Fluorene
5. Phenanthrene
6. Anthracene
7. Fluoranthene
8. Pyrene
9. Benz[*a*]anthracene
10. Chrysene
11. Benzo[*b*]fluoranthene
12. Benzo[*k*]fluoranthene
13. Benzo[*a*]pyrene
14. Indeno[1,2,3-*cd*]pyrene
15. Dibenz[*ah*]anthracene
16. Benzo[*ghi*]perylene

## Ordering information

### OPTIMA® 35 MS

| | Length → 30 m | 60 m |
|---|---|---|
| 0.25 mm ID (0.4 mm OD) | | |
| 0.25 µm film | 726154.30 | 726154.60 |
| 0.32 mm ID (0.5 mm OD) | | |
| 0.25 µm film | 726157.30 | 726157.60 |

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 303.

Further applications can be found online in our application database at *www.mn-net.com/apps*

## OPTIMA® 17 phenylmethylpolysiloxane (50 % phenyl) · USP G3

### Key features
- Midpolar phase
- Structure see page 309

### Recommended application
- Steroids, pesticide, drug analysis

### Temperature
- $T_{max}$ 320 °C (long-term temperature), $T_{max}$ 340 °C (short-term max. temperature in a temperature program)
- 0.53 mm ID: $T_{max}$ 300 and 320 °C resp.

### Similar phases
- OV-17, DB-17, HP-50+, HP-17, SPB™-50, SP-2250, Rxi®-17, Rtx®-50, CP-Sil 24 CB, 007-17, ZB-50

Analysis of pesticides

MN Appl. No. 200930

Column: OPTIMA® 17, 25 m x 0.2 mm ID, 0.20 µm film
Sample: pesticides, standard of the cantonal laboratory Schaffhausen (Switzerland), 0.1 mg/mL or 0.01 mg/mL each
Injection: 1.0 µL, 3 s without split
Carrier gas: He, 25 cm/s
Temperature: 100 °C (3 min), 8 °C/min → 250 °C, 10 °C/min → 320 °C
Detector: MSD HP 5971

Peaks:
1. Dichlorphos
2. Naled
3. Vinclozolin
4. Chlorthalonil
5. Chlorpyrifos
6. Dichlofluanid
7. Procymidon
8. Captan
9. Folpet
10. Carbophenothion
11. Iprodion
12. Captafol
13. Coumaphos

## Ordering information

### OPTIMA® 17

| | Length → 10 m | 12 m | 15 m | 25 m | 30 m | 50 m | 60 m |
|---|---|---|---|---|---|---|---|
| 0.1 mm ID (0.4 mm OD) | | | | | | | |
| 0.10 µm film | 726848.10 | | | | | | |
| 0.2 mm ID (0.4 mm OD) | | | | | | | |
| 0.20 µm film | | 726065.12 | | 726065.25 | | 726065.50 | |
| 0.50 µm film | | | | 726066.25 | | 726066.50 | |
| 0.25 mm ID (0.4 mm OD) | | | | | | | |
| 0.15 µm film | | | | 726742.25 | 726742.30 | 726742.50 | 726742.60 |
| 0.25 µm film | | | 726022.15 | 726022.25 | 726022.30 | 726022.50 | 726022.60 |
| 0.50 µm film | | | | 726067.25 | 726067.30 | 726067.50 | 726067.60 |
| 0.32 mm ID (0.5 mm OD) | | | | | | | |
| 0.15 µm film | | | | | 726755.30 | | |
| 0.25 µm film | | | | 726351.25 | 726351.30 | 726351.50 | 726351.60 |
| 0.35 µm film | | | | 726757.25 | 726757.30 | 726757.50 | 726757.60 |
| 0.50 µm film | | | | 726744.25 | 726744.30 | 726744.50 | 726744.60 |
| 0.53 mm ID (0.8 mm OD) | | | | | | | |
| 1.00 µm film | 726747.10 | | 726747.15 | 726747.25 | 726747.30 | | |

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 303.

## OPTIMA® 17 MS silarylene phase · USP G3

### Key features

- Medium polar silarylene phase with selectivity analogue to 50 % phenyl – 50 % methylpolysiloxane, no CN groups in the polymer
- Structure see page 309

### Recommended application

- Ideal for ion trap detectors
- Optimum reference column in combination with a 1 MS or 5 MS
- All-round phase for environmental analysis, ultra-trace analysis, EPA methods, pesticide, PCBs, food and drug analysis

### Temperature

- $T_{max}$ 340 °C (long-term temperature),
- $T_{max}$ 360 °C (short-term max. temperature in a temperature program)

### Similar phases

- OV-17, AT™-50, BPX™-50, DB-17, DB-17ms, HP-50+, HP-17, SPB™-50, SPB™-17, SP-2250, Rtx®-50, CP-Sil 24 CB, 007-17, VF-17ms, ZB-50

Analysis of phenols

MN Appl. No. 213600

| | |
|---|---|
| Column: | OPTIMA® 17 MS, 30 m x 0.25 mm ID, 0.25 µm film |
| Sample: | phenol mix 604 |
| Injection: | 1.0 µL, 230 °C, split 1:30 |
| Carrier gas: | 0.8 bar He |
| Temperature: | 100 °C, 10 °C/min → 250 °C |
| Detector: | FID 280 °C |

Peaks:
1. Phenol
2. 2-Chlorophenol
3. 2,4-Dimethylphenol
4. 2-Nitrophenol
5. 2,4-Dichlorophenol
6. 4-Chloro-3-methylphenol
7. 2,4,6-Trichlorophenol
8. 4-Nitrophenol
9. 2,4-Dinitrophenol
10. 2-Methyl-4,6-dinitrophenol
11. Pentachlorophenol

## Ordering information

### OPTIMA® 17 MS

| | Length → 30 m | 60 m |
|---|---|---|
| 0.25 mm ID (0.4 mm OD) | | |
| 0.25 µm film | 726162.30 | 726162.60 |
| 0.32 mm ID (0.5 mm OD) | | |
| 0.25 µm film | 726165.30 | 726165.60 |

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 303.

Further applications can be found online in our application database at *www.mn-net.com/apps*

## OPTIMA® 210 trifluoropropyl-methylpolysiloxane (50 % trifluoropropyl) · close equivalent to USP G6

### Key features
- Midpolar phase
- Structure see page 309

### Recommended application
- Environmental analysis, especially for *o*-, *m*- and *p*-substituted aromatic hydrocarbons

### Temperature
- $T_{max}$ 260 °C (long-term temperature), $T_{max}$ 280 °C (short-term max. temperature in a temperature program)

### Similar phases
- OV-210, DB-210, Rtx®-200, 007-210

Aromatic hydrocarbons (BTX)

MN Appl. No. 200230

| | |
|---|---|
| Column: | OPTIMA® 210, 50 m x 0.25 mm ID, 0.5 µm film |
| Injection: | 0.5 µL, split 105 mL/min |
| Carrier gas: | 130 kPa $N_2$ (1.1 mL/min) |
| Temperature: | 50 °C |
| Detector: | FID 250 °C |

Peaks:
1. Benzene
2. Toluene
3. Ethylbenzene
4. *p*-Xylene
5. *m*-Xylene
6. *o*-Xylene

## Ordering information

### OPTIMA® 210

| | Length → 15 m | 25 m | 30 m | 50 m | 60 m |
|---|---|---|---|---|---|
| 0.25 mm ID (0.4 mm OD) | | | | | |
| 0.25 µm film | 726871.15 | 726871.25 | 726871.30 | 726871.50 | 726871.60 |
| 0.50 µm film | | | 726874.30 | 726874.50 | 726874.60 |
| 0.32 mm ID (0.5 mm OD) | | | | | |
| 0.25 µm film | 726877.15 | | 726877.30 | 726877.50 | 726877.60 |
| 0.50 µm film | | 726880.25 | 726880.30 | 726880.50 | 726880.60 |

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 303.

## OPTIMA® 225 50 % cyanopropyl-methyl – 50 % phenylmethylpolysiloxane · close equivalent to USP G7 / G19

### Key features
- Midpolar phase
- Structure see page 309

### Recommended application
- Fatty acid analysis

### Temperature
- $T_{max}$ 260 °C (long-term temperature), $T_{max}$ 280 °C (short-term max. temperature in a temperature program)

### Similar phases
- OV-210, DB-210, Rtx®-200, 007-210

Analysis of FAME in porcine fat

MN Appl. No. 210060

| | |
|---|---|
| Column: | OPTIMA® 225, 25 m x 0.32 mm ID, 0.25 µm film |
| Injection: | 1 µL, split 1:40 |
| Carrier gas: | 60 kPa $H_2$ |
| Temperature: | 50 °C (2 min) → 125 °C, 30 °C/min → 160 °C, 5 °C/min → 180 °C, 20 °C/min → 200 °C, 3 °C/min → 220 °C, 20 °C/min (10 min) |
| Detector: | FID 260 °C |

Peaks:

| | |
|---|---|
| 1. C4:0 | 18. C18:0 |
| 2. C5:0 | 19. C18:1 |
| 3. C6:0 | 20. C18:2 |
| 4. C8:0 | 21. C18:3 |
| 5. C10:0 | 22. C19:0 |
| 6. C11:0 | 23. C20:0 |
| 7. C12:0 | 24. C20:1 |
| 8. C13:0 | 25. C20:2 |
| 9. C13:1 | 26. C20:4 |
| 10. C14:0 | 27. C20:3 |
| 11. C14:1 | 28. C20:5 |
| 12. C15:0 | 29. C22:0 |
| 13. C15:1 | 30. C22:1 |
| 14. C16:0 | 31. C22:2 |
| 15. C16:1 | 32. C22:6 |
| 16. C17:0 | 33. C24:0 |
| 17. C17:1 | 34. C24:1 |

FAME Standard

FAME in porcine fat

Courtesy of Dr. Bantleon, Mr. Leusche, Mr. Hagemann, VFG-Labor, Versmold, Germany

## Ordering information

### OPTIMA® 225

| | Length → 10 m | 15 m | 25 m | 30 m | 50 m | 60 m |
|---|---|---|---|---|---|---|
| 0.1 mm ID (0.4 mm OD) | | | | | | |
| 0.10 µm film | 726080.10 | | | | | |
| 0.25 mm ID (0.4 mm OD) | | | | | | |
| 0.25 µm film | | 726118.15 | 726118.25 | 726118.30 | 726118.50 | 726118.60 |
| 0.32 mm ID (0.5 mm OD) | | | | | | |
| 0.25 µm film | | | 726352.25 | 726352.30 | 726352.50 | 726352.60 |

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 303.

## OPTIMA® 240 33 % cyanopropyl-methyl – 67 % dimethylpolysiloxane

### Key features
- Midpolar phase
- Structure see page 309

### Recommended application
- FAMEs, dioxins

### Temperature
- $T_{max}$ 260 °C (long-term temperature), $T_{max}$ 280 °C (short-term max. temperature in a temperature program)

Fatty acid methyl esters *cis/trans* C18:1 (FAME)

MN Appl. No. 201620

| | |
|---|---|
| Column: | OPTIMA® 240, 60 m x 0.25 mm ID, 0.25 µm film |
| Sample: | FAME mixture |
| Injection: | 1.0 µL, split 1:25 |
| Carrier gas: | 150 kPa $H_2$ |
| Temperature: | 80 °C → 120 °C, 20 °C/min → 260 °C (10 min), 3 °C/min |
| Detector: | FID 280 °C |

Peaks:

1. C4:0
2. C5:0
3. C8:0
4. C10:0
5. C11:0
6. C12:0
7. C13:0
8. C14:0
9. C14:1
10. C15:0
11. C15:1
12. C16:0
13. C16:1
14. C17:0
15. C17:1
16. C18:0
17. *trans*-C18:1
18. *cis*-C18:1
19. C18:2
20. C18:3
21. C18:3
22. C20:0
23. C20:1
24. C20:2
25. C20:3
26. C20:4
27. C20:3
28. C22:0
29. C22:1
30. C22:3
31. C24:1

## Ordering information

### OPTIMA® 240

| | Length → 25 m | 30 m | 50 m | 60 m |
|---|---|---|---|---|
| 0.25 mm ID (0.4 mm OD) | | | | |
| 0.25 µm film | | 726089.30 | 726089.50 | 726089.60 |
| 0.50 µm film | | 726090.30 | | 726090.60 |
| 0.32 mm ID (0.5 mm OD) | | | | |
| 0.25 µm film | 726091.25 | 726091.30 | 726091.50 | 726091.60 |
| 0.35 µm film | | 726095.30 | | 726095.60 |
| 0.50 µm film | | 726096.30 | | 726096.60 |

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 303.

Further applications can be found online in our application database at *www.mn-net.com/apps*

## OPTIMA® WAX polyethylene glycol 20 000 Da · USP G16

### Key features
- Polar phase
- Structure see page 309

### Recommended application
- Solvent analysis and alcohols, suitable for aqueous solutions

### Temperature
- $T_{max}$ 240 °C (long-term temperature), $T_{max}$ 250 °C (short-term max. temperature in a temperature program)
- 0.53 mm ID: $T_{max}$ 220 and 240 °C resp.

### Similar phases
- PERMABOND® CW 20 M (see page 337), DB-Wax, Supelcowax, HP-Wax, HP-INNOWAX, Rtx-Wax, CP-Wax 52 CB, Stabilwax, 007-CW, BP20, AT-Wax, ZB-Wax

Modified Grob test

MN Appl. No. 211170

Column: OPTIMA® WAX, 50 m x 0.32 mm ID, 0.5 µm film
Injection: 1 µL, split 1:20
Carrier gas: 1,2 bar He
Temperature: 80 °C → 250 °C, 8 °C/min
Detector: FID 250 °C

Peaks:
1. Decane
2. Undecane
3. Octanol
4. Methyl decanoate
5. Dicyclohexylamine
6. Methyl undecanoate
7. Methyl dodecanoate
8. 2,6-Dimethylaniline
9. 2,6-Dimethylphenol

## Ordering information

### OPTIMA® WAX

| | Length → 25 m | 30 m | 50 m | 60 m |
|---|---|---|---|---|
| 0.25 mm ID (0.4 mm OD) | | | | |
| 0.25 µm film | 726600.25 | 726600.30 | 726600.50 | 726600.60 |
| 0.32 mm ID (0.5 mm OD) | | | | |
| 0.25 µm film | 726321.25 | 726321.30 | 726321.50 | 726321.60 |
| 0.50 µm film | 726296.25 | 726296.30 | 726296.50 | 726296.60 |
| 0.53 mm ID (0.8 mm OD) | | | | |
| 1.00 µm film | 726549.25 | 726549.30 | | |
| 2.00 µm film | | 726548.30 | | |

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 303.

Further applications can be found online in our application database at *www.mn-net.com/apps*

## OPTIMA WAXplus® cross-linked polyethylene glycol · USP G16

### Key features
- Polar phase with improved cross-linking for lower column bleed and better temperature stability
- Structure see page 309

### Recommended application
- Broad range of application, e.g., for solvents and alcohols, suitable for aqueous solutions

### Temperature
- $T_{max}$ 260 °C (long-term temperature), $T_{max}$ 270 °C (short-term max. temperature in a temperature program)

### Similar phases
- DB-Wax, Supelcowax, HP-Wax, HP-INNOWAX, Rtx-Wax, CP-Wax 52 CB, Stabilwax, 007-CW, BP20, AT-Wax, ZB-Wax

Alcohols

MN Appl. No. 214160

Column: OPTIMA WAXplus®, 30 m x 0.25 mm ID, 0.5 µm film
Injection: 0.1 µL, split 1:80
Carrier gas: 1.3 bar He
Temperature: 40 °C → 260 °C, 12 °C/min (15 min)
Detector: FID 260 °C

Peaks:
1. Methanol
2. 2-Propanol
3. Ethanol
4. 1-Propanol
5. 2-Methyl-1-propanol
6. 1-Butanol
7. 4-Methyl-2-pentanol
8. 1-Pentanol
9. 2-Methyl-1-pentanol
10. 1-Hexanol
11. Cyclohexanol
12. 1-Heptanol

## Ordering information

### OPTIMA WAXplus®

| | Length → 30 m | 60 m |
|---|---|---|
| 0.25 mm ID (0.4 mm OD) | | |
| 0.25 µm film | 726380.30 | 726380.60 |
| 0.50 µm film | 726381.30 | 726381.60 |
| 0.32 mm ID (0.5 mm OD) | | |
| 0.25 µm film | 726382.30 | 726382.60 |
| 0.50 µm film | 726383.30 | 726383.60 |

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 303.

## OPTIMA® FFAP polyethylene glycol 2-nitroterephthalate · USP G35 / close equivalent to USP G25

### Key features
- Polar phase (FFAP = Free Fatty Acid Phase)
- Structure see page 309

### Recommended application
- Fatty acid methyl esters (FAMEs), free carboxylic acids

### Temperature
- 0.10–0.32 mm ID: $T_{max}$ 250 °C (long-term temperature), $T_{max}$ 260 °C (short-term max. temperature in a temperature program)
- 0.53 mm ID: $T_{max}$ 220 and 240 °C, resp.

### Similar phases
- PERMABOND® FFAP (see page 338), DB-FFAP, HP-FFAP, CP-Wax 58 FFAP CB, 007-FFAP, CP-FFAP CB, Nukol™, AT-1000, SPB-1000, BP21, OV-351

FAME test

MN Appl. No. 211140

Column: OPTIMA® FFAP, 60 m x 0.32 mm ID, 0.25 µm film
Injection: 1.0 µL, 220 °C, split 1:40
Carrier gas: 1.2 bar He
Temperature: 55 °C → 250 °C, 6 °C/min
Detector: FID 220 °C

Peaks:
1. C4
2. C6
3. C8
4. C10
5. C12
6. C14
7. C16
8. C18
9. C18:1 *cis/trans*
10. C18:2
11. C18:3
12. C20
13. C22
14. C22:1
15. C24

## Ordering information

### OPTIMA® FFAP

| | Length → 10 m | 25 m | 30 m | 50 m | 60 m |
|---|---|---|---|---|---|
| 0.1 mm ID (0.4 mm OD) | | | | | |
| 0.10 µm film | 726180.10 | | | | |
| 0.25 mm ID (0.4 mm OD) | | | | | |
| 0.25 µm film | | 726116.25 | 726116.30 | 726116.50 | 726116.60 |
| 0.32 mm ID (0.5 mm OD) | | | | | |
| 0.25 µm film | | 726341.25 | 726341.30 | 726341.50 | 726341.60 |
| 0.50 µm film | | 726344.25 | 726344.30 | 726344.50 | |
| 0.53 mm ID (0.8 mm OD) | | | | | |
| 0.50 µm film | | | 726345.30 | | |
| 1.00 µm film | | 726346.25 | | | |

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 303.

## OPTIMA® FFAPplus polyethylene glycol 2-nitroterephthalate · USP G35 / close equivalent to G25

### Key features
- Polar phase
- Structure see page 309

### Recommended application
- FAMEs, free carboxylic acids

### Temperature
- $T_{max}$ 250 °C (long-term temperature), $T_{max}$ 260 °C (short-term max. temperature in a temperature program)

### Similar phases
- DB-FFAP, HP-FFAP, CP-SIL 58 CB, 007-FFAP, CP-FFAP CB, Nukol™

FAMEs from biodiesel

MN Appl. No. 214590

Column: OPTIMA® FFAPplus, 30 m x 0.25 mm ID, 0.25 µm film
Injection: 1 µL, 260 °C, split 1:15
Carrier gas: 40 cm/s He
Temperature: 70 °C (1 min) → 240 °C, 30 °C/min (10 min)
Detector: MS-EI, ion source 200 °C, interface temperature 250 °C

Peaks:
Methyl esters of:
1. Caproic acid (C6:0)
2. Caprylic acid (C8:0)
3. Capric acid (C10:0)
4. Lauric acid (C12:0)
5. Myristic acid (C14:0)
6. Palmitic acid (C16:0)
7. Palmitoleic acid (C16:1)
8. Stearic acid (C18:0)
9. Oleic acid (C18:1 *cis*)
10. Linoleic acid (C18:2 *cis*)
11. Nonadecanoic acid (C19:0)
12. Linolenic acid (C18:3)
13. Arachidic acid (C20:0)
14. Behenic acid (C22:0)
15. Erucic acid (C22:1 *cis*)
16. Lignoceric acid (C24:0)
17. Nervonic acid (C24:1 *cis*)

## Ordering information

### OPTIMA® FFAPplus

| | Length → 30 m | 60 m |
|---|---|---|
| 0.25 mm ID (0.4 mm OD) | | |
| 0.25 µm film | 726241.30 | 726241.60 |
| 0.50 µm film | 726242.30 | 726242.60 |
| 0.32 mm ID (0.5 mm OD) | | |
| 0.25 µm film | 726243.30 | 726243.60 |
| 0.50 µm film | 726246.30 | 726246.60 |

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 303.

Further applications can be found online in our application database at *www.mn-net.com/apps*

## PERMABOND® SE-30 100 % dimethylpolysiloxane · USP G1 / G2 / G38

### Key features
- Nonpolar phase

### Temperature
- $T_{max}$ 300 °C (long-term temperature), $T_{max}$ 320 °C (short-term max. temperature in a temperature program)

### Similar phases
- OPTIMA® 1 (see page 310)

### Ordering information

PERMABOND® SE-30

| | Length → 25 m | 50 m |
|---|---|---|
| 0.25 mm ID (0.4 mm OD) | | |
| 0.25 µm film | 723052.25 | 723052.50 |
| 0.32 mm ID (0.5 mm OD) | | |
| 0.25 µm film | 723306.25 | |
| 0.50 µm film | | 723308.50 |

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 303.

## PERMABOND® SE-52 5 % phenyl – 95 % dimethylpolysiloxane · USP G27

### Key features
- Nonpolar phase

### Temperature
- $T_{max}$ 300 °C (long-term temperature), $T_{max}$ 320 °C (short-term max. temperature in a temperature program)

### Similar phases
- OPTIMA® 5 (see page 314)

### Ordering information

PERMABOND® SE-52

| | Length → 25 m |
|---|---|
| 0.25 mm ID (0.4 mm OD) | |
| 0.25 µm film | 723054.25 |
| 0.32 mm ID (0.5 mm OD) | |
| 0.25 µm film | 723310.25 |
| 0.50 µm film | 723312.25 |

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 303.

## PERMABOND® CW 20 M polyethylene glycol 20 000 Dalton · USP G16

### Key features
- Polar phase

### Recommended application
- Solvent analysis and alcohols, suitable for aqueous solutions

### Temperature
- 0.1–0.32 mm ID: $T_{max}$ 220 °C (long-term temperature), $T_{max}$ 240 °C (short-term max. temperature in a temperature program)
- 0.53 mm ID: $T_{max}$ 200 and 220 °C, resp.

### Similar phases
- See OPTIMA® WAX (see page 332)

### Ordering information

PERMABOND® CW 20 M

| | Length → 10 m | 25 m | 30 m | 50 m | 60 m |
|---|---|---|---|---|---|
| 0.1 mm ID (0.4 mm OD) | | | | | |
| 0.10 µm film | 723064.10 | | | | |
| 0.25 mm ID (0.4 mm OD) | | | | | |
| 0.25 µm film | 723060.10 | 723060.25 | 723060.30 | 723060.50 | 723060.60 |
| 0.32 mm ID (0.5 mm OD) | | | | | |
| 0.25 µm film | 723321.10 | 723321.25 | 723321.30 | 723321.50 | 723321.60 |
| 0.35 µm film | 723827.10 | 723827.25 | | 723827.50 | |
| 0.50 µm film | 723296.10 | 723296.25 | 723296.30 | 723296.50 | 723296.60 |
| 0.53 mm ID (0.8 mm OD) | | | | | |
| 0.50 µm film | 723515.10 | 723515.25 | | | |
| 1.00 µm film | 723549.10 | 723549.25 | 723549.30 | | |
| 2.00 µm film | 723517.10 | 723517.25 | 723517.30 | | |

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 303.

Further applications can be found online in our application database at *www.mn-net.com/apps*

## PERMABOND® FFAP polyethylene glycol 2-nitroterephthalate · USP G35 / close equivalent to G25

### Key features
- Polar phase

### Recommended application
- FAMEs, free carboxylic acids

### Temperature
- 0.1–0.32 mm ID: $T_{max}$ 220 °C (long-term temperature), $T_{max}$ 240 °C (short-term max. temperature in a temperature program)
- 0.53 mm ID: $T_{max}$ 200 and 220 °C, resp.

### Similar phases
- See OPTIMA® FFAP (see page 334)

### Ordering information

PERMABOND® FFAP

| | Length → 10 m | 20 m | 25 m | 30 m | 50 m | 60 m |
|---|---|---|---|---|---|---|
| 0.1 mm ID (0.4 mm OD) | | | | | | |
| 0.10 µm film | 723180.10 | 723180.20 | | | | |
| 0.25 µm film | 723181.10 | | | | | |
| 0.25 mm ID (0.4 mm OD) | | | | | | |
| 0.10 µm film | | | 723936.25 | | 723936.50 | |
| 0.25 µm film | 723116.10 | | 723116.25 | 723116.30 | 723116.50 | 723116.60 |
| 0.32 mm ID (0.5 mm OD) | | | | | | |
| 0.10 µm film | | | 723356.25 | | 723356.50 | |
| 0.25 µm film | | | 723341.25 | 723341.30 | 723341.50 | 723341.60 |
| 0.35 µm film | 723830.10 | | 723830.25 | | 723830.50 | |
| 0.50 µm film | 723344.10 | | 723344.25 | 723344.30 | 723344.50 | 723344.60 |
| 0.53 mm ID (0.8 mm OD) | | | | | | |
| 1.00 µm film | 723555.10 | | 723555.25 | | 723555.50 | |

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 303.

Further applications can be found online in our application database at *www.mn-net.com/apps*

## Capillary columns for special GC separations

Certain analytical separations can be accomplished more easily with chromatographic columns, that have been especially developed for that task, compared with standard columns. The following table summarizes our program of GC speciality capillaries, the individual columns will be described in detail on the following pages.

### Overview

| Separation/special application | Recommended capillary column | Page |
|---|---|---|
| Fast GC column with 0.10 mm ID | | |
| | OPTIMA® 1, OPTIMA® 5, OPTIMA® δ-3, OPTIMA® δ-6<br>OPTIMA® 17, OPTIMA® 225, OPTIMA® FFAP<br>PERMABOND® CW 20 M, PERMABOND® FFAP | 340 |
| Enantiomer separation cyclodextrin phases | | |
| | FS-LIPODEX® A, FS-LIPODEX® B, FS-LIPODEX® C<br>FS-LIPODEX® D, FS-LIPODEX® E, FS-LIPODEX® G | 342 |
| | FS-HYDRODEX β-PM, FS-HYDRODEX β-3 P,<br>FS-HYDRODEX β-6TBDM, FS-HYDRODEX β-6TBDE,<br>FS-HYDRODEX β-6TBDE, FS-HYDRODEX β-TBDAc,<br>FS-HYDRODEX γ-DiMOM | 344 |
| Biodiesel | | |
| Methanol analysis | OPTIMA® BioDiesel M | 346 |
| FAME analysis | OPTIMA® BioDiesel F | 346 |
| Glycerol and triglycerides | OPTIMA® BioDiesel G | 346 |
| Triglycerides | | |
| | OPTIMA® 1-TG | 348 |
| | OPTIMA® 17-TG | 348 |
| High temperature GC | | |
| | OPTIMA® 5 HT | 349 |
| Amines | | |
| Polyfunctional amines | OPTIMA® 5 Amine | 350 |
| Amine separations | FS-CW 20 M-AM | 351 |
| Petrochemical products (complex hydrocarbon mixtures) | | |
| | PERMABOND® P-100 | 352 |
| Environmental analysis of volatile halogenated hydrocarbons | | |
| | PERMABOND® SE-54 HKW | 352 |
| Silanes (monomeric, e.g., chlorosilanes) | | |
| | PERMABOND® Silane | 354 |
| Diethylene glycol, e.g., for the quality control of wine | | |
| | PERMABOND® CW 20 M-DEG | 354 |

# Capillary columns for Fast GC

## Fast GC

### Key features

- Decreased column diameters, high heating rates and decreased column lengths for faster GC separations with high resolution efficiency
- Small inner diameters combined with very fast temperature programs can reduce the analysis time by up to 80 %
- High sensitivity detectors with small volume and very short response time, as well as very rapid data acquisition and processing
- Small inner diameters result in high column inlet pressures and a lower volume flow of the mobile phase: very fast injection of very small samples against a high pressure
- Amount of sample, which can be injected, is limited by the inner diameter and the thin film

### Temperature

- High heating rates place special demands on stationary phases. OPTIMA® columns meet exactly this requirement: very low bleeding, long lifetimes, even for continuous high heating rates

Comparison of a separation on a 50 m standard capillary with separation on a 10 m fast GC column

MN Appl. No. 211260

Peaks:
1. Octanol
2. Undecane
3. Dimethylaniline
4. Dodecane
5. Decylamine
6. Methyl decanoate
7. Methyl undecanoate
8. Henicosane
9. Docosane
10. Tricosane

A) Fast GC column
Column: OPTIMA® 5, 10 m x 0.1 mm ID, 0.1 µm film
Injection 1 µL, split 1:40, Carrier gas 0.75 bar He

B) standard GC column
Column: OPTIMA® 5, 50 m x 0.25 mm ID, 0.25 µm film
Injection 1 µL, split 1:35, Carrier gas 1.5 bar He

Both separations:
Temperature: 80 °C → 320 °C (10 min), 8 °C/min
Detector: FID

While maintaining the temperature program and halving the pressure a time saving of 30 % results with identical separation efficiency.

## Ordering information

### Columns for Fast GC

| Phase | Maximum temperature | ID [mm] | Film thickness [µm] | REF (10 m) | REF (20 m) |
|---|---|---|---|---|---|
| OPTIMA® 1 | | | | | |
| | 340 / 360 °C | 0.10 | 0.10 | 726024.10 | 726024.20 |
| | | 0.10 | 0.40 | | 726025.20 |
| OPTIMA® 5 | | | | | |
| | 340 / 360 °C | 0.10 | 0.10 | 726846.10 | |
| OPTIMA® δ-3 | | | | | |
| | 340 / 360 °C | 0.10 | 0.10 | 726410.10 | 726410.20 |
| OPTIMA® δ-6 | | | | | |
| | 340 / 360 °C | 0.10 | 0.10 | 726490.10 | |
| OPTIMA® 17 | | | | | |
| | 320 / 340 °C | 0.10 | 0.10 | 726848.10 | |
| OPTIMA® 225 | | | | | |
| | 260 / 280 °C | 0.10 | 0.10 | 726080.10 | |
| OPTIMA® FFAP | | | | | |
| | 250 / 260 °C | 0.10 | 0.10 | 726180.10 | |
| PERMABOND® CW 20 M | | | | | |
| | 220 / 240 °C | 0.10 | 0.10 | 723064.10 | |
| PERMABOND® FFAP | | | | | |
| | 220 / 240 °C | 0.10 | 0.10 | 723180.10 | 723180.20 |
| | | 0.10 | 0.25 | 723181.10 | |
| OPTIMA® 5 Amine | | | | | |
| | 300 / 320 °C | 0.10 | 0.40 | 726361.10 | |
| FS-CW 20 M-AM | | | | | |
| | 220 / 240 °C | 0.10 | 0.25 | 733111.10 | |
| FS-LIPODEX® E | | | | | |
| | 200 / 220 °C | 0.10 | 0.10 | 723382.10 | |
| FS-HYDRODEX β-6TBDM | | | | | |
| | 230 / 250 °C | 0.10 | 0.10 | 723383.10 | |

In addition to this standard program, all MN GC phases can be custom-made as fast GC columns

Further applications can be found online in our application database at *www.mn-net.com/apps*

## LIPODEX® cyclodextrin phases for enantiomer separation

### Key features

- Base material: cyclic oligosaccharides consisting of six (α-cyclodextrin), seven (β-cyclodextrin) or eight (γ-cyclodextrin) glucose units bonded through 1,4-linkages
- Regioselective alkylation and / or acylation of the hydroxyl groups leads to lipophilic phases with varying enantioselectivity, which are well suited for GC enantiomer analysis
- Important advantage: many compounds can be analyzed without derivatization (however, for certain substances enantioselectivity can be favorably influenced by formation of derivatives)

### Recommended application

- A large number of separations have been achieved, however, it is not possible to make a general prediction, which phase could solve a given separation task. Even for compounds with small structural differences or within homologous series the enantiodifferentiation can be quite different. The following table shows typical applications.

Note:

- Water as solvent is strictly forbidden for all cyclodextrin phases
- Dry the sample with our CHROMAFIX® Dry ($Na_2SO_4$) cartridges (see page 61)
- Use suitable nonpolar solvent

| Phase | Cyclodextrin derivate | $T_{max}$ [°C] | Recommended application |
|---|---|---|---|
| LIPODEX® A | | | |
| | hexakis-(2,3,6-tri-O-pentyl)-α-CD | 200 / 220 | carbohydrates, polyols, diols, hydroxycarboxylic acid esters, (epoxy-) alcohols, glycerol derivatives, spiroacetals, ketones, alkyl halides |
| LIPODEX® B | | | |
| | hexakis-(2,6-di-O-pentyl-3-O-acetyl)-α-CD | 200 / 220 | lactones, diols (cyclic carbonates), aminols, aldols (O-TFA), glycerol derivatives (cyclic carbonates) |
| LIPODEX® C | | | |
| | heptakis-(2,3,6-tri-O-pentyl)-β-CD | 200 / 220 | Alcohols, cyanhydrins, olefins, hydroxycarboxylic acid esters, alkyl halides |
| LIPODEX® D | | | |
| | heptakis-(2,6-di-O-pentyl-3-O-acetyl)-β-CD | 200 / 220 | aminols (TFA), β-amino acid esters, trans-cycloalkane-1,2-diols, trans-cycloalkane-1,2- diols, trans-cycloalkane-1,3-diols (TFA) |
| LIPODEX® E | | | |
| | octakis-(2,6-di-O-pentyl-3-O-butyryl)-γ-CD | 200 / 220 | α-amino acids, α- and β-hydroxycarboxylic acid esters, alcohols (TFA), diols (TFA), ketones, pheromones (cyclic acetals), amines, alkyl halides, lactones |
| LIPODEX® G | | | |
| | octakis-(2,3-di-O-pentyl-6-O-methyl)-γ-CD | 220 / 240 | menthol isomers, ketones, alcohols, carboxylic acid esters, terpenes |

### Ordering information

#### LIPODEX®

| Length → | 10 m<br>0.10 mm ID | 25 m<br>0.25 mm ID | 50 m<br>0.25 mm ID |
|---|---|---|---|
| FS-LIPODEX® A | | | |
| | | 723360.25 | 723360.50 |
| FS-LIPODEX® B | | | |
| | | 723362.25 | 723362.50 |
| FS-LIPODEX® C | | | |
| | | 723364.25 | 723364.50 |
| FS-LIPODEX® D | | | |
| | | 723366.25 | 723366.50 |
| FS-LIPODEX® E | | | |
| | 723382.10 | 723368.25 | 723368.50 |
| FS-LIPODEX® G | | | |
| | | 723379.25 | 723379.50 |

All columns with 0.4 mm OD

### Enantiomer separation of amino acid methyl esters (TFA)

MN Appl. No. 202592

| | |
|---|---|
| Column: | FS-LIPODEX® E, 25 m x 0.25 mm ID |
| Injection: | 1 µL, split ~ 1: 100 |
| Carrier gas: | 60 kPa $H_2$ |
| Temperature: | 90 → 190 °C, 4 °C/min |
| Detector: | FID 250 °C |

Peaks:
(D is eluted before L except for proline: L before D)
1. Alanine
2. Valine
3. Leucine
4. Proline
5. Aspartic acid
6. Phenylalanine

### Separation of chiral constituents of peppermint oil

MN Appl. No. 250410

W. A. König et al., High Resol. Chromatogr. 20 (1997) 55–61

| | |
|---|---|
| Column: | FS-LIPODEX® G, 25 m x 0.25 mm ID |
| Carrier gas: | 50 kPa $H_2$ |
| Temperature: | 75 °C, isothermal |
| Detector: | FID |

Peaks:
1. (+)-trans-Sabinene hydrate
2. (+)-Menthone
3. (+)-Isomenthone
4. (–)-Menthone
5. (–)-Isomenthone
6. (+)-Menthofuran
7. (–)-Isopulegol
8. (–)-Menthyl acetate
9. (+)-Pulegone
10. (+)-Neomenthol
11. (–)-Neomenthol
12. (+)-Neoisomenthol
13. (+)-Menthol
14. (–)-Neoisomenthol
15. (+)-Piperitone
16. (–)-Menthol
17. (+)-Isomenthol
18. (–)-Isomenthol

## Cyclodextrin derivates

Further applications can be found online in our application database at *www.mn-net.com/apps*

## HYDRODEX cyclodextrin phases for enantiomer separation

### ✓ Recommended application

- Cyclodextrin derivatives (see page 343) with high melting point: for GC enantiomer separation diluted with polysiloxanes

**Enantiomer separation of dichlorprop methyl ester**

MN Appl. No. 202542

Column: FS-HYDRODEX β-3P, 25 m x 0.25 mm ID
Injection: 0.1 µL (~1 % in $CH_2Cl_2$), split 130 mL/min
Carrier gas: 60 kPa $H_2$ (1.9 mL/min)
Temperature: 160 °C
Detector: FID 250 °C

**Separation of isomeric antiinflammatory drugs**

MN Appl. No. 210150

Courtesy of Prof. W.A. König, Hamburg, Germany
Column: FS-HYDRODEX β-6TBDM, 25 m x 0.25 mm ID
Carrier gas: He
Temperature: 135 °C → 200 °C, 1 °C/min
Detector: FID

Peaks:

1. Ibuprofen
2. Flurbiprofen
3. Fenoprofen
4. Naproxen
5. Ketoprofen


| Phase | Cyclodextrin derivative (diluted with optimized polysiloxane) | $T_{max}$ [°C] | Recommended application |
|---|---|---|---|
| HYDRODEX β-PM | | | |
| | heptakis-(2,3,6-tri-O-methyl)-β-CD | 230 / 250 | hydroxycarboxylic acid esters, alcohols, diols, olefins, lactones, acetals |
| HYDRODEX β-3P | | | |
| | heptakis-(2,6-di-O-methyl-3-O-pentyl)-β-CD | 230 / 250 | terpenes, dienes, allenes, terpene alcohols, 1,2-epoxy-alkanes, carboxylic acids (esters), hydroxycarboxylic acid esters, pharmaceuticals, pesticides |
| HYDRODEX β-6TBDM | | | |
| | heptakis-(2,3-di-O-methyl-6-O-t-butyldimethyl-silyl)-β-CD | 230 / 250 | γ-lactones, cyclopentanones, terpenes, esters, tartrates |
| HYDRODEX β-6TBDE | | | |
| | heptakis-(2,3-di-O-ethyl-6-O-t-butyldimethyl-silyl)-β-CD | 230 / 250 | essential oils |
| HYDRODEX β-TBDAc | | | |
| | heptakis-(2,3-di-O-acetyl-6-O-t-butyldimethyl-silyl)-β-CD | 220 / 240 | alcohols, esters, ketones, aldehydes, δ-lactones |
| HYDRODEX γ-TBDAc | | | |
| | octakis-(2,3-di-O-acetyl-6-O-t-butyldimethyl-silyl)-γ-CD | 220 / 240 | cyclic ketones, aromatic ketones, oxiranes, aromatic esters, aromatic amides |
| HYDRODEX γ-DIMOM | | | |
| | octakis-(2,3-di-O-methoxymethyl-6-O-t-butyldimethyl-silyl)-γ-CD | 220 / 240 | ketones, terpenes, cyclic ethers, alcohols, amines |

### Separation of (R/S) citronellol + citronellal

MN Appl. No. 212440

| | |
|---|---|
| Column: | FS-HYDRODEX β-TBDAc, 50 m x 0.25 mm ID |
| Injection: | 1 µL, 1:1000 in $CH_2Cl_2$, split 25 mL/min |
| Carrier gas: | 1.5 bar $H_2$ |
| Temperature: | 100 °C |
| Detector: | FID 220 °C |

Peaks:
1. (R)/(S)-Citronellal
2. (S)/(R)-Citronellal
3. (S)-Citronellol
4. (R)-Citronellol

### Separation of essential oils

MN Appl. No. 212980/212990/213000

| | |
|---|---|
| Column: | FS-HYDRODEX γ-TBDAc, 50 m x 0.25 mm ID |
| Injektor: | 220 °C |
| Carrier gas: | 1.2 bar $H_2$ |
| Temperature: | 125 °C |
| Detector: | FID 220 °C |

Peaks:
1. Fenchone (1.5 mg/mL)
2. Menthone (0.5 mg/mL)
3. Menthol (2 mg/mL)

## Ordering information

### HYDRODEX

| Length → | 10 m<br>0.10 mm ID | 25 m<br>0.25 mm ID | 50 m<br>0.25 mm ID |
|---|---|---|---|
| FS-HYDRODEX β-PM | | | |
| | | 723370.25 | 723370.50 |
| FS-HYDRODEX β-3P | | | |
| | | 723358.25 | 723358.50 |
| FS-HYDRODEX β-6TBDM | | | |
| | 723383.10 | 723381.25 | 723381.50 |
| FS-HYDRODEX β-6TBDE | | | |
| | | 723386.25 | |
| FS-HYDRODEX β-TBDAc | | | |
| | | 723384.25 | 723384.50 |
| FS-HYDRODEX γ-TBDAc | | | |
| | | 723387.25 | 723387.50 |
| FS-HYDRODEX γ-DiMOM | | | |
| | | 723388.25 | 723388.50 |
| All columns with 0.4 mm OD | | | |

Further applications can be found online in our application database at *www.mn-net.com/apps*

## OPTIMA® BioDiesel for the analysis of biodiesel (DIN EN 14214 / ASTM D 6751)

### OPTIMA® BioDiesel M for analysis of methanol in accordance with DIN EN 14110

**Key features**

- The methanol content in biodiesel as specified in DIN EN 14110 must not exceed 0.2 %. The column OPTIMA® BioDiesel M allows the GC headspace analysis of the methanol content in biodiesel in the concentration range from 0.01 to 0.5 % with 2-propanol as internal standard.

**Temperature**

- $T_{max}$ 340 °C (long-term temperature), $T_{max}$ 360 °C (short-term max. temperature in a temperature program)

**Similar phases**

- Select™ Biodiesel for Methanol, Trace TR-BioDiesel (M)

### OPTIMA® BioDiesel F for analysis of FAMEs in accordance with DIN EN 14103:2011

**Key features**

- The analysis of biodiesel requires separation of typical FAMEs between myristic acid ($C_{14}$) and nervonic acid ($C_{24}$:1) methyl esters. This analysis is possible on OPTIMA® BioDiesel F in only 22 min. Additionally, linolenic acid methyl ester can be determined due to the good resolution. The extended standard DIN EN 14103:2011 also covers smaller FAMEs starting from $C_6$ (see application 214510 on opposite page). Change of the internal standard from $C_{17}$ to $C_{19}$ also allows the analysis of animal fats.

**Temperature**

- $T_{max}$ 240 °C (long-term temperature), $T_{max}$ 250 °C (short-term max. temperature in a temperature program)

**Similar phases**

- Select™ Biodiesel for FAME, Trace TR-BioDiesel (F)

### OPTIMA® BioDiesel G for analysis of glycerol and glycerides in accordance with DIN EN 14105

**Key features**

- The capillary column OPTIMA® BioDiesel G allows determination of free glycerol and residues of mono-, di- and triglycerides in FAMEs intended as additives for mineral oils. The procedure can be applied for FAMEs from rapeseed oil, sunflower oil and soy bean oil. Glycerol as well as mono- and diglycerides are derivatized to more volatile substances by addition of MSTFA in the presence of pyridine (see page 363).

**Temperature**

- $T_{max}$ 380 °C (long-term temperature), $T_{max}$ 400 °C (short-term max. temperature in a temperature program)

**Similar phases**

- Select™ Biodiesel for Glycerides, Trace TR-BioDiesel (G), MET-Biodiesel

## Analysis of FAMEs from biodiesel in accordance with DIN EN 14103:2011

MN Appl. No. 214510

| | |
|---|---|
| Column: | OPTIMA® BioDiesel F, 30 m x 0.25 mm ID |
| Sample: | 50 µg/mL each in dichloromethane |
| Injection: | 10 µL, 250 °C, split 1:20 |
| Carrier gas: | 1.2 bar He |
| Temperature: | 80 °C → 250 °C (8.5 min), 20 °C/min |
| Detector: | FID 260 °C |

Peaks:

1. C6:0
2. C8:0
3. C10:0
4. C12:0
5. C14:0
6. C16:0
7. C16:1
8. C18:0
9. C18:1
10. C18:2
11. C19:0, int. st.
12. C18:3
13. C20:0
14. C22:0
15. C22:1
16. C24:0

## Analysis of glycerol and glycerides from biodiesel

MN Appl. No. 213640

| | |
|---|---|
| Column: | OPTIMA® BioDiesel G, 10 m x 0.25 mm ID |
| Sample: | A) standard in *n*-heptane<br>B) biodiesel |
| Injection: | 2 µL, 350 °C, CIS (15 °C → 350 °C, 12 °C/s) |
| Carrier gas: | 0.8 bar $H_2$, split 1: 2.6 |
| Temperature: | 50 °C (3.5 min) → 180 °C, 15 °C/min<br>→ 280 °C, 7 °C/min<br>→ 370 °C (10 min), 10 °C/min |
| Detector: | FID 380 °C |

Peaks:

1. Glycerol (TMS)
2. Butanetriol (TMS), IS
3. Monoolein = glycerol monooleate (TMS)
   + monoacylglycerides
4. Tricaprin (glycerol tricaprate), IS
5. Diolein = glycerol dioleate (TMS)
   + diacylglycerides
6. Triolein = glycerol trioleate
   + triacylglycerides

## Ordering information

### OPTIMA® BioDiesel

| | Length → 10 m | 30 m |
|---|---|---|
| OPTIMA® BioDiesel M | | |
| 0.32 mm ID (0.5 mm OD) | | 726905.30 |
| OPTIMA® BioDiesel F | | |
| 0.25 mm ID (0.4 mm OD) | | 726900.30 |
| OPTIMA® BioDiesel G | | |
| 0.25 mm ID (0.4 mm OD) | 726903.10 | |

# Capillary columns for triglyceride analysis

## OPTIMA® 1-TG · 17-TG for triglyceride analysis · USP G1 / G2 / G38 (1-TG) · USP G3 (17-TG)

### Key features

- Short capillary columns (max. 25 m and 0.32 mm ID) with low-bleeding stationary phases thermally stable with optimized deactivation

### Recommended application

- OPTIMA® 1-TG
  100 % dimethylpolysiloxane offers separation according to carbon number
- OPTIMA® 17-TG
  phenyl-methyl-polysiloxane (50 % phenyl) for separation according to degree of unsaturation

### Temperature

- $T_{max}$ 370 °C (both phases)

**Similar phases der OPTIMA® 1-TG:**

- SPB-1 TG, DB-1 HT, 400-1 HT, HT-5

Triglycerides (from butter)

MN Appl. No. 201790

| | |
|---|---|
| Column: | OPTIMA® 1-TG, 25 m x 0.32 mm ID |
| Injection: | 0.5 µL |
| Carrier gas: | 80 kPa $H_2$ |
| Temperature: | 80 °C (1 min) → 250 °C, 20 °C/min → 370 °C (10 min), 5 °C/min |
| Detector: | FID 380 °C |

Peaks:
1. Cholesterol
2. T-30
3. T-34
4. T-38
5. T-42
6. T-46
7. T-50
8. T-54

## Ordering information

### OPTIMA® 1-TG · OPTIMA® 17-TG

| | Length → 10 m | 25 m |
|---|---|---|
| OPTIMA® 1-TG | | |
| 0.25 mm ID (0.4 mm OD) | 726133.10 | 726133.25 |
| 0.32 mm ID (0.5 mm OD) | 726132.10 | 726132.25 |
| OPTIMA® 17-TG | | |
| 0.32 mm ID (0.5 mm OD) | 726131.10 | 726131.25 |

## OPTIMA® 5 HT for high temperature GC · USP G27 / G36

### Key features

- Chemically bonded, cross-linked silarylene phase with polarity similar to a 5 % diphenyl - 95 % dimethylpolysiloxane phase
- Nonpolar phase, low bleeding

### Recommended application

- Ideal for MS detectors, can be rinsed with solvents
- For simulated distillation, hydrocarbon, fuel and oil analysis, high-boiling analytes

### Temperature

- $T_{max}$ 380 °C (long-term temperature), $T_{max}$ 400 °C (short-term max. temperature in a temperature program)

### Similar phases

- DB-5HT, VF-5HT, HT-5, XTI-5HT, ZB-5HT

Separation of motor oil / mineral oil (type A + B), rapid determination in accordance with DIN H-53 / ISO DIS

MN Appl. No. 213400

| | |
|---|---|
| Column: | OPTIMA® 5 HT, 15 m x 0.32 mm ID, 0.25 µm film |
| Sample: | mineral oil type A + B (hydrocarbon index kit acc. to EN ISO 9377-2) in hexane |
| Injection: | 1 µL, splitless, 300 °C |
| Carrier gas: | 0.6 bar He |
| Temperature: | 40 °C (5 min) → 390 °C, 50 °C/min |
| Detector: | FID 280 °C |

Peaks:
1. Decane (C10)
2. Tetracontane (C40)

## Ordering information

### OPTIMA® 5 HT

| | Length → 15 m | 30 m |
|---|---|---|
| 0.25 mm ID (0.4 mm OD) | | |
| 0.10 µm film | 726102.15 | 726102.30 |
| 0.25 µm film | 726106.15 | 726106.30 |
| 0.32 mm ID (0.5 mm OD) | | |
| 0.10 µm film | 726104.15 | 726104.30 |
| 0.25 µm film | 726108.15 | 726108.30 |

Further applications can be found online in our application database at *www.mn-net.com/apps*

# Capillary columns for amine separation

## OPTIMA® 5 Amine special column for analysis of amines · USP G27 / G36

### Key features

- Nonpolar phase
- Improved linearity for analysis of active components at trace levels: no amine absorptions even for aliphatic and aromatic amines at concentrations of 100 pg/peak
- Tested with the OPTIMA® Amine test mixture (REF 722317), which contains, amongst others, diethanolamine and propanol-pyridine (this test mixture is supplied with each column)

### Recommended application

- Especially deactivated for the analysis of polyfunctional amines such as ethanolamines, amino-functionalized diols and similar compounds, which are important base materials in industrial chemistry, and show strong tailing on standard-deactivated columns

### Temperature

- $T_{max}$ 300 °C (long-term temperature), $T_{max}$ 320 °C (short-term max. temperature in a temperature program)

### Similar phases

- Rtx®-5 Amine, PTA-5

Separation of secondary and tertiary amines

MN Appl. No. 210280

| | |
|---|---|
| Column: | OPTIMA® 5 Amine, 30 m x 0.25 mm ID, 1.0 µm film |
| Injection: | 1 µL, split 1:100 |
| Carrier gas: | 0.6 bar $H_2$ |
| Temperature: | 100 °C (3 min) → 280 °C, 10 °C/min |
| Detector: | FID 280 °C |

Peaks:

1. Diethylamine
2. Di-isopropylamine
3. Triethylamine
4. Di-*n*-propylamine
5. Di-*n*-butylamine
6. Tri-*n*-propylamine
7. Di-isobutylamine
8. Tri-*n*-butylamine
9. Di-isohexylamine
10. Dicyclohexylamine
11. Dibenzylamine
12. Tri-*n*-hexylamine

## Ordering information

### OPTIMA® 5 Amine

| | Length → 10 m | 25 m | 30 m |
|---|---|---|---|
| 0.1 mm ID (0.4 mm OD) | | | |
| 0.40 µm film | 726361.10 | | |
| 0.2 mm ID (0.4 mm OD) | | | |
| 0.35 µm film | | 726355.25 | |
| 0.25 mm ID (0.4 mm OD) | | | |
| 0.50 µm film | | | 726354.30 |
| 1.00 µm film | | | 726358.30 |
| 0.32 mm ID (0.5 mm OD) | | | |
| 0.25 µm film | | | 726360.30 |
| 1.00 µm film | | | 726353.30 |
| 1.50 µm film | | | 726356.30 |
| 0.53 mm ID (0.8 mm OD) | | | |
| 1.00 µm film | | | 726359.30 |
| 3.00 µm film | | | 726357.30 |

## FS-CW 20 M-AM polyethylene glycol 20 000, non-immobilized · USP G16

### Key features

- Polyethylene glycol, basic for amine separations

### Temperature

- $T_{max}$ 220 °C (long-term temperature), $T_{max}$ 240 °C (short-term max. temperature in a temperature program)

### Similar phases

- Carbowax™ Amine, CP-Wax 51, CAM, Stabilwax® DB

### Ordering information

FS-CW 20 M-AM

| | Length → 10 m | 25 m | 50 m |
|---|---|---|---|
| 0.1 mm ID (0.4 mm OD) | | | |
| 0.25 µm film | 733111.10 | | |
| 0.25 mm ID (0.4 mm OD) | | | |
| 0.25 µm film | | 733110.25 | 733110.50 |
| 0.32 mm ID (0.5 mm OD) | | | |
| 0.25 µm film | | 733299.25 | 733299.50 |
| 0.35 µm film | | | 733442.50 |
| 0.53 mm ID (0.8 mm OD) | | | |
| 1.00 µm film | | 733551.25 | |

Further applications can be found online in our application database at *www.mn-net.com/apps*

## MACHEREY-NAGEL CHROMAFIL® syringe filters

### Ideal for the filtration of GC, HPLC and UHPLC sample solutions

- Diverse membrane types and filter sizes for a variety of applications
- Optimal flow geometry because of star-shaped distribution device
- Lowest content of extractable substances
- Luer lock inlet, Luer outlet
- Prefiltration of solvents protects sensitive instrument parts and chromatography columns from solid contamination and increases their lifetime.

Find CHROMAFIL® products from page 81 onwards.

## PERMABOND® P-100 for analysis of petrochemical products · USP G1 / G2 / G38

### Key features
- Extra long column with nonpolar dimethylpolysiloxane phase

### Recommended application
- High resolution and sufficient capacity for analysis of complex mixtures of hydrocarbons

### Temperature
- $T_{max}$ 300 °C (long-term temperature), $T_{max}$ 320 °C (short-term max. temperature in a temperature program)

### Ordering information

PERMABOND® P-100

| | Length → 100 m |
|---|---|
| 0.25 mm ID (0.4 mm OD) | |
| 0.50 µm film | 723890.100 |

## PERMABOND® SE-54-HKW for volatile halogenated hydrocarbons · USP G36

### Recommended application
- SE-54 optimized for volatile halogenated hydrocarbons

### Temperature
- $T_{max}$ 300 °C (long-term temperature), $T_{max}$ 320 °C (short-term max. temperature in a temperature program)

For the analysis of halogenated hydrocarbons, we recommend our optimized column PERMABOND® SE-54-HKW at 25 or 50 m length with our approved polysiloxane phase SE-54.

As an alternative, or to verify analytical results, the OPTIMA® 624 has proven itself as advantageous, especially for the determination of 1,1,2-trichlorotrifluoroethane (F 113) along with dichloromethane.

Both phases are also suited for the determination of vinyl chloride as well as for the separation of cis/trans isomers of 1,2-dichloroethene. The high film thickness secures a high capacity and an outstanding resolution. For GC/MS coupling, we recommend OPTIMA® 624 LB or OPTIMA® 624 with 0.2 or 0.25 mm ID

Volatile halogenated hydrocarbons

MN Appl. No. 212480

Column: PERMABOND® SE-54-HKW, 50 m x 0.32 mm ID
Injection: 1 µL, split ~ 1:30
Carrier gas: 0.9 bar He
Temperature: 35 °C (25 min) → 160 °C (5 min), 10 °C/min
Detector: ECD 300 °C

Peaks:
1. Dichloromethane (795 ng/mL)
2. Trichloromethane (75 ng/mL)
3. 1,1,1-Trichloroethane (67 ng/mL)
4. 1,2-Dichloroethane (100 ng/mL)
5. Tetrachloromethane (15.9 ng/mL)
6. Trichloroethene (14.6 ng/mL)
7. Bromodichloromethane (20 ng/mL)
8. Dibromochloromethane (122 ng/mL)
9. Tetrachloroethene (81 ng/mL)
10. Tribromomethane (28.9 ng/mL)

### Volatile halogenated hydrocarbons and BTX

MN Appl. No. 200160

| | |
|---|---|
| Column: | OPTIMA® 624, 50 m x 0.25 mm ID, 1.40 µm film |
| Injection: | 1 µL, split 50 mL/min |
| Carrier gas: | 0.9 mL/min He (constant flow) |
| Temperature: | 40 °C (5 min) → 160 °C, 10 °C/min |
| Detector: | MSD 5971 |

Peaks:

1. Vinyl chloride
2. Trichlorofluoromethane (F 11)
3. Pentane
4. 1,1,2-Trichlorotrifluoroethane (F 113)
5. Dichloromethane
6. *trans*-1,2-Dichloroethene
7. Hexane
8. *cis*-1,2-Dichloroethene
9. Trichloromethane
10. 1,1,1-Trichloroethane
11. Tetrachloromethane
12. 1,2-Dichloroethane + benzene
13. Trichloroethene
14. Bromodichloromethane
15. Toluene
16. Tetrachloroethene
17. Dibromochloromethane
18. Chlorobenzene
19. Ethylbenzene
20. *m*- + *p*-Xylene
21. *o*-Xylene
22. Tribromomethane
23. Bromobenzene

## Ordering information

### PERMABOND® SE-54-HKW

| | Length → 25 m | 50 m |
|---|---|---|
| 0.32 mm ID (0.5 mm OD) | | |
| 1.80 µm film | 723945.25 | 723945.50 |

Further applications can be found online in our application database at *www.mn-net.com/apps*

## PERMABOND® Silane for silane analysis

### Recommended application

- Developed especially for the analysis of monomeric silanes and chlorosilanes (not for the separation of trimethylsilyl derivatives)
- Also suited for the separation of dimeric siloxanes and silazanes

### Temperature

- 0.32 mm ID: $T_{max}$ 260 °C (long-term temperature), $T_{max}$ 280 °C (short-term max. temperature in a temperature program)
- 0.53 mm ID: $T_{max}$ 240 and 260 °C, resp.

### Ordering information

PERMABOND® Silane

| | Length → 25 m | 50 m |
|---|---|---|
| 0.32 mm ID (0.5 mm OD) | | 723409.50 |
| 0.53 mm ID (0.8 mm OD) | 723411.25 | |

**Chloromethylsilanes**

MN Appl. No. 200090

Column: PERMABOND® Silane, 50 m x 0.32 mm ID
Injection: 0.5 µL gas, split 80 mL/min
Carrier gas: 1 mL/min He (constant flow)
Temperature: 50 °C → 100 °C, 5 °C/min
Detector: MSD 5971

Peaks:
1. Tetramethylsilane
2. Dichloromethane
3. Tetrachlorosilane
4. Chlorotrimethylsilane
5. Methyltrichlorosilane
6. Dichlorodimethylsilane
7. Hexamethyldisiloxane

**Diethylene glycol standard in wine**

MN Appl. No. 201500

Column: PERMABOND® CW 20 M-DEG, 25 m x 0.25 mm ID
Injection: 0.5 µL, split ~1:40
Carrier gas: 1.2 bar $N_2$
Temperature: 80 °C → 200 °C, 10 °C/min
Detector: FID 260 °C

Peaks:
DEG standard
1. 1,4-Butanediol
2. Diethylene glycol
3. Glycerol

## PERMABOND® CW 20 M-DEG for determination of diethylene glycol · USP G16

### Key features

- Polyethylene glycol 20 000 (diethylene glycol tested)

### Recommended application

- Determination of diethylene glycol (DEG), e.g., for the quality control of wine

### Temperature

- $T_{max}$ 220 °C (long-term temperature), $T_{max}$ 240 °C (short-term max. temperature in a temperature program)

### Ordering information

PERMABOND® CW 20 M-DEG

| | Length → 25 m |
|---|---|
| 0.25 mm ID (0.4 mm OD) | |
| 0.25 µm film | 723063.25 |
| 0.32 mm ID (0.5 mm OD) | |
| 0.25 µm film | 723327.25 |

Further applications can be found online in our application database at *www.mn-net.com/apps*

## Untreated capillaries

**Recommended application**

- Capillary electrophoresis
- Preparation of capillary columns
- Capillary LC applications

### Ordering information

#### Untreated capillaries

| | Length → 1 m<br>Pack of 3 | 10 m<br>Pack of 1 | 25 m<br>Pack of 1 |
|---|---|---|---|
| Capillaries for electrophoresis | | | |
| 0.025 mm ID (0.4 mm OD) | 723793.1 | 723793.2 | |
| 0.05 mm ID (0.4 mm OD) | 723790.1 | 723790.2 | |
| 0.075 mm ID (0.4 mm OD) | 723791.1 | 723791.2 | |
| 0.10 mm ID (0.4 mm OD) | 723792.1 | 723792.2 | |
| Untreated capillaries | | | |
| 0.20 mm ID (0.4 mm OD) | | 723148.10 | 723148.25 |
| 0.25 mm ID (0.4 mm OD) | | 723101.10 | 723101.25 |
| 0.32 mm ID (0.5 mm OD) | | 723151.10 | 723151.25 |
| 0.53 mm ID (0.8 mm OD) | | 723501.10 | 723501.25 |

Untreated capillaries are supplied without cage.

## Deactivated capillary columns precolumns / guard columns

**Recommended application**

- As precolumns / guard columns, whenever a larger contamination capacity is required
- Preparation of capillary columns

### Ordering information

#### Deactivated capillary columns

| | Length →<br>10 m | 25 m |
|---|---|---|
| Methyl-Sil deactivated ($T_{max}$ 320 °C) | | |
| 0.25 mm ID (0.4 mm OD) | 723106.10 | 723106.25 |
| 0.32 mm ID (0.5 mm OD) | 723346.10 | 723346.25 |
| 0.53 mm ID (0.8 mm OD) | 723558.10 | 723558.25 |
| Phenyl-Sil deactivated ($T_{max}$ 320 °C) | | |
| 0.25 mm ID (0.4 mm OD) | 723108.10 | 723108.25 |
| 0.32 mm ID (0.5 mm OD) | 723348.10 | 723348.25 |
| 0.53 mm ID (0.8 mm OD) | 723560.10 | 723560.25 |
| CW deactivated ($T_{max}$ 250 °C) | | |
| 0.25 mm ID (0.4 mm OD) | 723105.10 | 723105.25 |
| 0.32 mm ID (0.5 mm OD) | 723349.10 | 723349.25 |
| 0.53 mm ID (0.8 mm OD) | 723562.10 | 723562.25 |

Untreated capillaries are supplied without cage.

For a considerably longer lifetime, even for contaminated or matrix-containing samples, MN offers the option of integrated precolumns. All capillary columns are available with a 10 m guard column with matched deactivation. For ordering, please add V1 at the end of the REF number. Guard column combinations with other lengths, IDs or different deactivation are available on request.

## Retention gaps

### Key features

- The retention gap technique in combination with on-column injection allows to concentrate a large sample volume in the capillary column.
- Choice of the retention gap depends on the solvent used: the flooded zone after injection should be between 20–30 cm/µL
- Me-Sil retention gap: only for use with *n*-hexane and diethyl ether
- Phe-Sil retention gap: for all solvents except methanol and water
- CW retention gap: for all solvents and especially for methanol and water

### Temperature

- $T_{max}$ 250 °C (CW retention gaps), $T_{max}$ 320 °C (Me-Sil and Phe-Sil retention gaps)

Note:

- Calculation example: length of flooded zone ~ 20–30 cm/µL, retention gap 10 m x 0.32 mm ID, capillary column: 25 m x 0.32 mm ID, max. injection volume ~ 30–50 µL
- A retention gap must be inert without any noticeable retention: Me-Sil retention gaps are more inert than Phe-Sil, while Phe-Sil is less susceptible to contamination
- Retention gaps can also be used as transfer lines or precolumns (contamination capacity about 5–10 µg).

### Ordering information

#### Retention gaps

| | Length → | |
|---|---|---|
| | 10 m | 25 m |
| Me-Sil retention gaps ($T_{max}$ 320 °C) | | |
| 0.25 mm ID (0.4 mm OD) | 723706.10 | 723706.25 |
| 0.32 mm ID (0.5 mm OD) | 723707.10 | 723707.25 |
| 0.53 mm ID (0.8 mm OD) | 723708.10 | 723708.25 |
| Phe-Sil retention gaps ($T_{max}$ 320 °C) | | |
| 0.25 mm ID (0.4 mm OD) | 723709.10 | 723709.25 |
| 0.32 mm ID (0.5 mm OD) | 723710.10 | 723710.25 |
| 0.53 mm ID (0.8 mm OD) | 723711.10 | 723711.25 |
| CW retention gaps ($T_{max}$ 250 °C) | | |
| 0.25 mm ID (0.4 mm OD) | 723712.10 | 723712.25 |
| 0.32 mm ID (0.5 mm OD) | 723713.10 | 723713.25 |
| 0.53 mm ID (0.8 mm OD) | 723714.10 | 723714.25 |
| Retention gaps are supplied without cage. | | |

For a considerably longer lifetime, even for contaminated or matrix-containing samples, MN offers the option of integrated precolumns. All capillary columns are available with a 10 m guard column with matched deactivation. For ordering, please add V1 at the end of the REF number. Guard column combinations with other lengths, IDs or different deactivation are available on request.

## Derivatization reagents

### Key features

- Derivatization reagents:
  To improve volatility, increase thermal stability or to achieve a lower limit of detection in gas chromatography
- Prerequisite: quantitative, rapid and reproducible formation of only one derivative
- Halogen atoms inserted by derivatization, e.g., trifluoro-acetates, allow the specific detection in an ECD with the advantage of high sensitivity.
- Specific derivatizations may influence elution orders and fragmentation patterns in a MS
- We provide reagents for
  - acylation
  - alkylation (methylation)
  - silylation
- For 1 x 10 mL, 1 x 50 mL and 6 x 50 mL also available with screw closure

### Ordering information

#### Derivatization method development kits*

| Designation | Contents of the kit | REF |
|---|---|---|
| Which type of derivatization is suited best for your sample (alkylation, acylation or silylation)? | 2 x 1 mL each of TMSH, MSTFA, MBTFA | 701952 |
| Acylation kit | | |
| Which is the proper reagent for acylation? | 2 x 1 mL each of MBTFA, TFAA, MBHFBA | 701950 |
| Alkylation kit | | |
| Which is the proper reagent for methylation? | 3 x 1 mL each of TMSH, DMF-DMA | 701951 |
| Silylation kit | | |
| Which is the proper reagent for silylation? | 2 x 1 mL each of MSTFA, BSTFA, TSIM, MSHFBA | 701953 |

* These products contain harmful substances which must be specially labeled as hazardous. For detailed information please see SDS.

### Selection guide for derivatization of important functional groups in GC

| Function | Method | Derivative | Recommended reagents |
|---|---|---|---|
| alcohols, phenols | silylation | R'O – TMS | BSA, MSTFA, MSHFBA, TSIM, SILYL-2110, SILYL-21, SILYL-1139 |
| R'OH | acylation | R'O – CO – R | TFAA, HFBA, MBTFA, MBHFBA |
| | alkylation | R'O – R | TMSH |
| sterically hindered | silylation | R'O – TMS | TSIM, BSTFA, SILYL-991 |
| amines | silylation | R' – NR'' – TMS | BSA, MSTFA, MSHFBA, SILYL-991 |
| primary, secondary | acylation | R' – NR'' – CO – R | TFAA, HFBA, MBTFA, MBHFBA |
| hydrochlorides | silylation | R' – NR'' – TMS | MSTFA |
| amides | silylation | not stable | |
| | acylation | R' – CO – NH – CO – R | TFAA, MBTFA, HFBA, MBHFBA |
| amino acids | silylation | R' – CH(NH – TMS) – CO – O – TMS | BSA, BSTFA, MSTFA, MSHFBA |
| | alkylation (a) | R' – CH(NH – CO-R) – CO – O – R | a) MeOH/TMCS, TMSH |
| | + acylation (b) | | b) TFAA, HFBA, MBTFA, MBHFBA |
| Carboxylic acids (fatty acids) | silylation | R' – CO – O – TMS susceptible to hydrolysis | BSA, MSTFA, MSHFBA, TMCS, TSIM, SILYL-2110, SILYL-21, Silyl-1139 |
| | alkylation | R' – CO – O – R | DMF-DMA, MeOH/TMCS (1 M), TMSH |
| salts | silylation | R' – CO – O – TMS susceptible to hydrolysis | TMCS |
| carbohydrates | silylation | | MSTFA, TSIM, HMDS, SILYL-1139 |
| | acylation | | TFAA, MBTFA |
| steroids | silylation | | BSA, TSIM |
| | acylation | | TFAA, MBTFA, HFBA, MBHFBA |

These products contain harmful substances which must be specially labeled as hazardous. For detailed information please see SDS.

Due to their purpose, derivatization reagents are very reactive substances. For this reason, they should be stored cool and protected from moisture. For easy access with a syringe, our derivatization reagents are supplied in vials with crimp caps (exception DMCS and TMCS with screw closure). Vials with pierced sealing disks have limited stability and should be used soon.

The derivatization procedures can be found on page 367.

# Reagents / methods for derivatization

## General reaction mechanisms

### Silylation

X = e.g., O, S, COO, etc.
Y = rest of silylation reagents

### Alkylation (Methylation) · example TMSH

X = e.g., O, S, COO, etc.

### Acylation

X = e.g., O, S, NH, etc.
Y = rest of acylation reagents

## MACHEREY-NAGEL derivatization reagents for GC

### Content of brochure

- Product range for acylation, alkylation and silylation reagents
- Protocols for derivatization
- Diverse tips and hints

Ordner now your derivatization brochure KATEN200144

## Acylation reagents

### Acyl halides

**Key features**

- By-product of acylation with acyl halides: corresponding hydrohalic acids excess of reagent and acid have to be removed or trapped by a suitable base (e.g., pyridine)
- Pentafluorobenzoyl chloride
  PFBC: $C_6F_5-CO-Cl$
  M 230.52 g/mol, Bp 158–159 °C (760 mm Hg),
  Density d20°/4° = 1.601

### Anhydrides

**Key features**

- By-products of acylation with anhydrides: corresponding acids excess reagent and the acid formed are to be removed
- Trifluoroacetic acid anhydride TFAA: $CF_3-CO-O-CO-CF_3$
  M 210.04 g/mol, Bp 39.5–40.5 °C (760 mm Hg),
  Density d20°/4° = 1.490
- Heptafluorobutyric acid anhydride
  HFBA: $C_3F_7-CO-O-CO-C_3F_7$
  M 410.06 g/mol, Bp 106–107 °C (760 mm Hg),
  Density d20°/4° = 1.665

### Bisacylamides

**Key features**

- By-products: corresponding neutral acylamides: high volatility
- Easily removed; due to the neutral conditions and their favorable chromatographic characteristics, the removal of surplus bisacylamides and their by-products is often not necessary. Therefore, the sample preparation is much easier.
- *N*-methyl-bis(trifluoroacetamide)
  MBTFA: $CF_3-CO-N(CH_3)-CO-CF_3$
  M 223.08 g/mol, Kp 123–124 °C (760 mm Hg),
  Density d20°/4° = 1.55
- *N*-methyl-bis(heptafluorobutyramide)
  MBHFBA: $C_3F_7-CO-N(CH_3)-CO-C_3F_7$
  M 423.1 g/mol, Kp 165–166 °C (760 mm Hg),
  Density d20°/4° = 1.673

## Methods for acylation

### Acylation with fluorinated acid anhydrides (TFAA, HFBA)

- Applicable for alcohols, phenols, carboxylic acids, amines, amino acids and steroids, stable derivatives for FID or ECD detection
- Procedure see page 367 or online at
  *www.mn-net.com/apps*
  TFAA: MN Appl. Nr. 213041
  HFBA: MN Appl. Nr. 213042

### Acylation with fluorinated acid amides (MBTFA, MBHFBA)

- Recommended for alcohols, primary and secondary amines as well as for thiols under mild, neutral conditions
- MBTFA also forms very volatile derivatives with carbohydrates [17].
- Procedure see page 367 or online at
  *www.mn-net.com/apps*
  MBTFA: MN Appl. Nr. 213051
  MBHFBA: MN Appl. Nr. 21305

### Ordering information

#### Acylation reagents*

| Substance | Packing unit | | | |
|---|---|---|---|---|
| | 10 x 1 mL | 20 x 1 mL | 1 x 10 mL | 5 x 10 mL |
| HFBA | | | | |
| | | 701110.201 | 701110.110 | 701110.510 |
| MBTFA | | | | |
| | | 701410.201 | 701410.110 | 701410.510 |
| MBHFBA | | | | |
| | 701420.101 | 701420.201 | | |
| PFBC | | | | |
| | 701120.101 | | | |
| TFAA | | | | |
| | | | 701130.110 | 701130.510 |

* These products contain harmful substances which must be specially labeled as hazardous. For detailed information please see SDS.

On request for 1 x 10 mL, 1 x 50 mL and 6 x 50 mL also available with screw closure.

## Alkylation / methylation reagents

### DMF-DMA *N*,*N*-dimethylformamide dimethylacetal

- M 119.17 g/mol,
  Kp 106–107 °C (760 mm Hg),
  Density d20°/4° = 0.897

**Key features**

- Methylation reagents

### TMSH (0.2 mol/L in methanol) Trimethylsulfonium hydroxide

- M 94.06 g/mol

**Key features**

- Methylation reagents

## Methods for alkylation / methylation

### Methylation with TMSH

- Suited for free acids, chlorophenoxycarboxylic acids, their salts and derivatives as well as for phenols and chlorophenols [18]
- The great advantage is the simplification of the sample preparation. Lipids or triglycerides can be converted to the corresponding fatty acid methyl esters (FAMEs) by simple transesterification.
- This reaction is very elegant and convenient, because it is only necessary to add the reagent (0.2 mol/L in methanol) to the sample solution. Removal of surplus reagent is not required, since at 250 °C inside the injector of the gas chromatograph, TMSH will pyrolyze solely to volatile methanol and dimethylsulfide. Due to high reactivity, a complete conversion is usually obtained at ambient temperature. Heating (e.g., 10 min at 100 °C) in a closed sample vial may be necessary, however.
- Procedure see page 367 or online at
  *www.mn-net.com/apps*
  MN Appl. Nr. 213060

### Methylation with DMF-DMA

- Applicable for fatty acids, primary amines and (partially) amino acids, under formation of *N*-dimethyl-aminomethylene amino acid methyl esters [19]
- Since DMF-DMA is a poor solvent, it is essential to use a mixture of DMF-DMA with pyridine, THF, acetone (barbiturates) or another solvent.
- Procedure see page 367 or online at
  *www.mn-net.com/apps*
  MN Appl. Nr. 213070

### Methylation with methanol – TMCS (1 M)

- Suited for the esterification of free carboxylic acids and the transesterification of glycerides. Formation of HCl catalyzes the reaction. TMCS, resp. silyl ethers remove the water and thus drive the reaction to completion. The mixture should be freshly prepared.
- Procedure see page 367 or online at
  *www.mn-net.com/apps*
  MN Appl. Nr. 213080

For GC separation of FAMEs from natural butter fat after derivatization with TMSH see Appl. 201680 at *www.mn-net.com/apps*

### Ordering information

#### Alkylation reagents*

| | Packing unit | | | |
|---|---|---|---|---|
| Substance | 10 x 1 mL | 20 x 1 mL | 1 x 10 mL | 5 x 10 mL |
| DMF-DMA | | | | |
| | | 701430.201 | 701430.110 | |
| TMSH | | | | |
| | 701520.101 | 701520.201 | 701520.110 | 701520.510 |

* These products contain harmful substances which must be specially labeled as hazardous. For detailed information please see SDS.

On request for 1 x 10 mL, 1 x 50 mL and 6 x 50 mL also available with screw closure.

# Reagents / methods for silylation

## Silylation reagents

The most common form of silylation in GC is the replacing of active hydrogen atoms with a trimethylsilyl group (TMS derivative). Less frequently, trialkylsilyl groups or dimethylsilyl groups with longer alkyl chains are also in use. The alkylsilyl group increases volatility and enhances thermal stability of the sample.

Silylation can be catalyzed either acidic by addition of TMCS or basic by addition of pyridine or TSIM (e.g., for sterically hindered functionalities like tert. alcohols).

Reactivity of silylation reagents (acc. to M. Donike): TMS amide (e.g., BSA, MSTFA) > TMS amine = TSIM > Enol-O-TMS ether > S-TMS ether > O-TMS ether > TMS-O-TMS

Stability of the TMS derivatives: O-TMS ether > S-TMS ether > Enol-O-TMS ether > TMS amine > TMS amide

### BSA *N,O*-bis-trimethylsilyl-acetamide

- M 203.4 g/mol, Bp 71–73 °C (35 mm Hg), Density d20°/4° = 0.832

**Key features**

- Strong silylation reagent
- Not recommended for use with carbohydrates or very low molecular weight compounds
- Good solvent for polar compounds, but frequently used in combination with a solvent (pyridine, DMF etc.) or with other silylation reagents. Dissolved in DMF, BSA is the prime derivatization reagent for phenols.

**Recommended application**

- Alcohols, amines, carboxylic acids, phenols, steroids, biogenic amines and alkaloids are derivatized to stable TMS derivatives

### BSTFA *N,O*-bis-trimethylsilyl-trifluoroacetamide

- M 257.4 g/mol, Bp 40 °C (12 mm Hg), Density d20°/4° = 0.961

**Key features**

- Powerful trimethylsilyl donor with approx. the same donor strength as the nonfluorinated analog BSA
- Advantage of BSTFA over BSA: greater volatility of its reaction products, particularly useful for GC analysis of low boiling TMS amino acids
- BSTFA is nonpolar (less polar than MSTFA) and can be mixed with acetonitrile for improved solubility. For the silylation of fatty acid amides, hindered hydroxyl groups and other difficult to silylize compounds, e.g., secondary alcohols and amines, we recommend BSTFA + 1 % trimethylchlorosilane (TMCS), available under the designation SILYL-991 (see page 366).

### Silylation with BSA, BSTFA or SILYL-991 (BSTFA + 1 % TMCS)

- Procedure see page 367 or online at *www.mn-net.com/apps*

| | |
|---|---|
| BSA | MN Appl. Nr. 213091 |
| BSTFA | MN Appl. Nr. 213092 |
| SILYL-991 | MN Appl. Nr. 213093 |

### Silylation with BSA in combination with other silylation reagents

- Procedure see page 367 or online at *www.mn-net.com/apps*
  MN Appl. Nr. 213100

## Ordering information

### Silylation reagents*

| Substance | Packing unit 20 x 1 mL | 1 x 10 mL | 5 x 10 mL | 1 x 50 mL | 1 x 100 mL |
|---|---|---|---|---|---|
| BSA | | | | | |
| | | 701210.110 | 701210.510 | 701210.150 | |
| BSTFA | | | | | |
| | 701220.201 | 701220.110 | 701220.510 | | |
| SILYL-991 –(BSTFA – TMCS (99:1)) | | | | | |
| | 701490.201 | | | 701490.150 | 701490.1100 |

* These products contain harmful substances which must be specially labeled as hazardous. For detailed information please see SDS.

On request for 1 x 10 mL, 1 x 50 mL and 6 x 50 mL also available with screw closure.

## MSTFA *N*-methyl-*N*-trimethylsilyl-trifluoroacetamide

- M 199.1 g/mol, Bp 70 °C (75 mm Hg), Density d20°/4° = 1.11

**Key features**

- The most volatile trimethylsilyl amide available, very strong TMS donor which does not cause noticeable FID fouling even during long-time measuring series

**Recommended application**

- Carboxylic acids, hydroxy and ketocarboxylic acids, amino acids, amines, alcohols, polyalcohols, sugars, mercaptans and similar compounds with active hydrogen atoms. Even amine hydrochlorides can be silylated directly.

- The addition of protic solvents in submolar quantities, e.g., TFA for extremely polar compounds (hydrochlorides) or pyridine for carbohydrates), can improve the already good dissolving power of MSTFA.
- Advantages: complete conversion with high reaction rates, even without a catalyst (1–2 % TMCS or TSIM); the by-product of the reaction (*N*-methyltrifluoroacetamide) shows a high volatility and a short retention time

## MSHFBA *N*-methyl-*N*-trimethylsilyl-heptafluorobutyramide

- M 299.1 g/mol, Bp 148 °C (760 mm Hg)

**Key features**

- Similar to MSTFA in reactivity and chromatography
- Either applied alone or in combination with a catalyst (TMCS, TSIM) or another silylation reagent with or without solvent; the by-product *N*-methylheptafluorobutyric amide has a lower retention time than the silylating reagent

**Recommended application**

- Carboxylic acids, alcohols, phenols, primary and secondary amines and amino acids

- Especially useful for flame ionization detection due to the large ratio of fluorine to silicon of 7:1, since degradation of the surplus MSHFBA does not produce $SiO_2$ but volatile, non-corrosive silicon compounds

## MBDSTFA *N*-methyl-*N*-*tert*-butyldimethylsilyl-trifluoroacetamide

- M 241.3 g/mol, Bp 170 °C (760 mm Hg), Density d20°/4° = 1.121

**Key features**

- Silylation reagent that donates a *tert*-butyldimethylsilyl group (TBDMS) for derivatizing active hydrogen atoms in hydroxyl, carboxyl and thiol groups as well as primary and secondary amines
- Fast reactions (typically 5–20 min) with high yields (> 96 %), by-products are neutral volatiles
- TBDMS ethers are $10^4$ times more stable than the corresponding TMS ethers
- Due to the large protecting group, chromatographic retention times are longer. This may have a beneficial impact on some separations. The high concentration of $M^+$-57 ions is an interesting topic for GC/MS.

## Silylation with MSTFA, MSHFBA or MBDSTFA

- Procedure see page 367 or online at *www.mn-net.com/apps*
  MSTFA MN Appl. Nr. 213111 · MSHFBA MN Appl. Nr. 213112 · MBDSTFA MN Appl. Nr. 213113

### Ordering information

### Silylation reagents*

| | Packing unit | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Substance | 10 x 1 mL | 20 x 1 mL | 1 x 10 mL | 5 x 10 mL | 1 x 100 mL | 6 x 50 mL | 6 x 100 mL | 12 x 100 mL |
| MSTFA | | | | | | | | |
| | | 701270.201 | 701270.110 | 701270.510 | 701270.1100 | 701270.650 | 701270.6100 | 701270.12100 |
| MSHFBA | | | | | | | | |
| | | 701260.201 | 701260.110 | 701260.510 | 701260.1100 | | 701260.6100 | |
| MBDSTFA | | | | | | | | |
| | 701440.101 | 701440.201 | | | | | | |

* These products contain harmful substances which must be specially labeled as hazardous. For detailed information please see SDS.

On request for 1 x 10 mL, 1 x 50 mL and 6 x 50 mL also available with screw closure.

Ultrapure derivatization reagents for acylation, alkylation and silylation.

## DMCS Dimethyldichlorosilane

- M 129.06 g/mol,
  Bp 70 °C (760 mm Hg),
  Density d20°/4° = 1.07

### Key features

- Used to form dimethylsilyl (DMS) derivatives
- DMS derivatives are much more susceptible to hydrolysis than TMS derivatives, it is therefore vital to have strictly anhydrous conditions during the conversion.

## HMDS Hexamethyldisilazane

- M 161.4 g/mol,
  Bp 126 °C (760 mm Hg),
  Density d20°/4° = 0.7742

### Key features

- Weak TMS donor; used as a sole reagent, it is slow and not very effective.
- Aprotic solvents like acetonitrile, pyridine, dimethylformamide, carbon disulfide and dimethylacetamide recommend themselves for use with HMDS.
- With catalytic quantities, e.g., 1 % of, or as a mixture with TMCS (2:1, v/v; SILYL-21 and SILYL-2110) it is perfectly suited for a quick and quantitative trimethylsilylation of organic compounds.

## TMCS Trimethylchlorosilane

- M 108.7 g/mol,
  Bp 57 °C (760 mm Hg),
  Density d20°/4° = 0.8580

### Key features

- Often used as a catalyst with other trimethylsilyl reagents
- As a sole reagent, it can be used to prepare TMS derivatives of organic acids.

## TSIM *N*-trimethylsilyl-imidazole

- M 140.3 g/mol,
  Bp 94–96 °C (760 mm Hg),
  Density d20°/4° = 0.961

### Key features

- Strongest hydroxyl silylator
- It is remarkable that TSIM reacts quickly and smooth with hydroxyl (even tert. OH) and carboxyl groups, but not with amines. Hence it is especially suited for multiple derivatizations, when compounds with various functional groups are to be derivatized in different ways (e.g., -O-TMS, -*N*-HFB derivatives of catecholamines).

### Recommended application

- Alcohols, phenols, organic acids, steroids, hormones, glycols, nucleotides, narcotics
- Reagent of choice for carbohydrates and most steroids (even strongly hindered steroids)

### Silylation with TSIM or SILYL-1139 (TSIM – pyridine 11:39)

- Procedure see page 367 or online at *www.mn-net.com/apps*
  TSIM: MN Appl. Nr. 213121
  SILYL-1139: MN Appl. Nr. 213122

## Ordering information

### Silylation reagents*

| Substance | Packing unit 20 x 1 mL | 1 x 10 mL | 5 x 10 mL | 6 x 50 mL |
|---|---|---|---|---|
| DMCS | | | | |
| | | | | 701230.650 |
| HMDS | | | | |
| | | | 701240.510 | 701240.650 |
| TMCS | | | | |
| | 701280.201 | | | 701280.650 |
| TSIM | | | | |
| | 701310.201 | 701310.110 | 701310.510 | |

* These products contain harmful substances which must be specially labeled as hazardous. For detailed information please see SDS.

On request for 1 x 10 mL, 1 x 50 mL and 6 x 50 mL also available with screw closure.

## Ordering information

### Reagent mixtures for silylation*

| Mixture | Composition | Packing unit 20 x 1 mL | 1 x 10 mL | 5 x 10 mL | 1 x 50 mL | 1 x 100 mL |
|---|---|---|---|---|---|---|
| SILYL-271 | | | | | | |
| | BSA - HMDS - TSIM (2:7:1) | 701450.201 | 701450.110 | 701450.510 | | |
| SILYL-1139 | | | | | | |
| | TSIM - Pyridine (11:39) | 701460.201 | | | | |
| SILYL-21 | | | | | | |
| | HMDS - TMCS (2:1) | 701470.201 | | | | |
| SILYL-2110 | | | | | | |
| | HMDS - TMCS - Pyridine (2:1:10) | 701480.201 | | | | |
| SILYL-991 | | | | | | |
| | BSTFA - TMCS (99:1) | 701490.201 | | | 701490.150 | 701490.1100 |

* These products contain harmful substances which must be specially labeled as hazardous. For detailed information please see SDS.

On request for 1 x 10 mL, 1 x 50 mL and 6 x 50 mL also available with screw closure.

Due to their purpose, derivatization reagents are very reactive substances. For this reason, they should be stored cool and protected from moisture. For easy access with a syringe, our derivatization reagents are supplied in vials with crimp caps (exception DMCS and TMCS with screw closure). Vials with pierced sealing disks have limited stability and should be used soon.

### Silylation with SILYL-21 or SILYL-2110

- Recommended applications: sugars, glycols, sterically unhindered alcohols, carboxylic acids, acids in urine, hydroxy fatty acids, nucleotides, steroids, vitamin D, xanthone derivatives
- Procedure see page 367 or online at *www.mn-net.com/apps*
  SILYL-21 MN Appl. Nr. 213131
  SILYL-2110 MN Appl. Nr. 213132

### *O*-trimethylsilylation with MSTFA followed by *N*-trifluoroacetylation with MBTF

- Procedure see page 367 or online at *www.mn-net.com/apps*
  MSTFA / MBTFA MN Appl. Nr. 213140

## Acylation

### with fluorinated acid anhydrides · TFAA MN Appl. No. 213041 · HFBA MN Appl. No. 213042

Dissolve 0.1 to 1 mg sample in 0.1 mL solvent, add 0.1 mL of the anhydride and heat to 60–70 °C for 1–2 h. If the sample needs not be concentrated prior to the analysis and if there is no danger of catalytically induced side reactions, pyridine is used as solvent. The reaction solution can be injected directly into the gas chromatograph. Otherwise, use a volatile solvent and evaporate solvent, excess reagent and free acid in a stream of nitrogen. Dissolve residue in 50 µL hexane, chloroform etc. and inject aliquot portions.

### with fluorinated acid amides · MBTFA MN Appl. No. 213051 · MBHFBA MN Appl. No. 213052

Add 0.5 mL MBTFA or MBHFBA to about 2 mg sample. If there is no reaction at ambient temperature, heat the reaction mixture to 120 °C. Compounds difficult to dissolve, can be trifluoroacetylated in suitable solvent mixtures. It is recommended to use a ratio of solvent to MBTFA or MBHFBA of 4:1. The reaction mixture is chromatographed directly.

## Alkylation (Methylation)

### with TMSH · MN Appl. No. 213060

Dissolve 100 mg sample (e.g., butter) in 5 mL of a solvent (e.g., *tert*.-butyl methyl ether). Add 50 µL reagent to 100 µL of this solution. The mixture is injected directly. The temperature of the injector must be at least 250 °C.

### with DMF-DMA · MN Appl. No. 213070

Add 1 mL of a mixture of DMF-DMA and pyridine (1:1) to 1–50 mg fatty acids. The sample can be injected as soon as a clear solution has formed. It is recommended, however, to heat the solution to 60–100 °C for 10–15 min.

### with methanol – TMCS · MN Appl. No. 213080

Add 1 mL methanol – TMCS to about 50 mg carboxylic acid or glyceride and heat. Then evaporate in a stream of nitrogen and dissolve again for injection in, e.g., *n*-heptane.

## Silylation

### with BSA, BSTFA oder SILYL-991 (BSTFA + 1 % TMCS)
### BSA MN Appl. No. 213091 · BSTFA MN Appl. No. 213092 SILYL-991 MN Appl. No. 213093

Add 0.5 mL of the silylation reagent to 1–10 mg sample; if necessary, add some solvent (normally pyridine or DMF [dimethylformamide]). Heat to 60–80 °C for 20 min to increase the reaction rate. 1–2 drops of TMCS (trimethylchlorosilane) or TSIM will also speed up the reaction.

### with BSA in combination with other silylation reagents · MN Appl. No. 213100

BSA alone silylates all sterically unhindered hydroxyl groups of the steroid skeleton; addition of TMCS will enable reaction of moderately hindered OH groups (reaction time 3–6 h at 60 °C). After addition of TSIM even strongly hindered hydroxyl groups will react (reaction time 6–24 h at 60 °C).

### with MSTFA, MSHFBA or MBDSTFA
### MSTFA MN Appl. No. 213111 · MSHFBA MN Appl. No. 213112 · MBDSTFA MN Appl. No. 213113

Dissolve 10–15 mg sample in 0.8 mL solvent, then add 0.2 mL of the silylation reagent. The reaction mixture can be heated to 60–70 °C for up to 1 h and can be analyzed directly. If TFA is used as a solvent, proceed as follows [20]: dissolve 1–2 mg sample in 100 µL TFA. Dropwise add 0.9 mL of the silylating reagent. After cooling the sample can be chromatographed directly.

### with TSIM or SILYL-1139 (TSIM – pyridine 11:39) · TSIM MN Appl. No. 213121 · SILYL-1139 MN Appl. No. 213122

Dissolve 10–15 mg sample in 0.8 mL solvent, then add 0.2 mL of the silylation reagent. The reaction mixture can be heated to 60–70 °C for up to 1 hour and can be analyzed directly. Recommended solvent pyridine. When using SILYL-1139, the presence of water does not interfere.

### with SILYL-21 or SILYL-2110 · SILYL-21 MN Appl. No. 213131 · SILYL-2110 MN Appl. No. 213132

Carefully add SILYL-21 or SILYL-2110 to 1–10 mg of the sample. Precipitated ammonium chloride does not interfere. If the sample should not dissolve within 5 min, heat to 75–85 °C. If no mutarotation is to be expected, you may dissolve the sugar in warm pyridine first and then add the silylation reagent. In some cases it may be advantageous to use a different solvent instead of pyridine. For derivatization of 3-ketosteroids we recommend to use DMF (dimethylformamide)

### *O*-trimethylsilylation with MSTFA followed by *N*-trifluoroacetylation with MBTFA · MN Appl. No. 213140

Completely silylate 2 mg of the sample with 0.3 mL MSTFA, e.g., as described on page 363. After addition of 0.3 mL MBTFA the *N*-trimethylsilyl group is replaced by the *N*-trifluoroacetyl group. The mixture can be analyzed directly.

## Test mixtures

### Key features

- Test mixtures for GC capillary columns to control the performance of fused silica capillary columns and the GC system

### Ordering information

#### Test mixtures*

| Designation | | Pack of | REF |
|---|---|---|---|
| Activity test mixture (FA-TMS test according to Donike) in MSTFA/*n*-hexane (1 + 4) | 1 mg/mL each of TMS capric acid (C10), TMS myristic acid (C14), TMS stearic acid (C18), TMS behenic acid (C22), hexadecane (C16), eicosane (C20), tetracosane (C24), octacosane (C28) | 1 mL | 722307 |
| Grob test mixture (modified) in *n*-hexane | (in mg/mL) *n*-decane (~ 2.8), *n*-undecane (~ 2.9), *n*-octanol (~ 3.6), 2,6-dimethylphenol (~ 3.2), 2,6-dimethylaniline (~ 3.2), methyl decanoate (~ 4.2), dicyclohexylamine (~ 3.1), methyl undecanoate (~ 4.2), methyl dodecanoate (~ 4.1) | 1 mL | 722310 |
| MN OPTIMA® test mixture in pentane | 0.1 % each of undecane, dodecane, octanol, dimethylaniline, decylamine, methyl decanoate, methyl undecanoate, henicosane, docosane, tricosane (chromatograms see page 305) | 1 mL | 722316 |
| MN OPTIMA® amine test mixture in ethanol | 0.2 % diisobutylamine, 1 % diethanolamine, 0.2 % 2,6-dimethylaniline, 0.2 % *o*-propanol-pyridine, 0.2 % dicyclohexylamine, 0.2 % dibenzylamine | 1 mL | 722317 |
| FAME test mixture in hexane | 0.1 % each of FAMEs C4, C6, C8, C10, C12, C14, C16, C18, C18:1 cis, C18:1 trans, C18:2, C18:3, C20, C22, C22:1, C24 (chromatogram see page 334) | 1 mL | 722320 |

* These products contain harmful substances which must be specially labeled as hazardous. For detailed information please see SDS.

Grob test mixture (modified) (REF 722310)

MN Appl. No. 211250

Column: OPTIMA® 5, 50 m x 0.25 mm ID, 1.0 µm film
Injection: 1 µL, split 1:40, 280 °C
Carrier gas: 1.5 bar $H_2$
Temperature: 80 °C → 280 °C (10 min), 8 °C/min
Detector: FID 280 °C

Peaks:
1. *n*-Decane
2. 1-Octanol
3. *n*-Undecane
4. 2,6-Dimethylphenol
5. 2,6-Dimethylaniline
6. Methyl decanoate
7. Methyl undecanoate
8. Dicyclohexylamine
9. Methyl dodecanoate

### Activity test mixture (REF 722307)

MN Appl. No. 211240

| | |
|---|---|
| Column: | OPTIMA® 5, 25 m x 0.32 mm ID, 1.0 µm film |
| Injection: | 1 µL, split 1:40, 300 °C |
| Carrier gas: | 0.6 bar $H_2$ |
| Temperature: | 150 °C → 300 °C (8 min), 10 °C/min |
| Detector: | FID 300 °C |

Peaks:
1. TMS capric acid ($C_{10}$)
2. Hexadecane ($C_{16}$)
3. TMS myristic acid ($C_{14}$)
4. Eicosane ($C_{20}$)
5. TMS stearic acid ($C_{18}$)
6. Tetracosane ($C_{24}$)
7. TMS behenic aicd ($C_{22}$)
8. Octacosane ($C_{28}$)

### OPTIMA® Amine test mixture (REF 722317)

MN Appl. No. 250020

| | |
|---|---|
| Column: | OPTIMA® 5 Amine, 30 m x 0.32 mm ID, 1.5 µm film |
| Injection: | 1 µL, split 1:40 |
| Carrier gas: | 0.6 bar $H_2$ |
| Temperature: | 100 °C → 280 °C, 10 °C/min |
| Detector: | FID 280 °C |

Peaks:
1. Diisobutylamine
2. Diethanolamine
3. 2,6-Dimethylaniline
4. o-Propanol-pyridine
5. Dicyclohexylamine
6. Dibenzylamine

## Ferrules

### Key features

- Graphite ferrules provide the highest temperature stability (up to 450 °C). They are reusable, if handled with care. We also offer 1/16” graphite ferrules specially designed for Carlo Erba / Fisons or for Agilent gas chromatographs.
- Vespel ferrules with 40 % graphite. Temperature-stable up to 400 °C and reusable.

### Ordering information

#### Ferrules

| Bore (= column OD)<br>$T_{max}$ → | Graphite<br>450 °C | Vespel<br>+40 % Graphite<br>400 °C |
|---|---|---|
| 1/16” ferrules | | |
| 0.4 mm | | 706246 |
| 0.5 mm | 708308 | |
| 1/16” ferrules for Carlo Erba (Fisons) instruments | | |
| 0.8 mm | 708340 | |
| 1/16” ferrules for Hewlett-Packard (Agilent) instruments | | |
| 0.4 mm | 708353 | |
| 0.5 mm | 708354 | |
| 0.8 mm | 708355 | |
| 1/8” ferrules | | |
| no bore | 708341 | |
| 1/4” ferrules | | |
| no bore | 708344 | |
| 0.4 mm | 708345 | |
| 0.5 mm | 708346 | |

## Injection Port Septa blister pack for cleanliness and easily handling

### Key features

- BTO septa
  for highest demands in GC and GC-MS
  – pierced, soft – CenterGuide™
- AG3 septa
  with higher durability than BTO
  – pierced, hard – CenterGuide™
- Marathon Septa
  with extreme durability for > 400 injections
  – pierced – CenterGuide™

### Ordering information

#### Injection port septa

| Septum grade | | BTO septa | AG3 septa | Marathon septa |
|---|---|---|---|---|
| | | | | |
| OD | $T_{max}$ | | | |
| 9 mm | 400 °C | 702646 | 702656 | 702660 |
| 11 mm | 400 °C | 702647 | 702657 | 702661 |
| 11.5 mm | 400 °C | 702648 | 702658 | 702662 |
| Shimadzu® | 300 °C | 702649 | 702659 | 702663 |
| | Pack of | 25 | 25 | 25 |

## Standard Septa in classical plastic container

### Key features

- Standard septa (ST)
  beige silicone, 60° shore A, 4 mm
- High temperature septa (HT)
  red non-bleeding silicone, 60° shore A, 3 mm
  (320 °C max.)
- Silicone septa
  soft, transparent
- Silicone / PTFE septa
  white silicone, one side coated with grey PTFE, 3 mm

### Ordering information

#### Classical septa

| Septum grade | | Standard septa (ST) | High temperature septa (HT) | Silicone septa | Silicone septa / PTFE |
|---|---|---|---|---|---|
| | | | | | |
| OD | | | | | |
| 9 mm | | 702609 | 702619 | 702602 | |
| 10 mm | | 702610 | 702620 | | 702625 |
| 11 mm | | 702611 | 702621 | 702604 | 702626 |
| 12 mm | | 702612 | 702622 | 702605 | 702627 |
| 13 mm | | 702613 | 702623 | 702606 | 702628 |
| 17 mm | | | 702632 | | |
| | Pack of | 50 | 50 | 50 | 50 |

## Connectors for capillary GC columns

### Key features

- Glass connectors for fused silica capillary columns from 0.2 to 0.53 mm ID:
  manufactured from deactivated glass with slightly tapered inner diameter; used to join two fused silica capillaries of equal or different diameters. Advantages compared to stainless steel fittings are easy connection without tools, optical control during connection, negligible heat capacity and no dead volume.
- Graphseal ferrules for capillary columns: a stainless steel ferrule filled with graphite – the ideal sealing material for capillaries. The capillary is mounted on a 1/16" exit (detector, injector etc.), with the appropriate ferrule, a nut (with slit) and an adapter (see table below).

### Ordering information

#### Connectors for capillary GC columns

| Description | Pack of | REF |
|---|---|---|
| Graphseal ferrules for capillary columns | | |
| 0.4 mm bore | 10 ferrules | 708337 |
| 0.5 mm bore | 10 ferrules | 708318 |
| 0.8 mm bore | 10 ferrules | 708319 |
| Universal capillary glass connectors | | |
| linear | 5 connectors | 707971 |
| linear | 10 connectors | 707972 |
| Y splitter | 1 connector | 707973 |

① 1/16" exit
② Graphseal ferrule
③ Capillary

## Tools and general accessories for GC

### Key features

- Magnifying lens with scale: an essential tool for any laboratory. In capillary GC it is often important to inspect column integrity or check cut ends of capillaries. When closing a column by melting the magnifying lens can be used to check whether the column is really closed or whether an open channel has been formed in the sealed end. Our lens provides 8fold magnification and is supplied with a scale as pictured in the figure below. The space between lines is equivalent to 1/10 mm.
- Diamond file: a useful tool for cutting capillaries and smoothing ends of capillaries. Square capillary ends are especially important for butt connections (e.g., in Valco unions).
- Glass wool, quartz wool and glass fiber wadding are used for, e.g., GC liners, packed GC columns etc.

### Ordering information

#### Tools and general accessories

| Description | | Pack of | REF |
|---|---|---|---|
| Tools for capillary GC | | | |
| Diamond file | for cutting capillaries and straightening capillary ends | 1 | 708300 |
| Magnifying lens with scale | magnification 8x | 1 | 706296 |
| PTFE tape for sealing, reels 12 m long, 12 mm wide, 0.1 mm thick | | 1 reel | 706512 |
| Glass wool | | | |
| Glass wool, long fibers, DMCS treated, for packed GC columns | | 50 g | 706201 |
| Glass fiber wadding silanized, very fine fibers | | 25 g | 718002 |
| Quartz wool, very fine fibers | | 25 g | 718587 |

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# List of abbreviations

| | |
|---|---|
| %C | carbon content in percent |
| Å | angstrom = 0.1 nm = $1.0 \times 10^{-10}$ m |
| ACN | acetonitrile |
| Alox | aluminum oxide |
| AOX | sum parameter for adsorbable organic bounded halogens |
| ASP | CHROMABOND® SPE cartridges for ASPEC systems |
| BDS | base deactivated octadecylsilan ($C_{18}$) |
| BET | analytical methods for determining of surfaces size (developer: Stephen Brunauer, Paul Hugh Emmett and Edward Teller) |
| BTEX | aromatic hydrocarbons: benzene, toluene, ethyl benzene and xylene |
| BTX | sum parameter for volatile aromatic hydrocarbons |
| DIN | German Institute for Standardization |
| DMA | dimethylamino = $N(CH_3)_2$ |
| DOC | dissolved organic carbon |
| DVB | divinylbenzene copolymer |
| EC | column hardware for analytical columns in HPLC |
| ec | endcapping or endcapped |
| EP | European Pharmacopoeia (Ph. Eur., PharmEurl., etc.) |
| EPA | US Environmental Protection Agency |
| ETFE | ethylene tetrafluoroethylene |
| F217 | gasket material (foamed polyethylene between two solid polyethylene layers) |
| FEP | fluorinated ethylene propylene |
| FID | flame ionization detector |
| FS | fused silica |
| GC | gas chromatography |
| HEPT | height equivalent to a theoretical plate |
| HILIC | hydrophylic interaction chromatography |
| HPLC | high performance liquid chromatography |
| HPTLC | high performance thin layer chromatography |
| HS | headspace |
| ID | internal diameter |
| IR | infrared spectroscopy, spectral range |
| ISO | International Organization for Standardization |
| LV | large volume |
| MPS | CHROMABOND® SPE cartridges for MultiPurposeSampler |
| MS | mass spectrometry (suitable) |
| MTBE | methyl *tert*-butyl ether |
| N | e.g., N 11, identified the nominal diameter of a bottle neck, an insert, a closure or a septum |
| nm | nanometer = $1.0 \times 10^{-9}$ m |
| NP | normal phase |
| OD | outer diameter |
| ODS | octadecylsilan ($C_{18}$) |
| PA | polyamide, nylon |
| PAH | polycyclic aromatic hydrocarbons |
| PCA | propylcarboxylic acid also butyric acid |
| PCB | polychlorinated biphenyls |
| PE | polyethylene |
| PEEK | polyether ether ketone |
| PEG | polyethylene glycol |
| PEI | polyethylenimin |
| PL | phospholipids |
| PP | polypropylene |
| ppb | parts per billion ( 1 per 1000000000 = $10^{-9}$) |
| ppm | parts per million (1 per 1000000 = $10^{-6}$) |
| PS/DVB | polystyrene divinylbenzene copolymer |
| PSA | propylsulfonic acid |
| PTFE | polytetrafluoroethylene |
| REF | reference number, article number, product number, ordering number |
| RI | refractive index |
| RP | reversed phase |
| SA | strong acidic, also see SCX |
| SAX | strong anion-exchanger |
| SB | strong basic, also see SAX |
| SCX | strong cation-exchanger |
| SiOH | silanol, unmodified silica |
| SPE | solid phase extraction |

# List of abbreviations

| | |
|---|---|
| SPME | solid phase micro extraction |
| TEF | Tefzel®, see ETFE |
| TFA | trifluoroacetic acid |
| THC | tetrahydrocannabinol |
| THF | tetrahydrofuran |
| TLC | thin layer chromatography |
| TOC | total organic carbon |
| UHPLC | ultra HPLC, high separation performance by < 2 µm particles or core-shell technology |
| UPLC | see UHPLC, but protected term of the company Waters Corporation (USA) |
| USP | United States Pharmacopeia |
| UV | ultraviolet wavelength range (e.g., 254 nm), spectral range |
| VOC | volatile organic compounds |
| VP | column hardware for preparative columns in HPLC |
| WCX | weak cation-exchanger |

## MACHEREY-NAGEL trademarks

| | |
|---|---|
| ALUGRAM | coated aluminium sheets for TLC |
| CHROMABOND | columns for solid phase extraction (SPE) |
| CHROMAFIL | syringe filters (membrane filters) |
| CHROMAFIX | cartridges for solid phase extraction (SPE) |
| ChromCart | cartridge system for HPLC |
| LIPODEX | fused silica capillary columns with cyclodextrin phases for GC enantiomer separation |
| NUCLEODUR | spherical high purity silica for HPLC |
| NUCLEOGEL | polymer-based HPLC columns |
| NUCLEOGEN | HPLC ion exchange columns for nucleic acid analyses |
| NUCLEOSHELL | core-shell silica phases for HPLC |
| NUCLEOSIL | spherical standard silica for HPLC |
| OPTIMA | fused silica high performance capillary columns with immobilized phases |
| OPTIMA WAXplus | fused silica high performance capillary columns with optimized polyethylene glycol phase |
| PERMABOND | fused silica capillary columns with immobilized phases |
| POLYGOSIL | irregular silica for HPLC |
| POLYGRAM | coated polyester sheets for TLC |

## Trademarks of other companies

### Registered trademarks (®)

| | |
|---|---|
| Accubond | Agilent Technologies Inc. (USA) |
| Acquity | Waters Corp. (USA) |
| Agilent | Agilent Technologies Inc. (USA) |
| Allure | Restek Corp. (USA) |
| Aqua | Phenomenex Inc. (USA) |
| Ascentis | Sigma-Aldrich Co. (USA) |
| Atlantis | Waters Corp. (USA) |
| AutoTrace | Caliper Life Sciences Inc. (USA) |
| AVICEL | FMC Corp. (USA) |
| Biomek | Beckman Coulter Inc. (USA) |
| Biotage | Biotage AB (Sweden) |
| Bond Elut | Varian Inc. (USA) |
| Celite | Manville Corp. (USA) |
| Cheminert | Valco Instruments Co. Inc. / VICI AG |
| ChiralCel | Daicel Chemical Industries Ltd. (Japan) |
| ChiralPak | Daicel Chemical Industries Ltd. (Japan) |
| Clean Screen | UCT United Chemical Technologies Inc. (USA) |
| CLEAN-UP | UCT United Chemical Technologies Inc. (USA) |
| CombiFlash | Teledyne Isco Inc. (USA) |
| Companion | Teledyne Isco Inc. (USA) |
| Discovery | Sigma-Aldrich Co. (USA) |
| Duran | Schott AG (Germany) |
| epMotion | Eppendorf AG (Germany) |
| Eurocel | Knauer GmbH (Germany) |
| EXtrelut | Merck KGaA (Germany) |
| Fiolax | Schott AG (Germany) |
| Florisil | U.S. Silica Co. |
| Gemini | Phenomenex Inc. (USA) |
| Hypersil | Thermo Fisher Scientific Inc. (USA) |
| HyPurity | Thermo Fisher Scientific Inc. (USA) |
| Inertsil | GL Sciences (Japan) |
| Isco | Teledyne Isco Inc. (USA) |
| Isolute | Biotage AB (Sweden) |
| Kromasil | Eka Chemicals AB (Sweden) |
| LiChrolut | Merck KGaA (Germany) |
| LiChrospher | Merck KGaA (Germany) |
| Luna | Phenomenex Inc. (USA) |
| Metrohm | Deutsche Metrohm GmbH & Co. KG (Germany) |
| Microlab | Hamilton Co. (USA) |
| MultiProbe | PerkinElmer Inc. (USA) |
| Oasis | Waters Corp. (USA) |
| PerkinElmer | PerkinElmer Inc. (USA) |
| Polaris | Agilent Technologies Inc. (USA) |
| ProntoSil | Bischoff Chromatography (Germany) |
| Purospher | Merck KGaA (Germany) |
| Pyrex | Corning Inc. (USA) |
| Quadra 3 | Tomtec Inc. (USA) |
| RapidTrace | Caliper Life Sciences Inc. (USA) |
| Rxi | Restek Corp. (USA) |
| Rtx | Restek Corp. (USA) |
| Sep-Pak | Waters Corp. (USA) |
| SOTAX | Sotax AG (Schweiz) |
| Spherisorb | Waters Corp. (USA) |
| Stabilwax | Restek Corp. (USA) |

# Trademarks

| | |
|---|---|
| Styre Screen | UCT United Chemical Technologies Inc. (USA) |
| Superspher | Merck KGaA (Germany) |
| Symmetry | Waters Corp. (USA) |
| Synergi | Phenomenex Inc. (USA) |
| Varian | Varian Medical Systems Technologies Inc. (USA) |
| Vespel | E. I. du Pont de Nemours & Co. (USA) |
| VICI | Valco Instruments Co. Inc. / VICI AG |
| Viton | DuPont Performance Elastomers (USA) |
| Xterra | Waters Corp. (USA) |
| YMC | YMC Co. Ltd. (Japan) |
| ZIC | Merck Sequant AB (Sweden) |
| Zorbax | Agilent Technologies Inc. (USA) |
| Zymark | Caliper Life Sciences Inc. (USA) |
| Zymate | Caliper Life Sciences Inc. (USA) |

### Common law trademarks (™)

| | |
|---|---|
| AmyCoat | Eka Chemicals AB (Sweden) |
| ASPEC | Gilson Inc. (USA) |
| AT | Alltech Associates Inc. (USA) |
| Bakerbond | Mallinckrodt Baker Inc. (USA) |
| Benchmate | Caliper Life Sciences Inc. (USA) |
| BPX | SGE Analytical Sciences Pty Ltd. (Australia) |
| Carbowax | Union Carbide Corp. (USA) |
| CelluCoat | Eka Chemicals AB (Sweden) |
| Chem Elut | Varian Inc. (USA) |
| DB | J&W Scientific Inc. (USA) |
| Equity | Sigma-Aldrich Co. (USA) |
| FlashMaster | Biotage AB (Sweden) |
| Flash 12i | Biotage AB (Sweden) |
| Focus | Varian Inc. (USA) |
| Genesis | Tecan Group AG |
| Hydromatrix | Varian Inc. (USA) |
| HyperSep | Thermo Fisher Scientific Inc. (USA) |
| Hypersil | Thermo Fisher Scientific Inc. (USA) |
| HyPURITY | Thermo Fisher Scientific Inc. (USA) |
| Kinetex | Phenomenex Inc. (USA) |
| Lux | Phenomenex Inc. (USA) |
| Obelisc | Sielc Technologies (USA) |
| Ostro | Waters Corp. (USA) |
| Nukol | Sigma-Aldrich Co. (USA) |
| PEEK | Victrex plc. (UK) |
| Phree | Phenomenex Inc. (USA) |
| Porapak | Waters Corp. (USA) |
| Poroshell | Agilent Technologies Inc. (USA) |
| SPB | Sigma-Aldrich Co. (USA) |
| Select | Agilent Technologies Inc. (USA) |
| Sequant | Merck Sequant AB (Sweden) |
| Strata | Phenomenex Inc. (USA) |
| SunFire | Waters Corp. (USA) |
| Supelclean | Sigma-Aldrich Co. (USA) |
| Supelcosil | Sigma-Aldrich Co. (USA) |
| Supelcowax | Sigma-Aldrich Co. (USA) |
| SymmetryShield | Waters Corp. (USA) |

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# Notes

# Notes

Chromatography

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