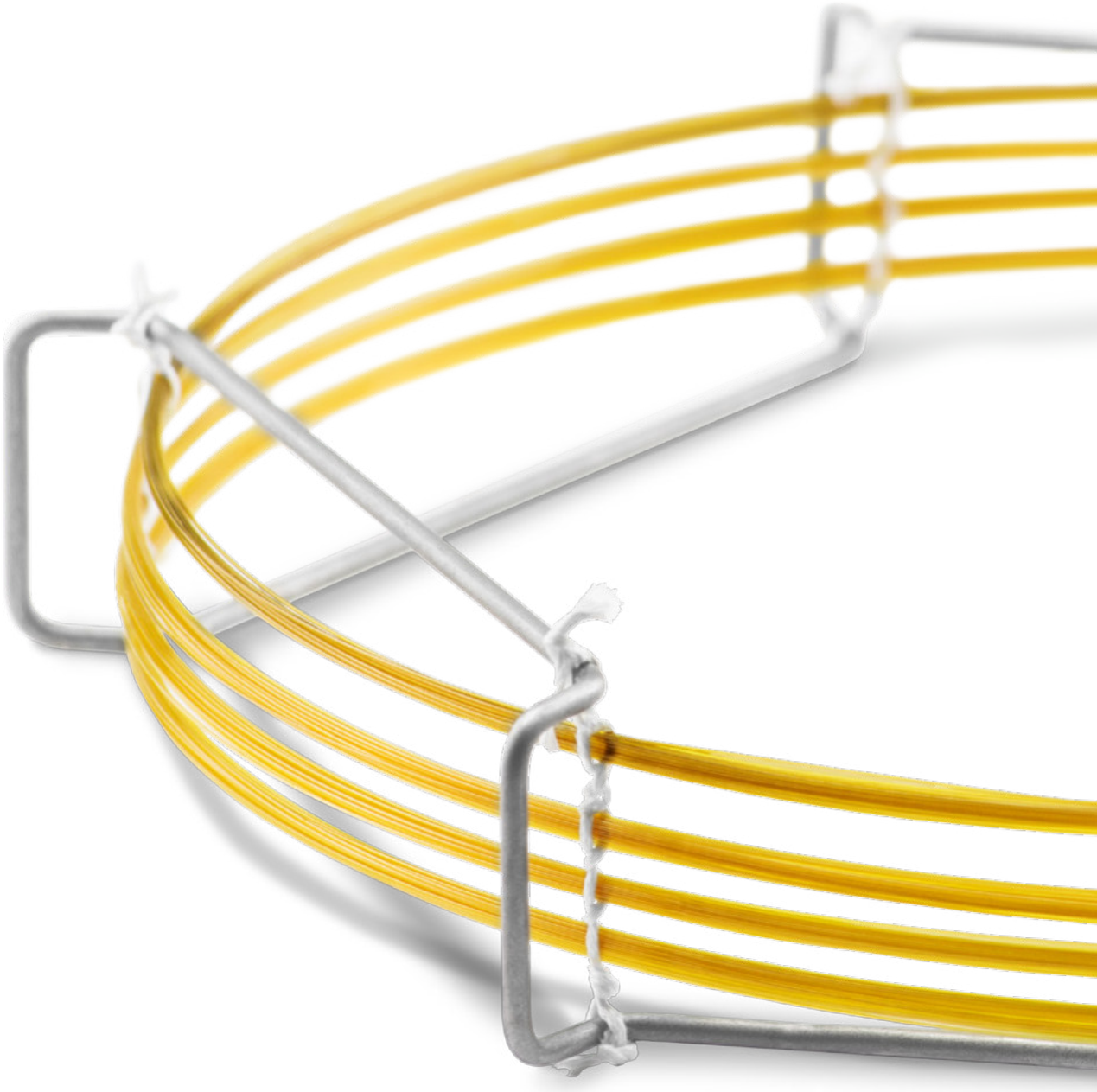
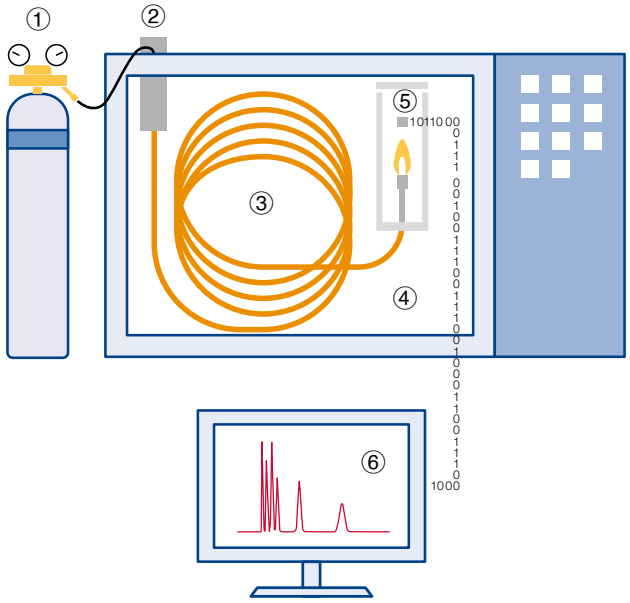


Contents

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:

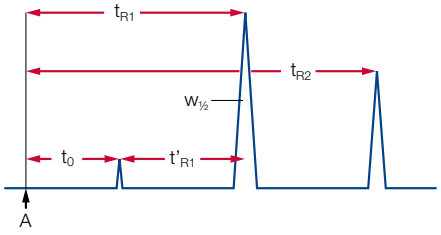
In GC, the mobile phase is always a gas, mostly either He, N_2 or H_2.

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:

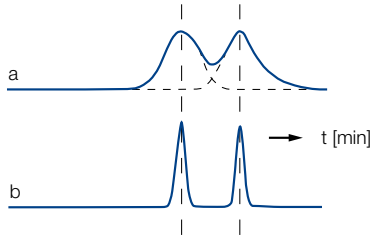
k': retention factor: a measure for the position of a sample peak in the chromatogram. The retention factor is specific for a given compound and constant under constant conditions.

$$k'_i = \frac{t_{Ri} - t_0}{t_0}$$

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:

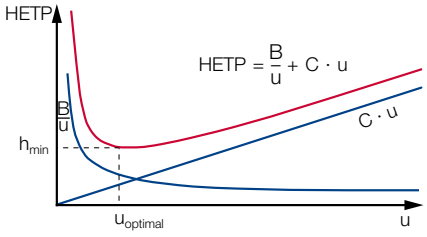
$$R = 1.18 \cdot \frac{t_{R2} - t_{R1}}{(w_{1/2})_2 + (w_{1/2})_1}$$

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

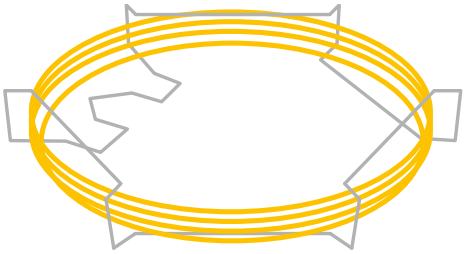
USP listing of MN GC phases

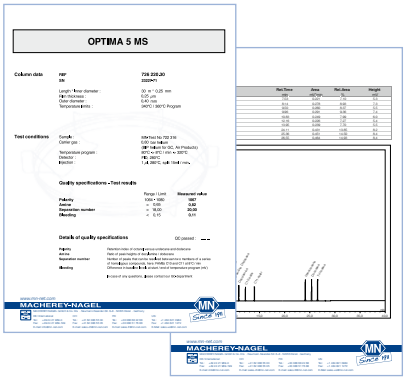
Code	Specifications	MN GC phases	Page
USP G1 / G2	dimethylpolysiloxane oil	OPTIMA® 1	310
		OPTIMA® 1 MS	312
		OPTIMA® 1 MS Accent	312
		OPTIMA® 1-TG	348
		PERMABOND® SE-30	336
		PERMABOND® P-100	352
USP G3	50 % phenyl - 50 % methylpolysiloxane	OPTIMA® 17	327
		OPTIMA® 17 MS	328
		OPTIMA® 17-TG	348
USP 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

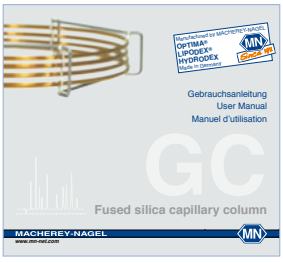
Additional information for GC columns

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.

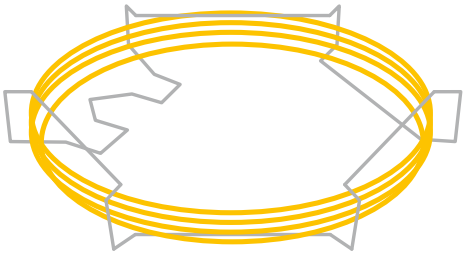




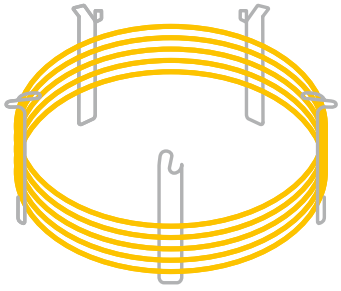


GC cages

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)



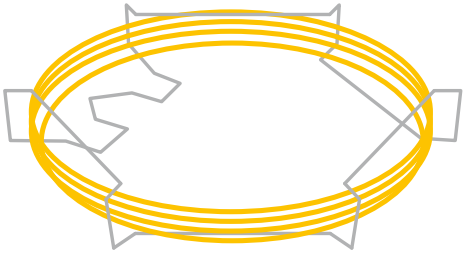
7 inches standard size e.g., REF 726600.30



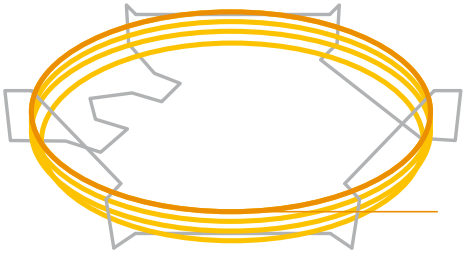
5 inches special cage e.g., REF 726600.30E

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



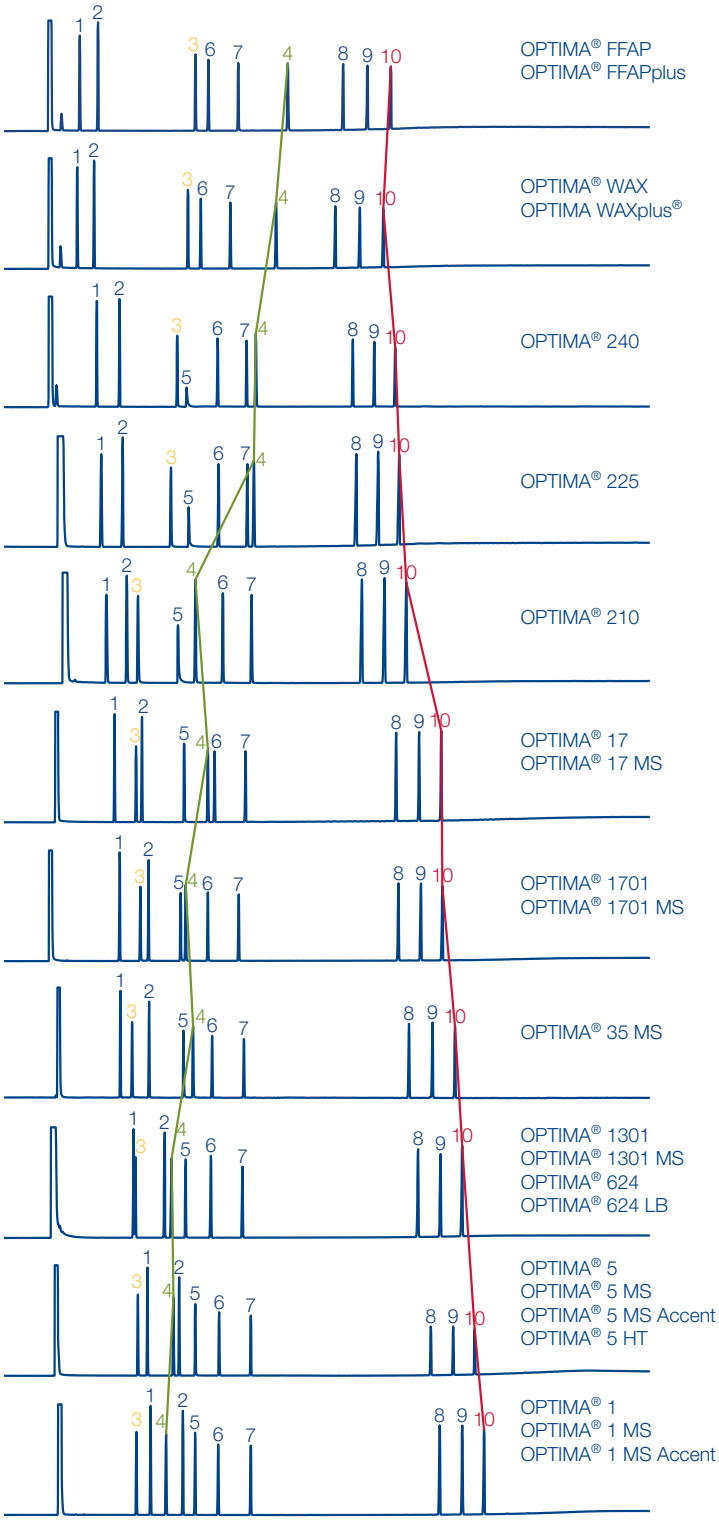
With integrated guard column e.g., REF 726600.30V1

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		
OPTIMA® 1 MS		312		340 / 360 °C
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

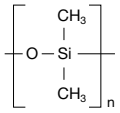
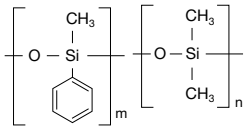
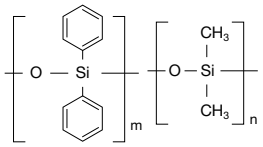
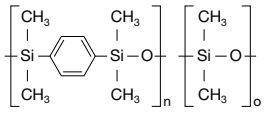
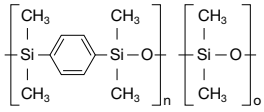
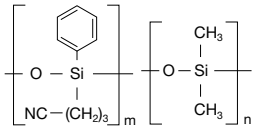
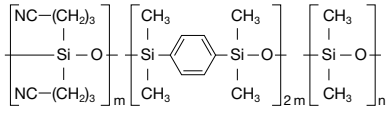
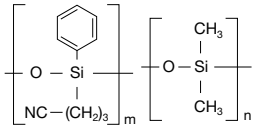
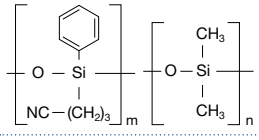
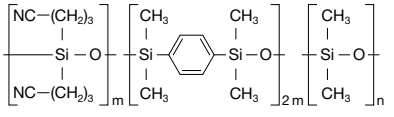
① = nonpolar, = polar

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

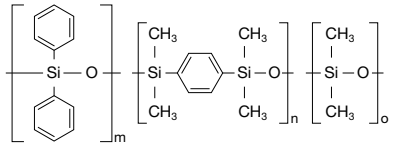
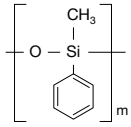
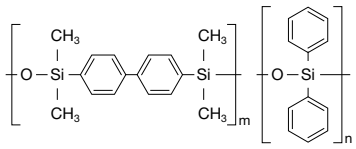
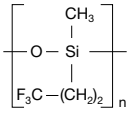
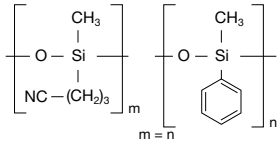
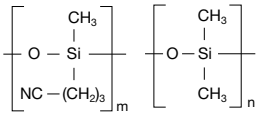
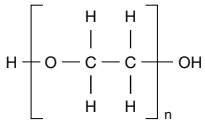
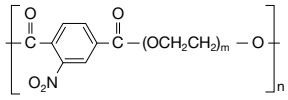
① = nonpolar, = polar

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.

Summary of MN phases for GC

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 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 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.

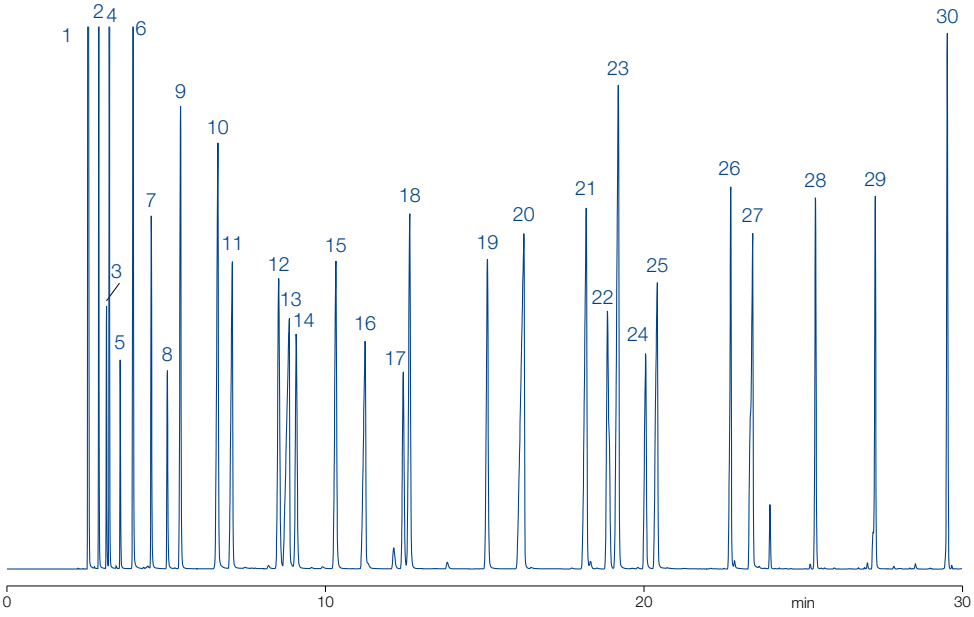
Solvent analysis

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,
8140 / 8141 OP pesticides calibration mix A
and 8141 OP pesticides calibration mix B;
IS triphenyl phosphate and tributyl phosphate

Injection: 250 °C, splitless (hold 1 min)

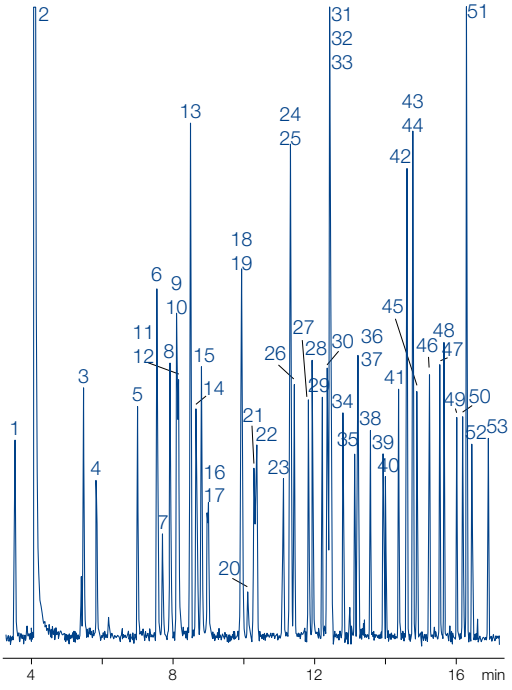
Carrier gas: He, 1 mL/min, constant pressure

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® · weakly polar capillary columns

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

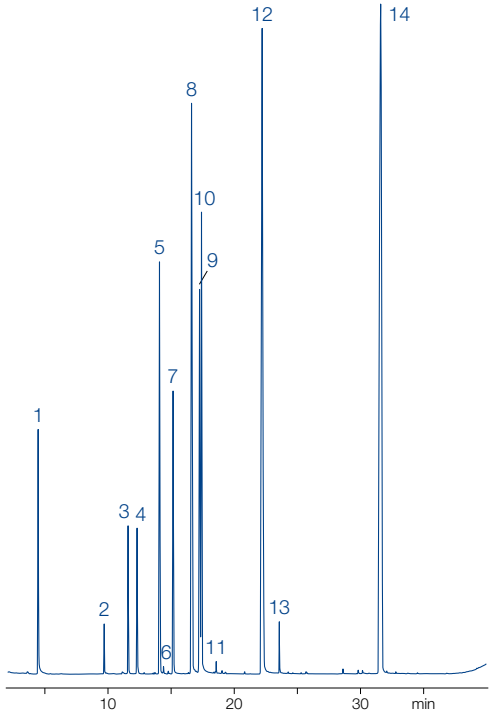
Analysis of various phenols

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.

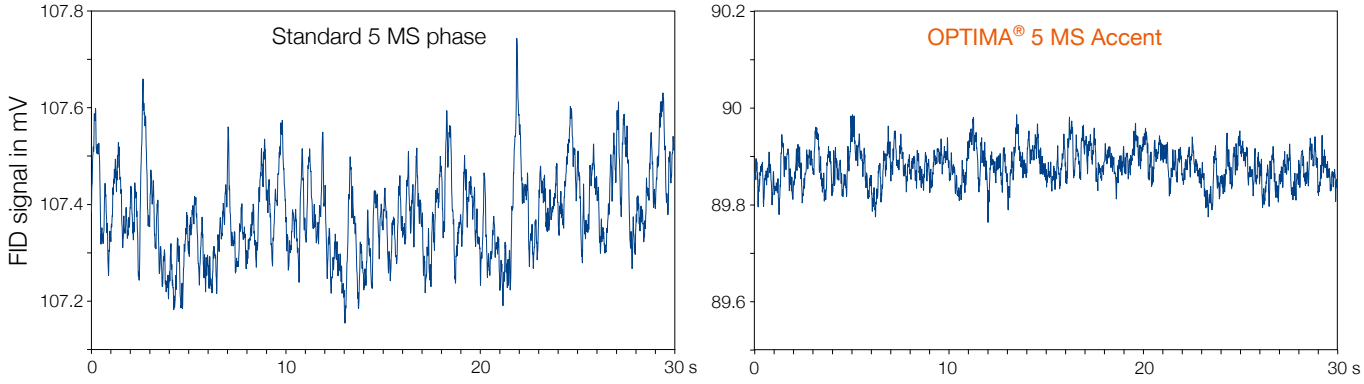
Similar phases
- DB-5, DB-5MS, HP-5MS, Ultra-2, Equity™-5, CP-Sil 8CB low bleed/MS, Rxi®-5MS, Rtx®-5SIL-MS, Rtx®-5MS, 007-5MS, BPX™5, MDN-5S, AT™-5MS, VF-5MS

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

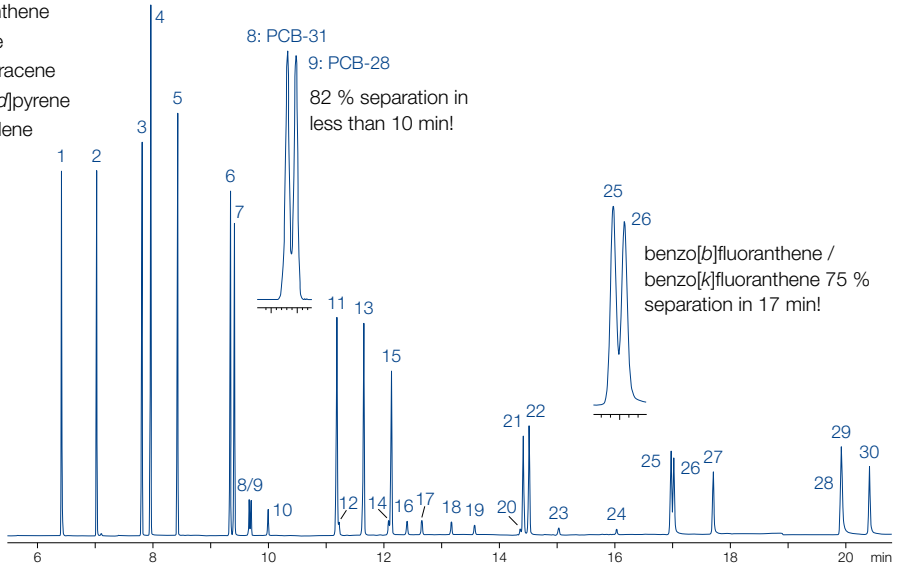
Rapid separation of PCB and PAH

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

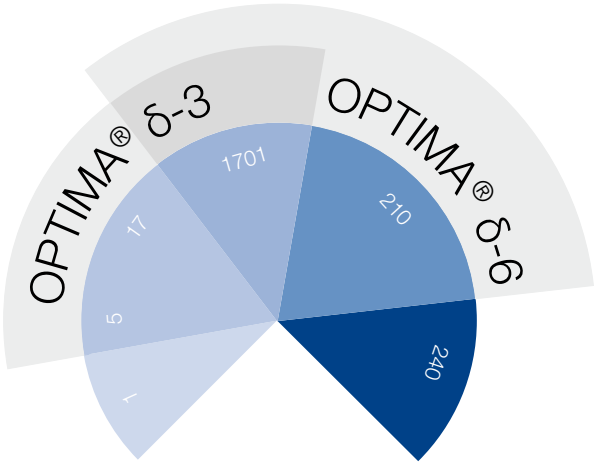
OPTIMA® XLB

	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



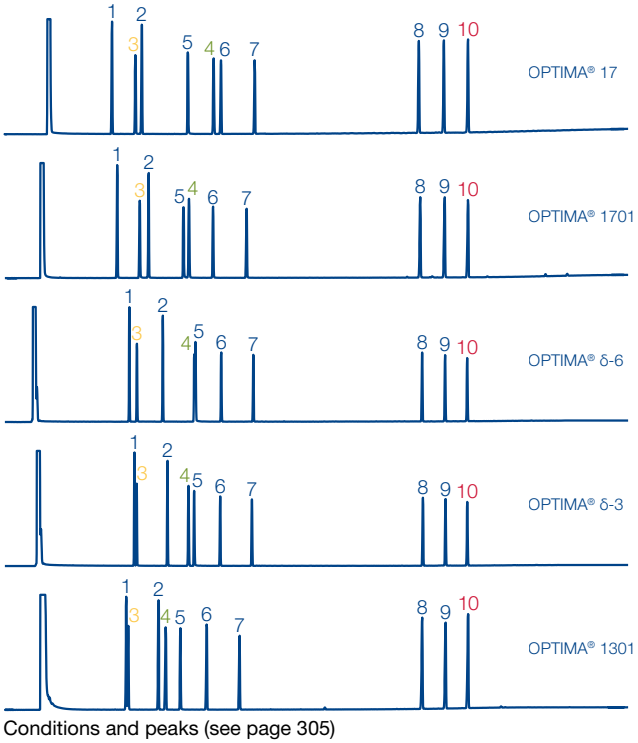
All stationary GC phases can be classified by their polarities. While the selectivity of common GC phases is generally determined by permanent dipole-dipole interactions, OPTIMA® δ-3 and OPTIMA® δ-6 show an additional feature. Large, polarizable groups in the polymer chain of the stationary phase enable 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

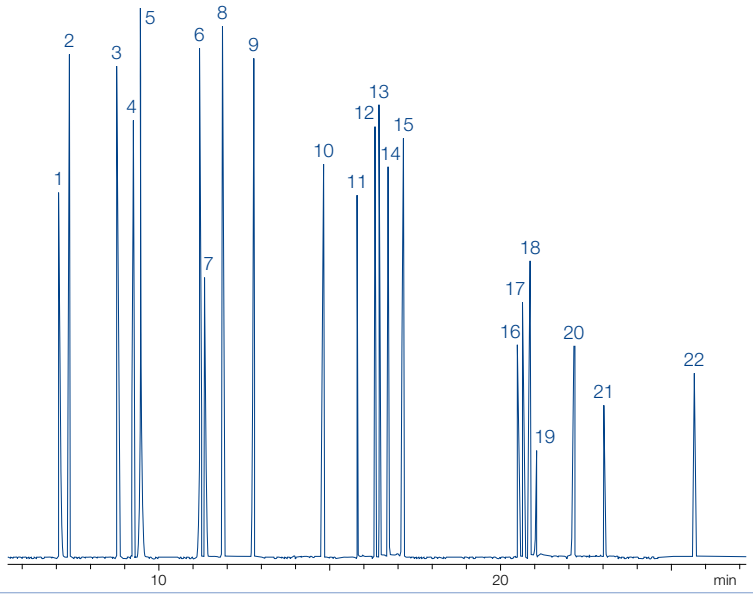
Analysis of isomeric phenols

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

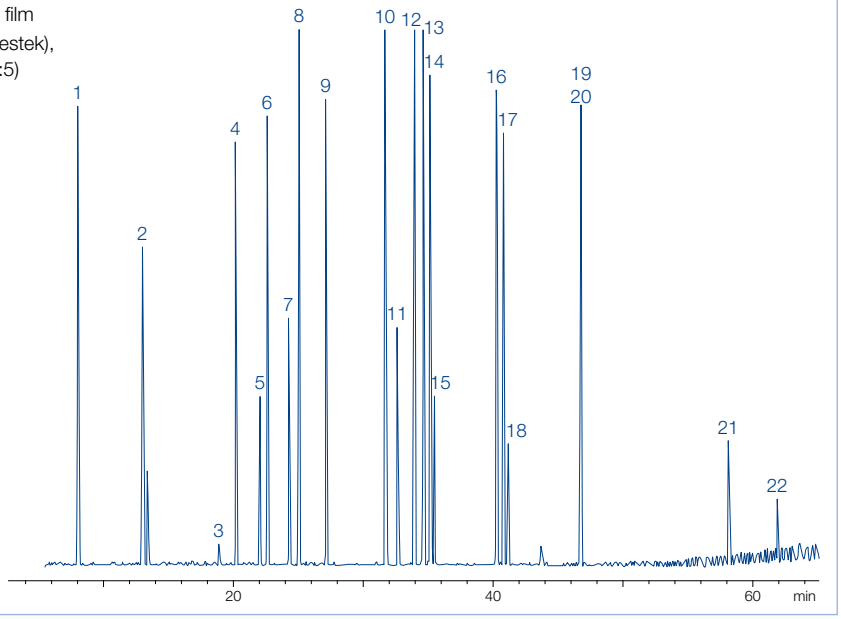
Separation of organophosphorus pesticides (EPA 8140 / 8141)

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)

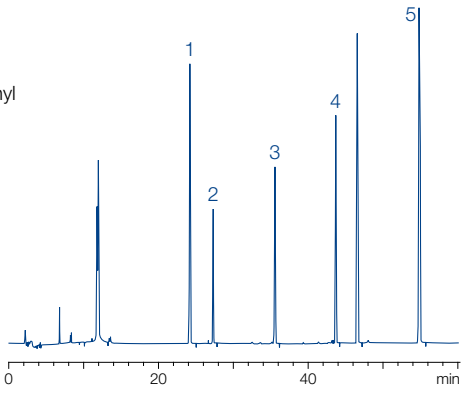
Similar phases
- HP-1301, DB-1301, SPB™-1301, Rtx®-1301, CP-1301, 007-1301

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

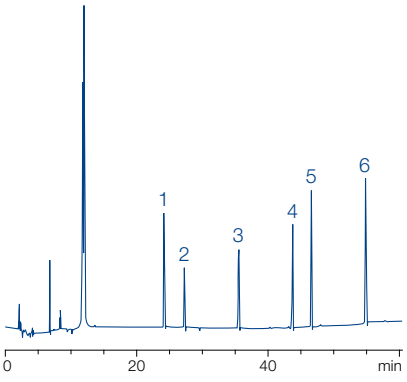


Analysis of a PCB mixture

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

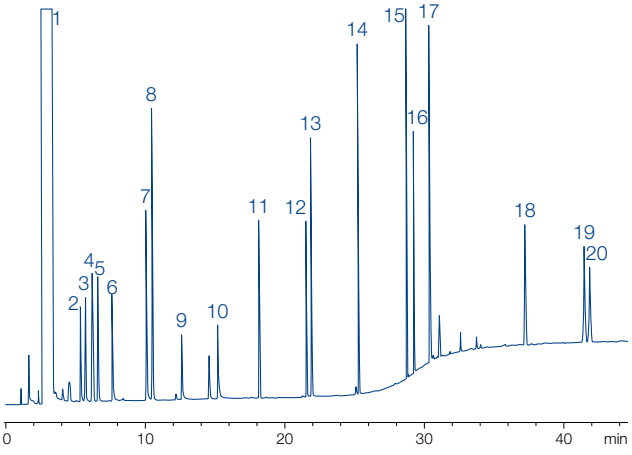
Recommended application
- Halogenated hydrocarbons, volatiles, aromatic compounds, solvents etc.

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® · medium polar capillary columns

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.

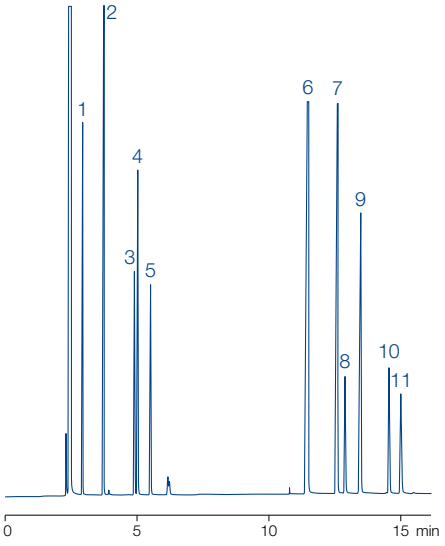
Similar phases
- OV-1701, DB-1701, CP-Sil 19 CB, HP-1701, Rtx®-1701, SPB™-1701, 007-1701, BP10, ZB-1701

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

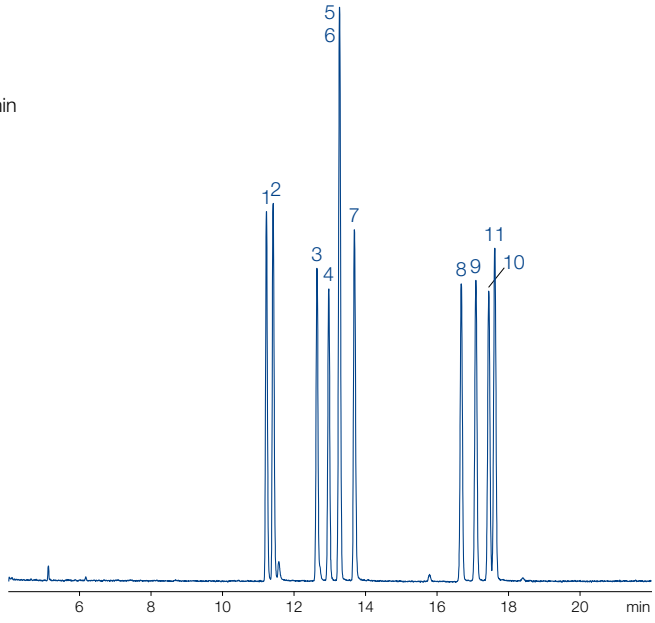
Separation of triazine pesticides (EPA 619)

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

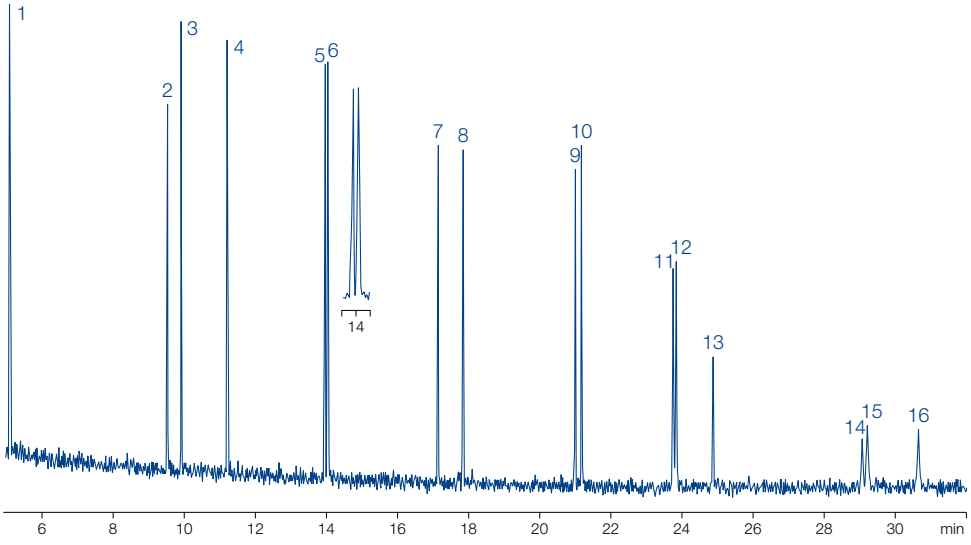
- DB-35 MS, HP-35, SPB™-35, Rxi®-35SIL MS, Rtx-35, 007-35, BPX™-35, MDN-35, AT™-35 MS, ZB-35, OV-11, VF-35 MS

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.

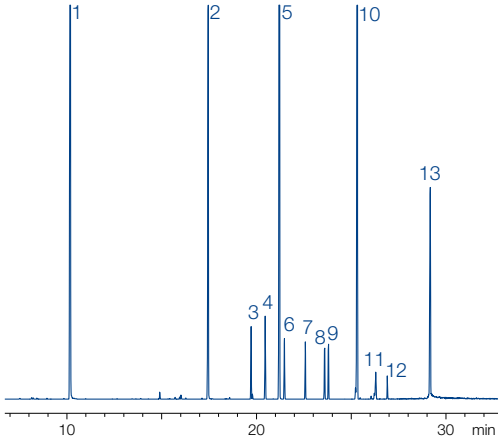
Similar phases
- OV-17, DB-17, HP-50+, HP-17, SPB™-50, SP-2250, Rxi®-17, Rtx®-50, CP-Sil 24 CB, 007-17, ZB-50

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

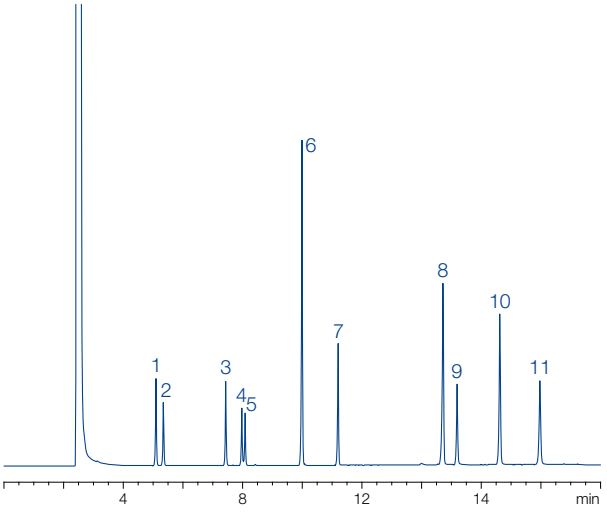
Analysis of phenols

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)

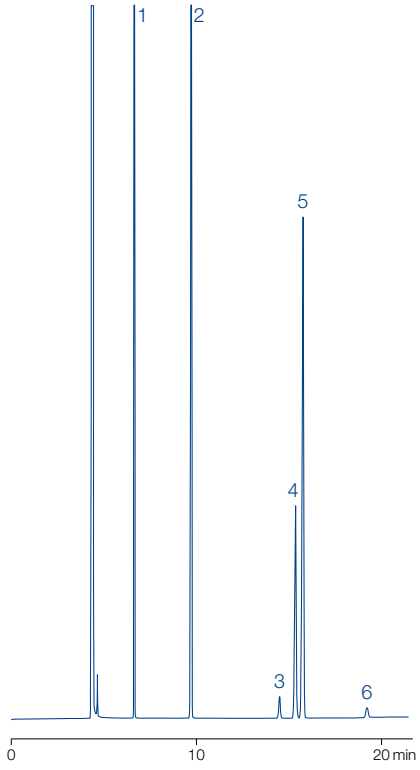
Similar phases
- OV-210, DB-210, Rtx®-200, 007-210

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

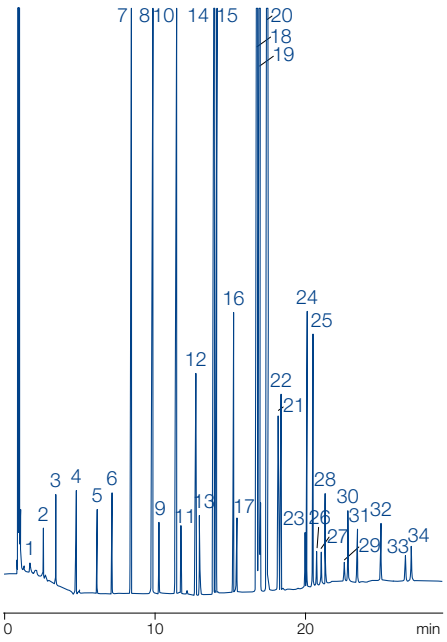
MN Appl. No. 210060

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

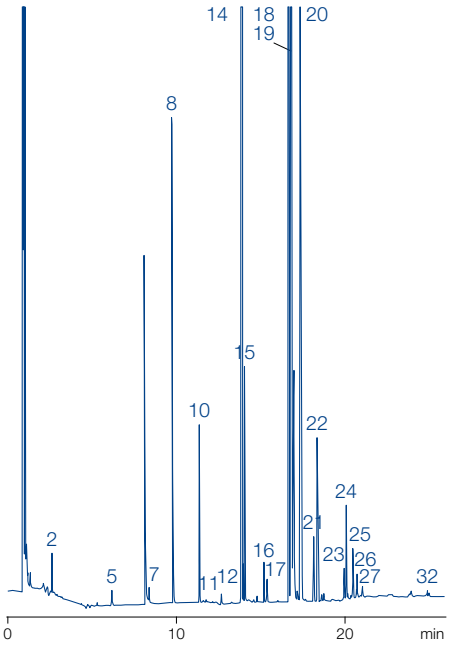
Peaks:

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

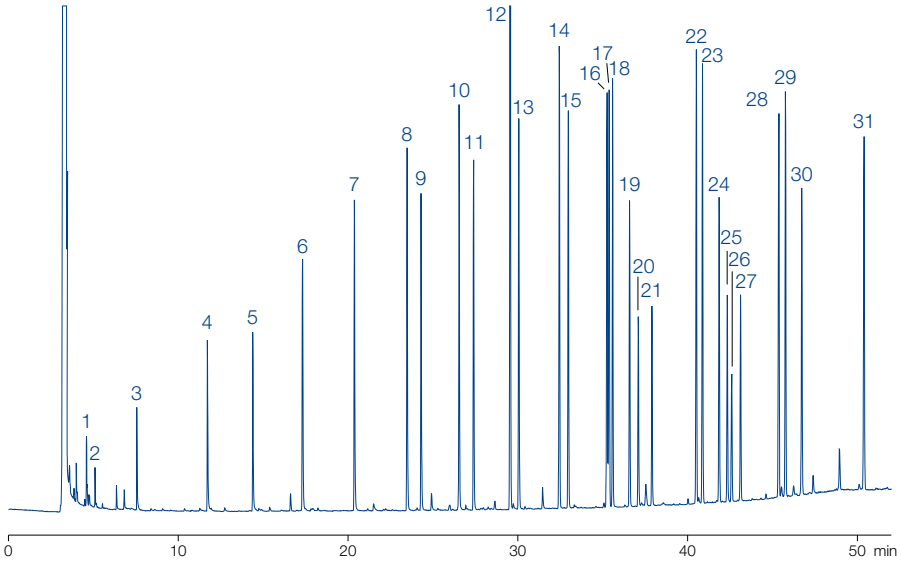
Temperature
- T_{max} 260 °C (long-term temperature), T_{max} 280 °C (short-term max. temperature in a temperature program)

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.

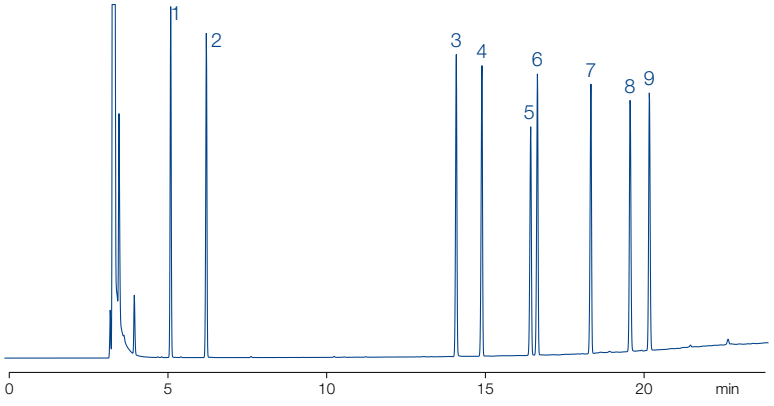
Similar phases
- PERMABOND® CW 20 M (see page 337), DB-Wax, Supelcowax, HP-Wax, HP-INNOWAX, Rtx-Wax, CP-Wax 52 CB, Stabilwax, 007-CW, BP20, AT-Wax, ZB-Wax

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)

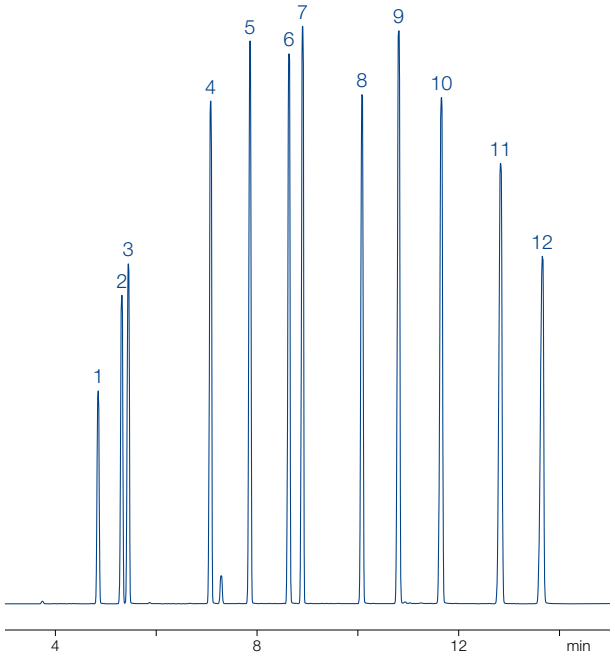
Similar phases
- DB-Wax, Supelcowax, HP-Wax, HP-INNOWAX, Rtx-Wax, CP-Wax 52 CB, Stabilwax, 007-CW, BP20, AT-Wax, ZB-Wax

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.

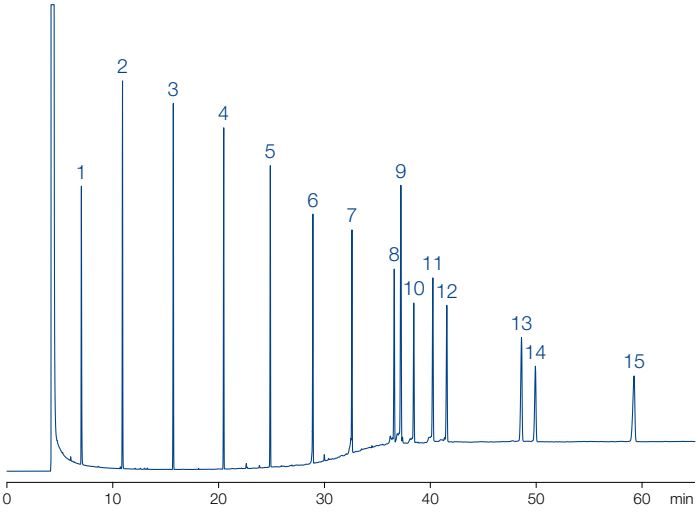
Similar phases
- PERMABOND® FFAP (see page 338), DB-FFAP, HP-FFAP, CP-Wax 58 FFAP CB, 007-FFAP, CP-FFAP CB, Nukol™, AT-1000, SPB-1000, BP21, OV-351

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)

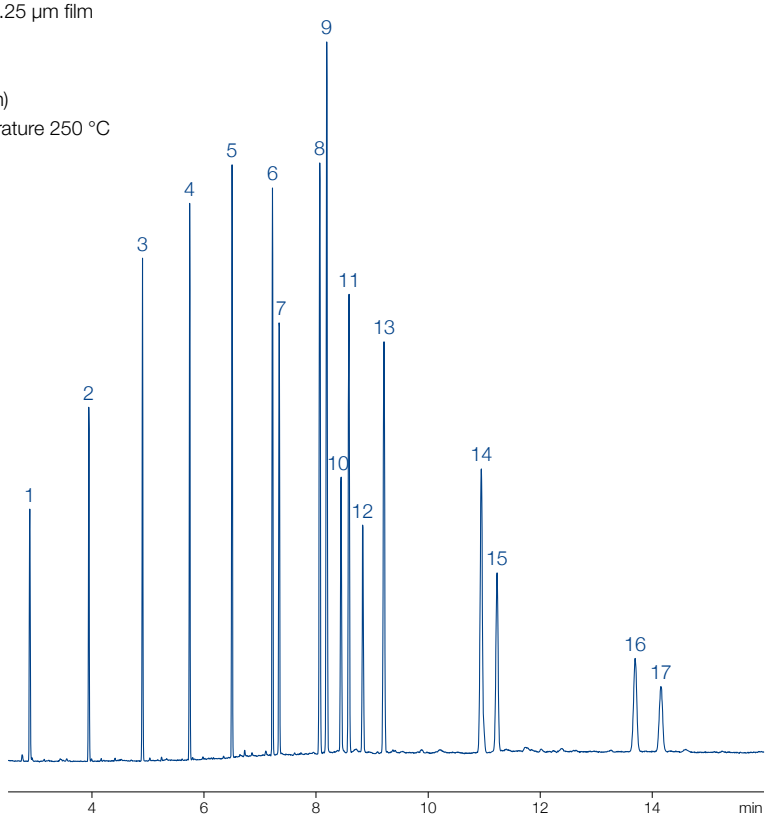
Similar phases
- DB-FFAP, HP-FFAP, CP-SIL 58 CB, 007-FFAP, CP-FFAP CB, Nukol™

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 OPTIMA® 17, OPTIMA® 225, OPTIMA® FFAP PERMABOND® CW 20 M, PERMABOND® FFAP	340
Enantiomer separation cyclodextrin phases		
	FS-LIPODEX® A, FS-LIPODEX® B, FS-LIPODEX® C FS-LIPODEX® D, FS-LIPODEX® E, FS-LIPODEX® G	342
	FS-HYDRODEX β-PM, FS-HYDRODEX β-3 P, FS-HYDRODEX β-6TBDM, FS-HYDRODEX β-6TBDE, FS-HYDRODEX β-6TBDE, FS-HYDRODEX β-TBDAc, 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

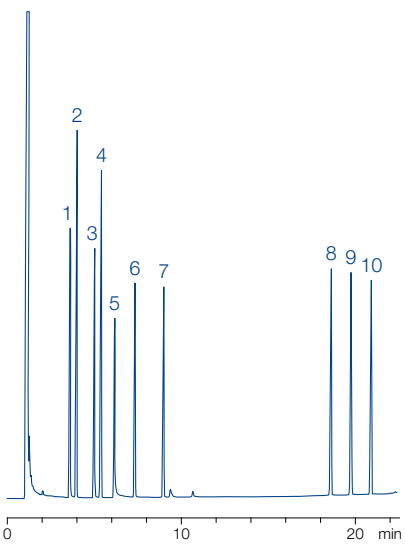
Peaks:

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

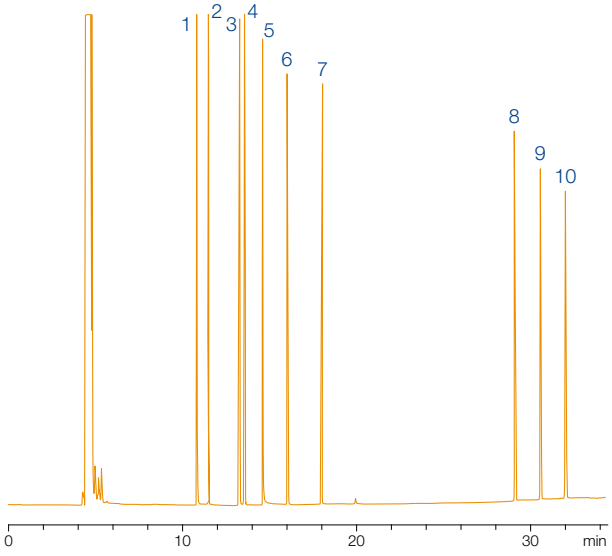
Injection 1 µL, split 1:40,
Carrier gas 0.75 bar He



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*

Capillary columns for enantiomer separation

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®

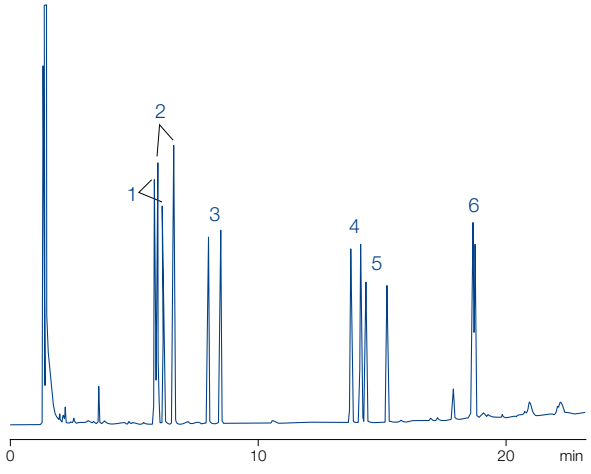
Length →	10 m 0.10 mm ID	25 m 0.25 mm ID	50 m 0.25 mm ID
FS-LIPODEX® A			
		723360.25	723360.50
FS-LIPODEX® B			
		723362.25	723362.50
FS-LIPODEX® C			
		723364.25	723364.50
FS-LIPODEX® D			
		723366.25	723366.50
FS-LIPODEX® E			
	723382.10	723368.25	723368.50
FS-LIPODEX® G			
		723379.25	723379.50
All 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



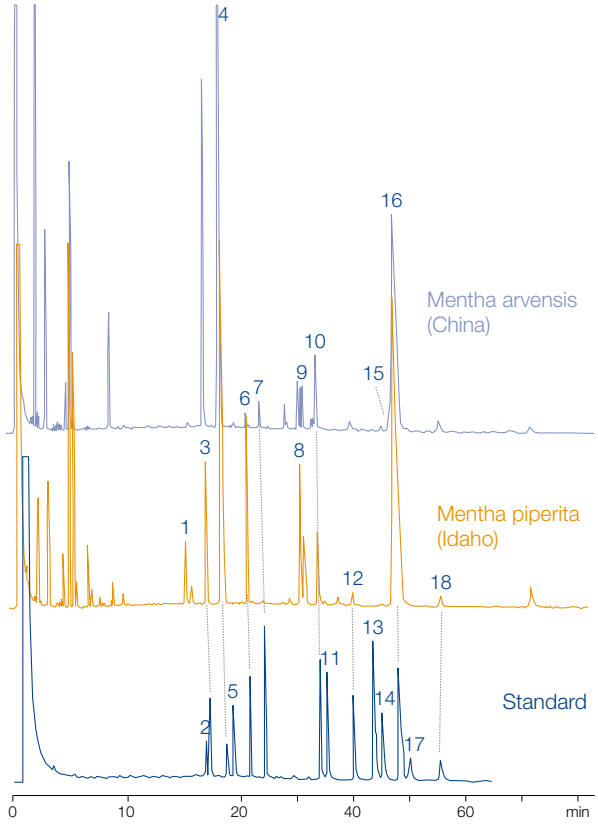
Separation of chiral constituents of peppermint oil

MN Appl. No. 250410

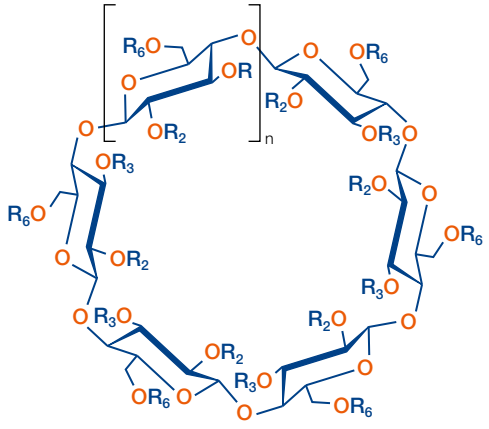
W. A. König et al., High Resol. Chromatogr. 20 (1997) 55–61

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

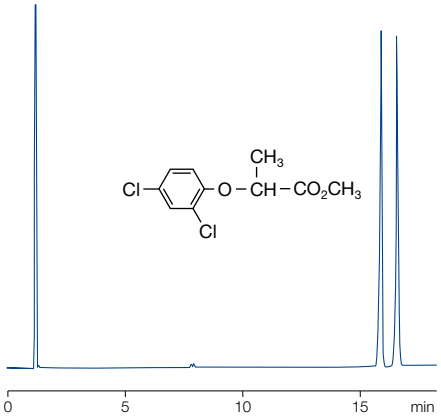
Recommended application

- 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

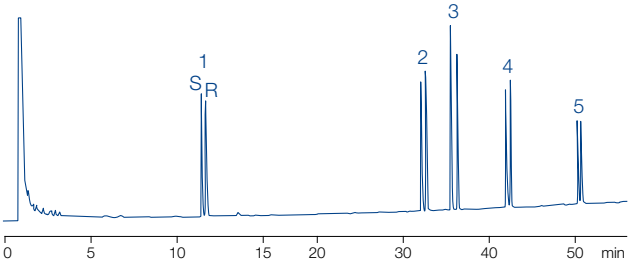


Separation of isomeric antiinflammatory drugs

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



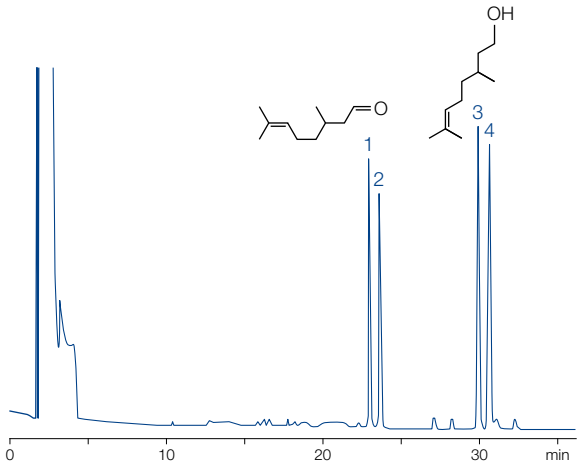
Phase	Cyclodextrin derivative (diluted with optimized polysiloxane)	T_{max} [°C]	Recommended application
HYDRODEX β-PM			
	heptakis-(2,3,6-tri-O-methyl)-β-CD	230 / 250	hydroxycarboxylic acid esters, alcohols, diols, olefins, lactones, acetals
HYDRODEX β-3P			
	heptakis-(2,6-di-O-methyl-3-O-pentyl)-β-CD	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

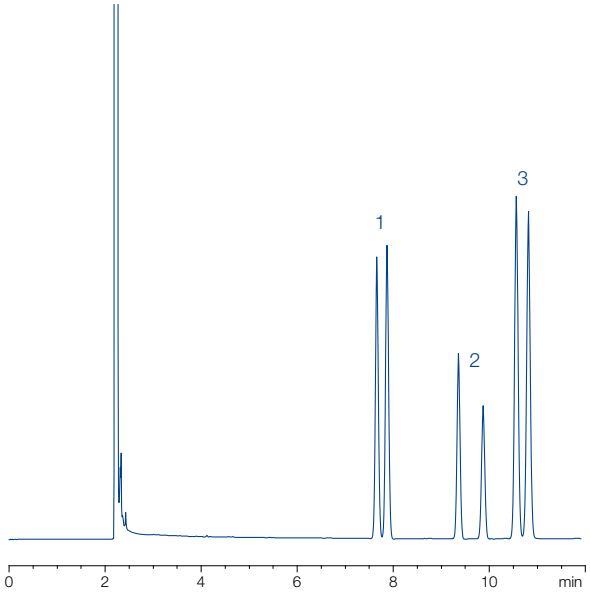


Separation of essential oils

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 0.10 mm ID	25 m 0.25 mm ID	50 m 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*

Capillary columns for biodiesel analysis

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® Bio-Diesel 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

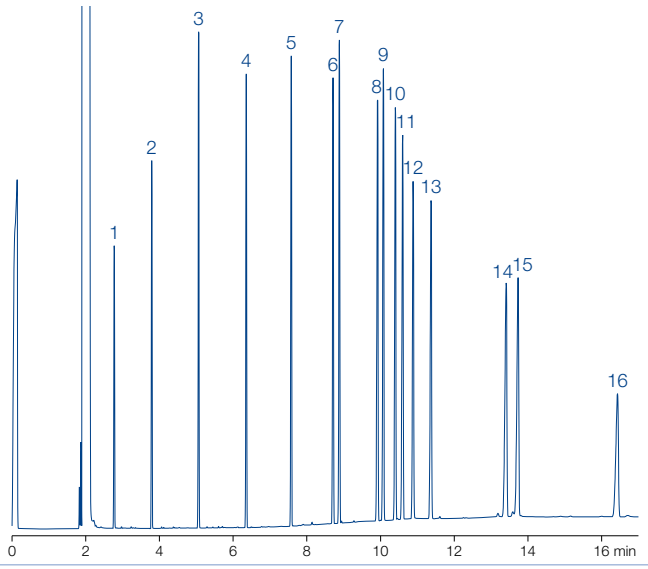
Analysis of FAMEs from biodiesel in accordance with DIN EN 14103:2011

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



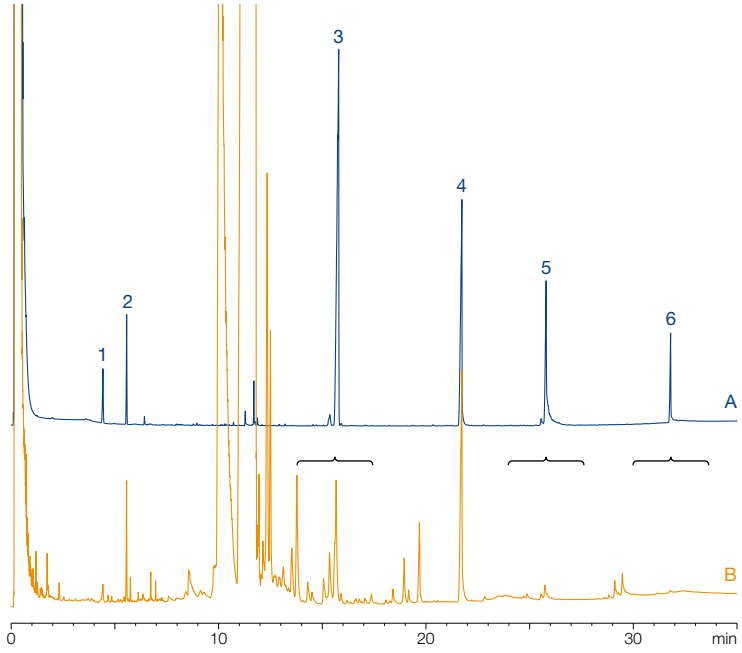
Analysis of glycerol and glycerides from biodiesel

MN Appl. No. 213640

Column: OPTIMA® BioDiesel G, 10 m x 0.25 mm ID
Sample: A) standard in *n*-heptane
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 → 280 °C, 7 °C/min → 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:

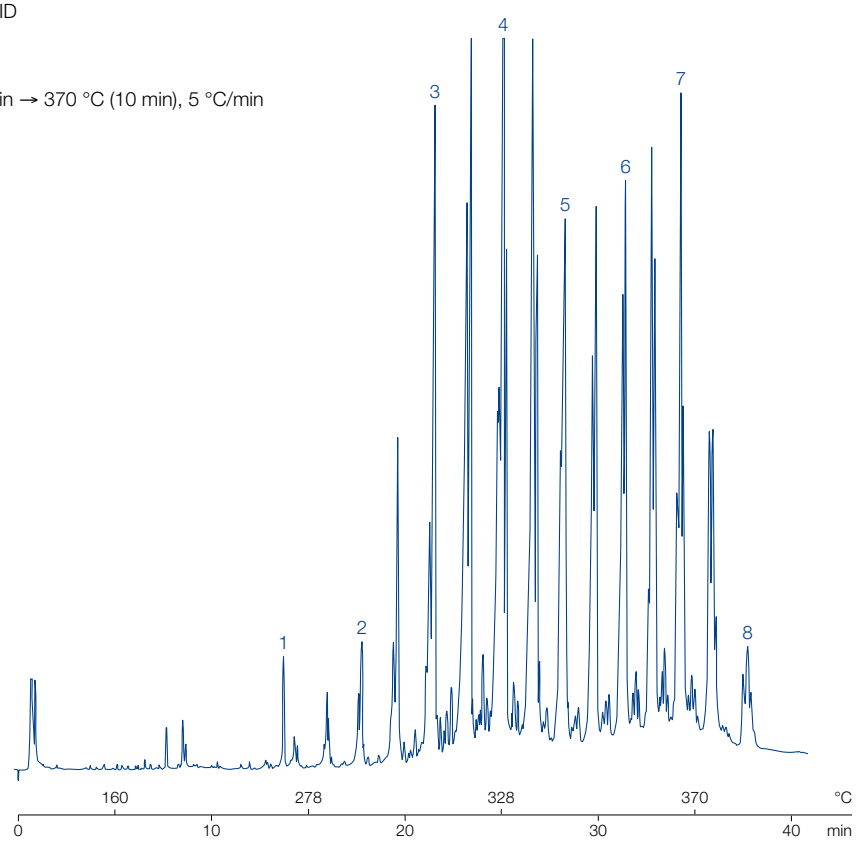
- SPB-1 TG, DB-1 HT, 400-1 HT, HT-5

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)

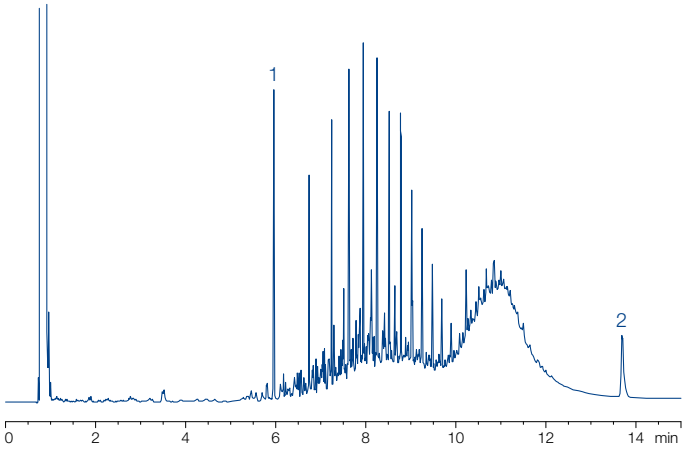
Similar phases
- DB-5HT, VF-5HT, HT-5, XTI-5HT, ZB-5HT

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

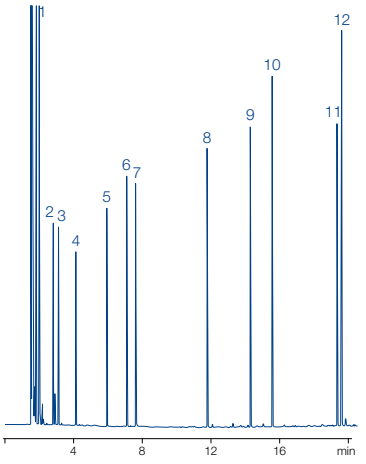
Separation of secondary and tertiary amines

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*

Capillary columns for hydrocarbons

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.

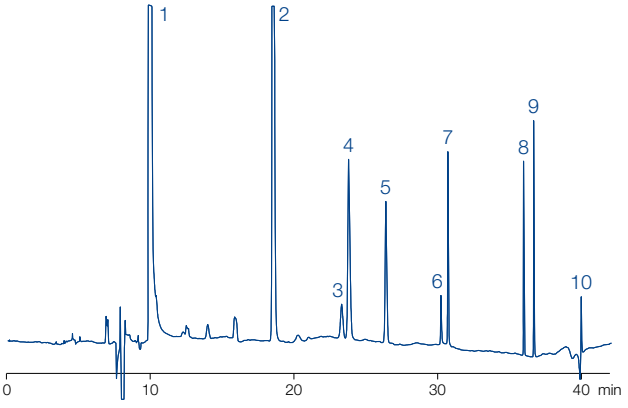
Both phases are also suited for the determination of vinyl chloride as well as for the separation of cis/trans isomers of 1,2-dichloroethene. The high film thickness secures a high capacity and an outstanding resolution. For GC/MS coupling, we recommend OPTIMA® 624 LB or OPTIMA® 624 with 0.2 or 0.25 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)



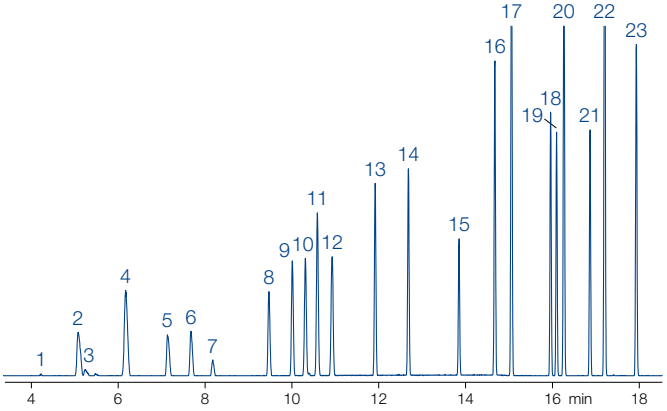
Volatile halogenated hydrocarbons and BTX

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*

Capillary columns for silane · DEG

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

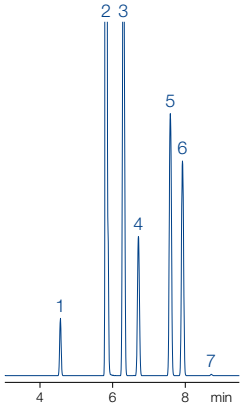
	Length → 25 m	50 m
0.32 mm ID (0.5 mm OD)		723409.50
0.53 mm ID (0.8 mm OD)	723411.25	

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

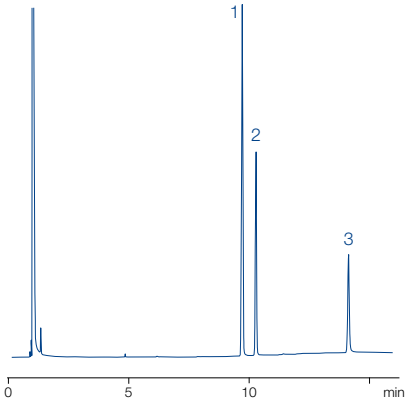


Diethylene glycol standard in wine

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 Pack of 3	10 m Pack of 1	25 m 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 → 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.

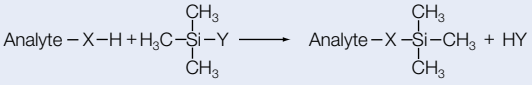
Due to their purpose, derivatization reagents are very reactive substances. For this reason, they should be stored cool and protected from moisture. For easy access with a syringe, our derivatization reagents are supplied in vials with crimp caps (exception DMCS and TMCS with screw closure). Vials with pierced sealing disks have limited stability and should be used soon.

The derivatization procedures can be found on page 367.

Reagents / methods for derivatization

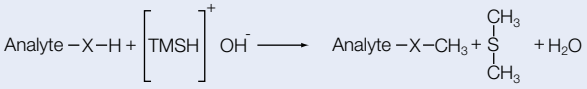
General reaction mechanisms

Silylation



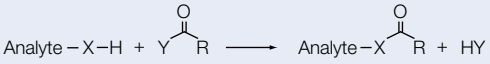
X = e.g., O, S, COO, etc.
Y = rest of silylation reagents

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*

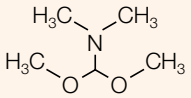
Substance	Packing unit			
	10 x 1 mL	20 x 1 mL	1 x 10 mL	5 x 10 mL
HFBA				
		701110.201	701110.110	701110.510
MBTFA				
		701410.201	701410.110	701410.510
MBHFBA				
	701420.101	701420.201		
PFBC				
	701120.101			
TFAA				
			701130.110	701130.510

* 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

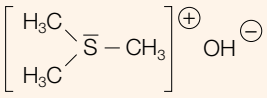


- M 119.17 g/mol,
  Kp 106–107 °C (760 mm Hg),
  Density d20°/4° = 0.897

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

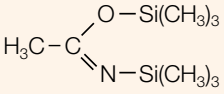
The most common form of silylation in GC is the replacing of active hydrogen atoms with a trimethylsilyl group (TMS derivative). Less frequently, trialkylsilyl groups or dimethylsilyl groups with longer alkyl chains are also in use. The alkylsilyl group increases volatility and enhances thermal stability 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

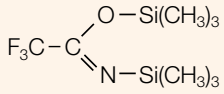
Key features

- 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

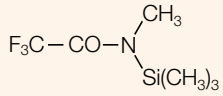
Silylation reagents*

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

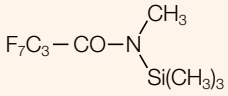
- The most volatile trimethylsilyl amide available, very strong TMS donor which does not cause noticeable FID fouling even during long-time measuring series

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

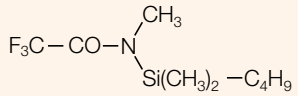
- Similar to MSTFA in reactivity and chromatography
- Either applied alone or in combination with a catalyst (TMCS, TSIM) or another silylation reagent with or without solvent; the by-product *N*-methylheptafluorobutyric amide has a lower retention time than the silylating reagent

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.

Reagents / methods for silylation

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*

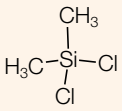
	Packing unit							
Substance	10 x 1 mL	20 x 1 mL	1 x 10 mL	5 x 10 mL	1 x 100 mL	6 x 50 mL	6 x 100 mL	12 x 100 mL
MSTFA								
		701270.201	701270.110	701270.510	701270.1100	701270.650	701270.6100	701270.12100
MSHFBA								
		701260.201	701260.110	701260.510	701260.1100		701260.6100	
MBDSTFA								
	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

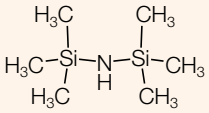


- M 129.06 g/mol,
  Bp 70 °C (760 mm Hg),
  Density d20°/4° = 1.07

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

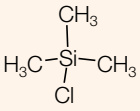


- M 161.4 g/mol,
  Bp 126 °C (760 mm Hg),
  Density d20°/4° = 0.7742

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

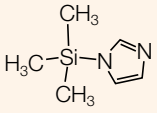


- M 108.7 g/mol,
  Bp 57 °C (760 mm Hg),
  Density d20°/4° = 0.8580

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

Reagents / methods for silylation

Ordering information

Silylation reagents*

	Packing unit			
Substance	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*

		Packing unit				
Mixture	Composition	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 for GC capillary columns

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

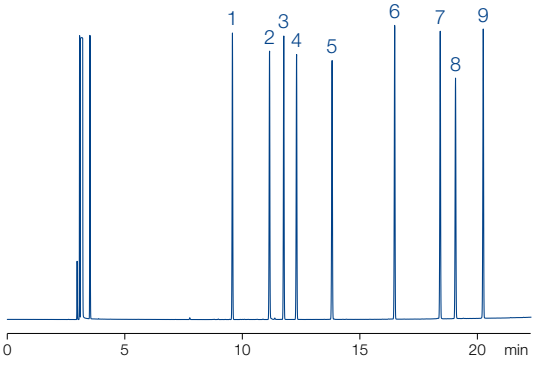
* These products contain harmful substances which must be specially labeled as hazardous. For detailed information please see SDS.

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



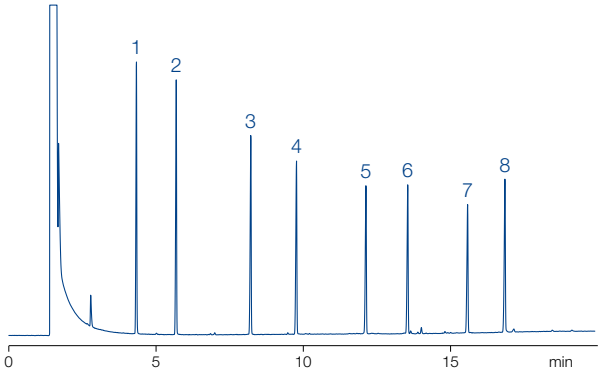
Test mixtures for GC capillary columns

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})

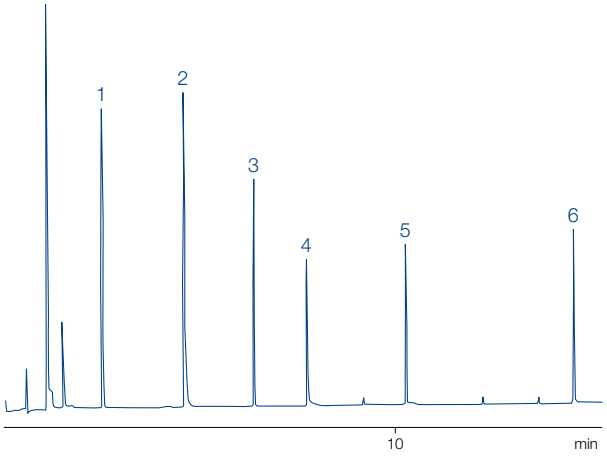


OPTIMA® Amine test mixture (REF 722317)

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 for capillary columns

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)	Graphite	Vespel +40 % Graphite
T_{max} →	450 °C	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

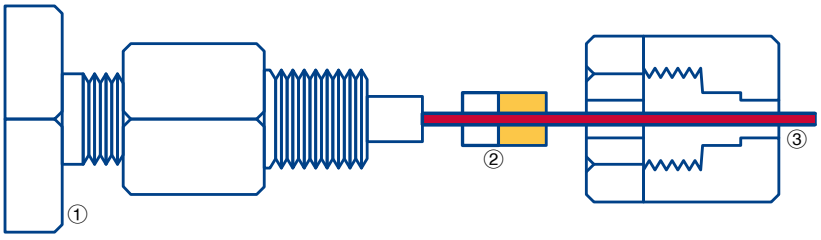
Key features

- 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