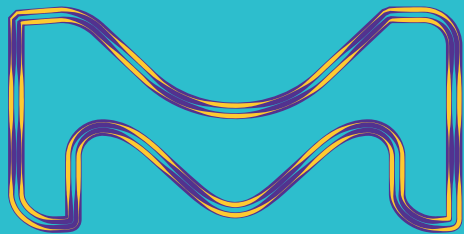


supelco HPLC and GC COLUMNS and ACCESSORIES

Irina Galushko,
irina.galushko@merckgroup.com



MERCK

01

HPLC

Leading Innovations in HPLC

Stable 5 μm (2nd after DuPont)

Monomeric bonded phase (maybe 1st)

5 cm columns for fast analysis (1st)

Base-deactivated (1st) (DB)

3 μm porous silica (2nd after Perkin-Elmer)

Special applications:

- Specialty column for tricyclic antidepressants (1st) (LC-PCN)
- 15 cm column for fast analysis of PAHs (1st, maybe 2nd after P-E) (LC-PAH)
- Nucleoside and nucleotide columns (1st) (LC-18-S, LC-18-T)
- Direct serum injection phase (2nd after Pinkerton) (Hisep SHP)
- Chiral phases (Many 1^{sts}) (Astec)

Polar embedded (1st) (amide-based phases, Suplex, ABZ, RP-Amides)

Fused-Core technology (co-1st with AMT) (Ascentis Express)

Titan – UHPLC columns with Monodisperse Silica

Late
1970s



Today

Supelco HPLC Product History

2013: Titan

2007: Ascentis Express

1998: Chirobiotic (by Astec)

Mid-1990s: Ascentis

1990s: Discovery

1970s: Supelcosil

Extensive knowledge and understanding of bonding chemistry by the R&D team of Supelco drove the innovations.



1978

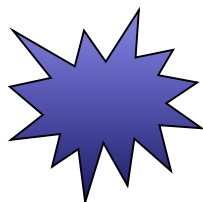


Ascentis Express – Fused-Core Technology

www.sigmaaldrich.com/express

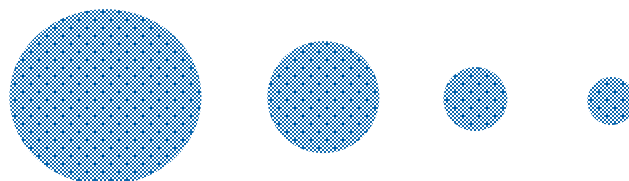
History of HPLC particle design

Irregular



*Difficult to pack, clogging,
not very robust*

Total Porous



*Current state-of-the-
art in HPLC*

Fused-Core™



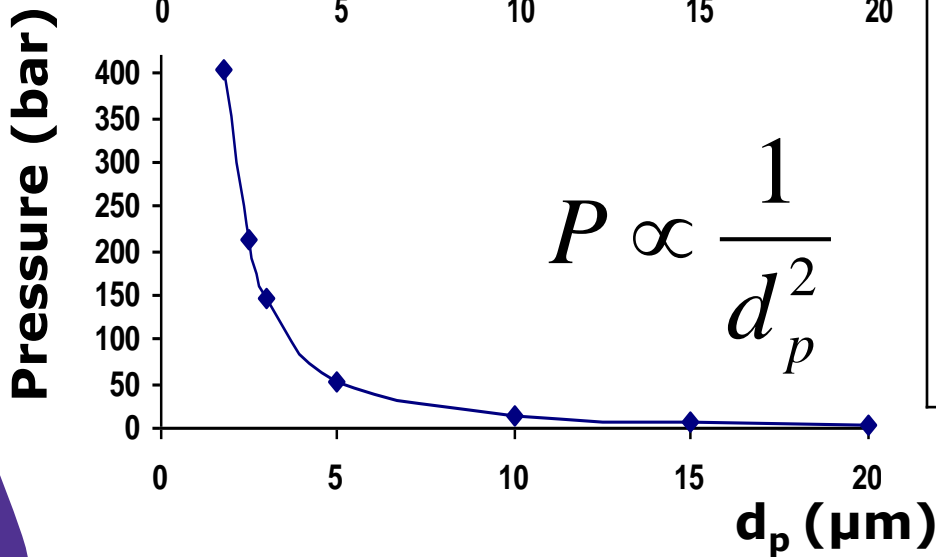
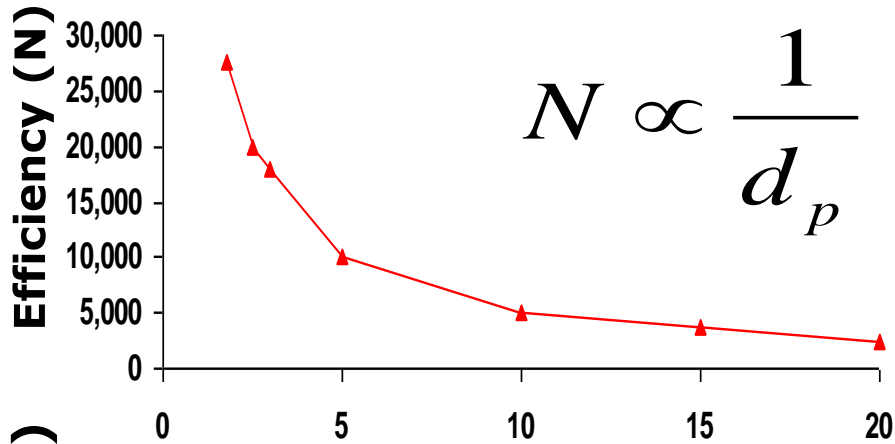
The NEW technology

Fused-Core is a trademark of
Advanced Materials Technology,
Inc.

Nowadays also known as core-shell, superficially porous, solid-core, ...

Particle size: Influence on efficiency and pressure

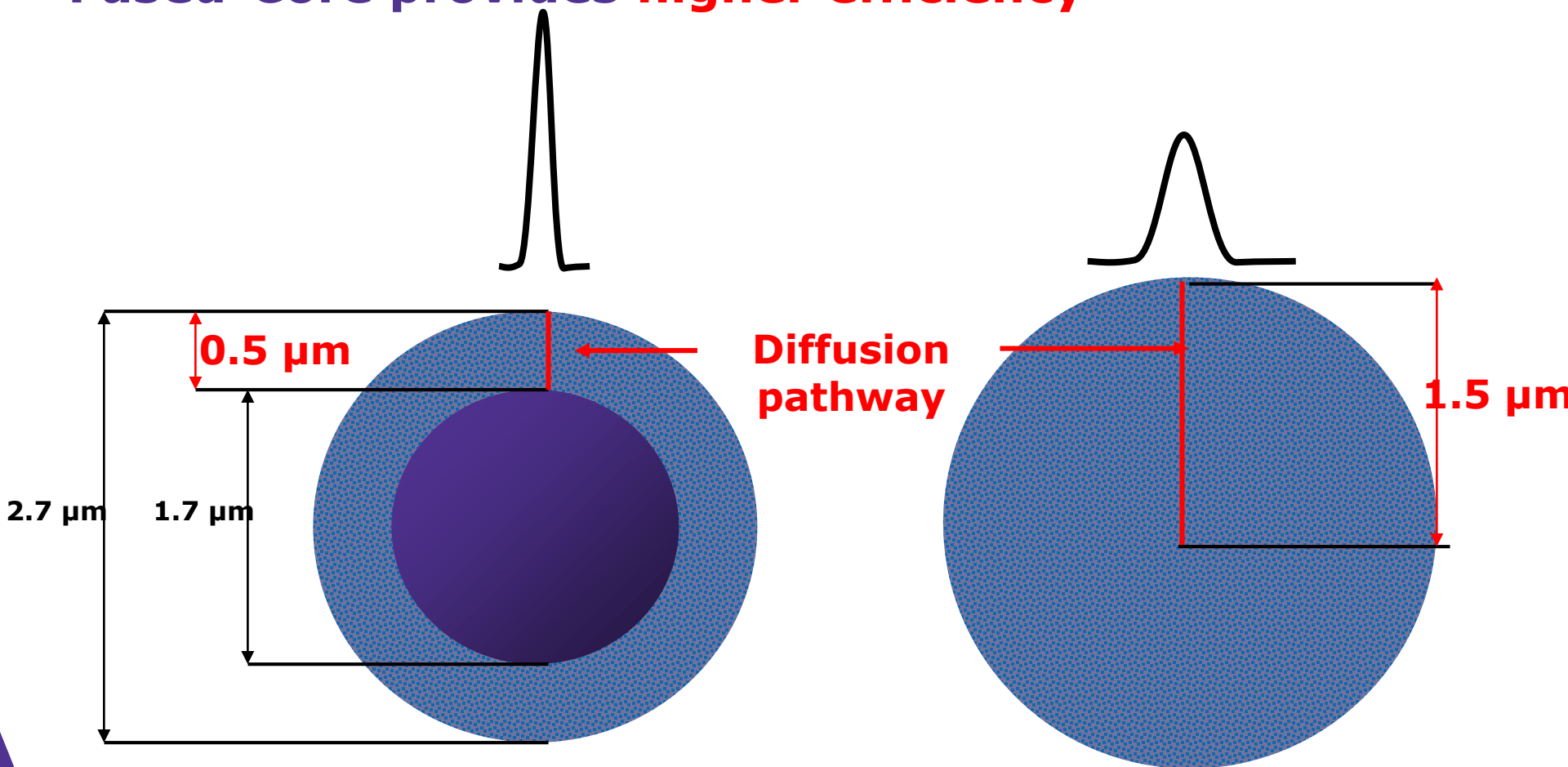
Doubling the efficiency by halving the particle size results in a pressure increase by a factor of four.



Particle (μm)	psi	bar	N
1.8	5889	406	27,500
2.5	3089	213	20,000
3	2118	146	16,500
5	769	53	10,000
10	189	13	5,000
15	87	6	3,750
20	44	3	2,500

10 cm column, 3 mm/s linear velocity

Fused-Core provides **higher efficiency**



The shorter diffusion pathway facilitates the mass transfer (C term)!

Fused-Core provides **higher efficiency**

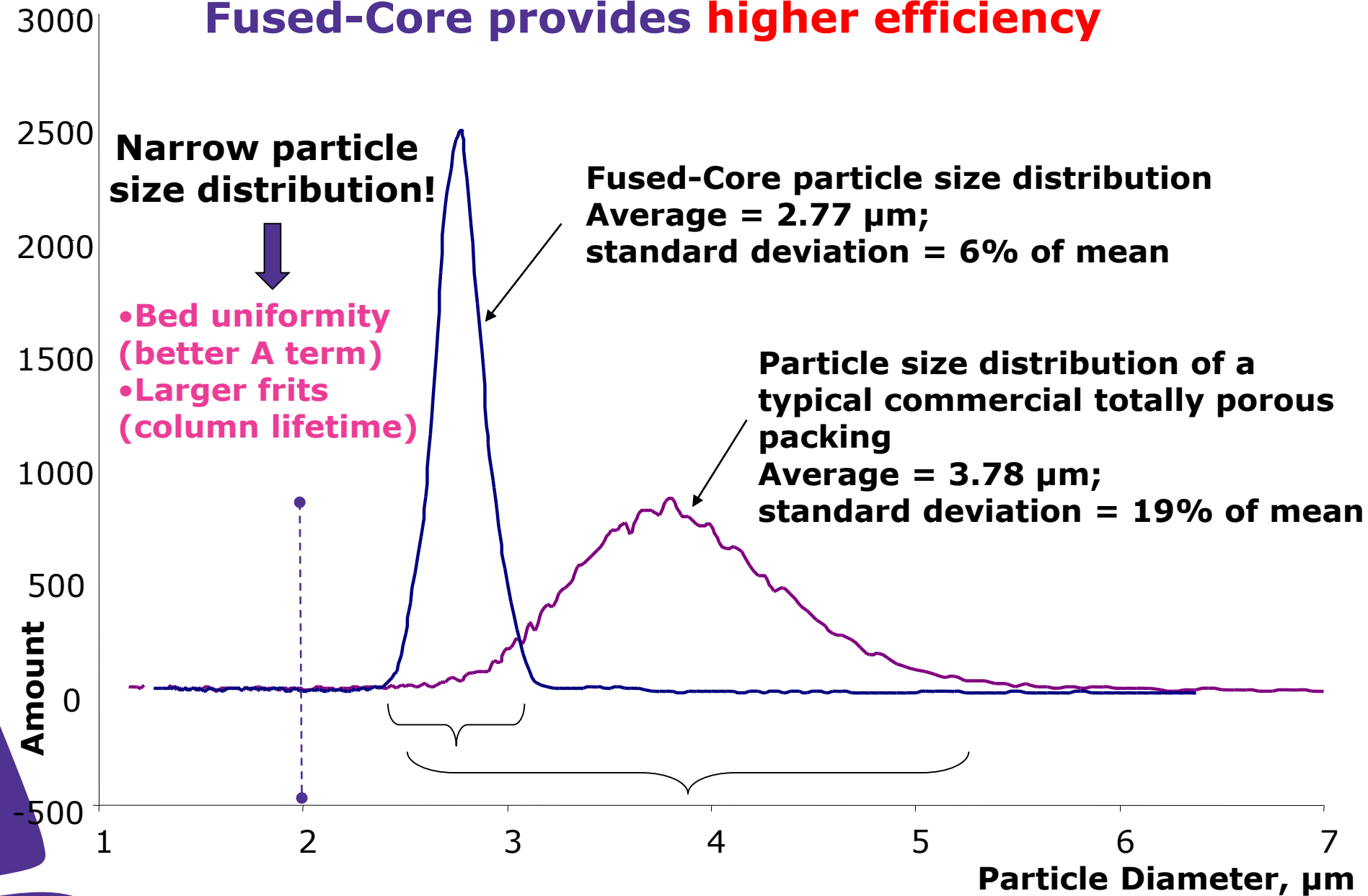
Narrow particle size distribution!



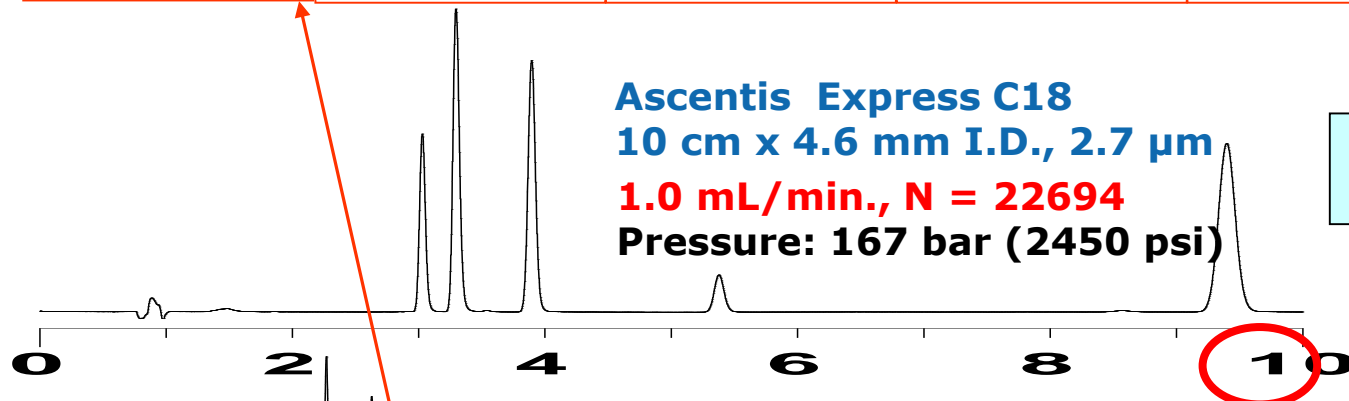
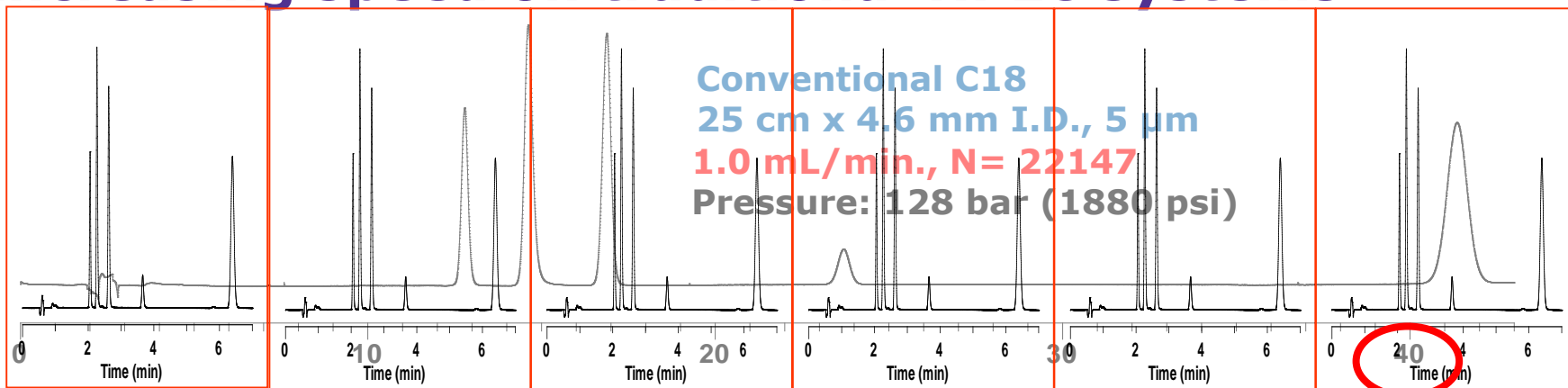
- Bed uniformity (better A term)
- Larger frits (column lifetime)

Fused-Core particle size distribution
Average = 2.77 μm ;
standard deviation = 6% of mean

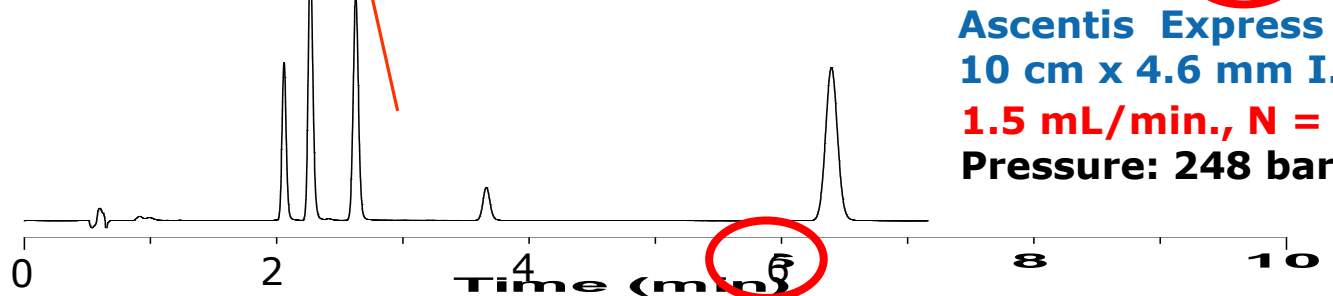
Particle size distribution of a typical commercial totally porous packing
Average = 3.78 μm ;
standard deviation = 19% of mean



Increasing speed on traditional HPLC systems*



Requirement on
method: N > 20.000



*Agilent 1100
HPLC System

Same efficiency compared to sub 2 μ m particles

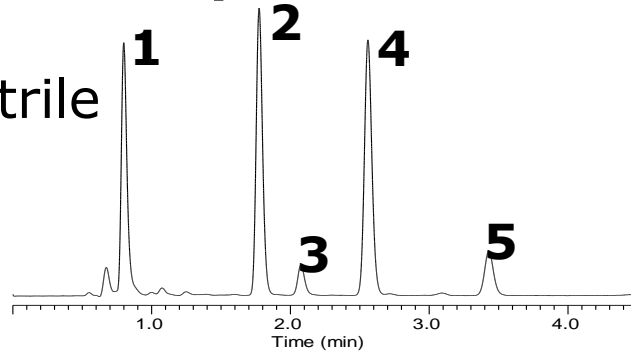
2.7 μ m Ascentis Express C18

0.3 mL/min

45 % acetonitrile

2130 psi

N = 12,500



Mobile Phase:

water : acetonitrile;
isoelutropic for β -
Estradiol

**Columns: 100 x 2.1
mm**

Flow: 0,3 mL/min

Det: 200 nm

Inj: 1 μ L

Elution order:

1. Estriol
2. β -Estradiol
3. Contaminant
4. Estrone
5. Estrone degradant

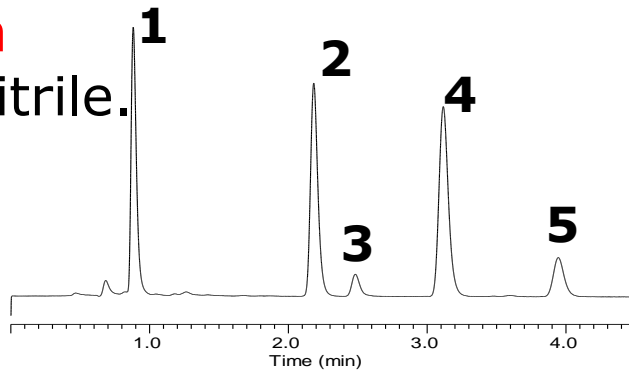
Sub-2 μ m column C18

0.3 mL/min

51 % acetonitrile.

7000 psi

N = 12,170



Fused-Core Milestones - Pioneering the Particles

2007: First 2.7 μm FC particles to achieve efficiencies $>250,000$ N/m

- Efficiencies comparable to sub-2 μm particles
- Pressure drop (flow resistance) comparable to 3 μm particle columns

2012: 5 μm FC particles to achieve efficiencies $>150,000$ N/m

- Operate at low pressures with unsurpassed ruggedness.
- Efficiencies exceed most 3 μm particles (150,000 N/m observed routinely at low pressure)
- Pressure drop of 5 μm particle columns
- Designed for traditional instruments & routine methods.

2014: 2.0 μm FC particles for superior performance in UHPLC

- Outperforms fully porous sub-2 μm particles in efficiency
- Perfect balance of pressure and performance
- Based on Fused-Core particle design geared toward maximizing performance of UHPLC systems

Ascentis Express Fused-Core Particles

NEW!

2.0 μm
Fused Core

The Best Fused Core UHPLC Column

Higher efficiencies than sub-3 μm SPP

Overcomes disadvantages of sub-2 μm FPPs

2.7 μm
Fused Core

FAST HPLC on ANY SYSTEM

A practical solution that delivers UHPLC performance from any HPLC instrument

5 μm
Fused Core

THE LAB-WORK HORSE COLUMN

True plug and play solution for improving existing 3 or 5 μm porous particle HPLC columns

Fused-Core Technology for Proteins/Peptides

BIOshell[™]
U/HPLC Columns

2.7 μm
Fused Core

*Peptide C18, CN
and Glycan*

3,4 μm
Fused Core

Protein C4 and C18

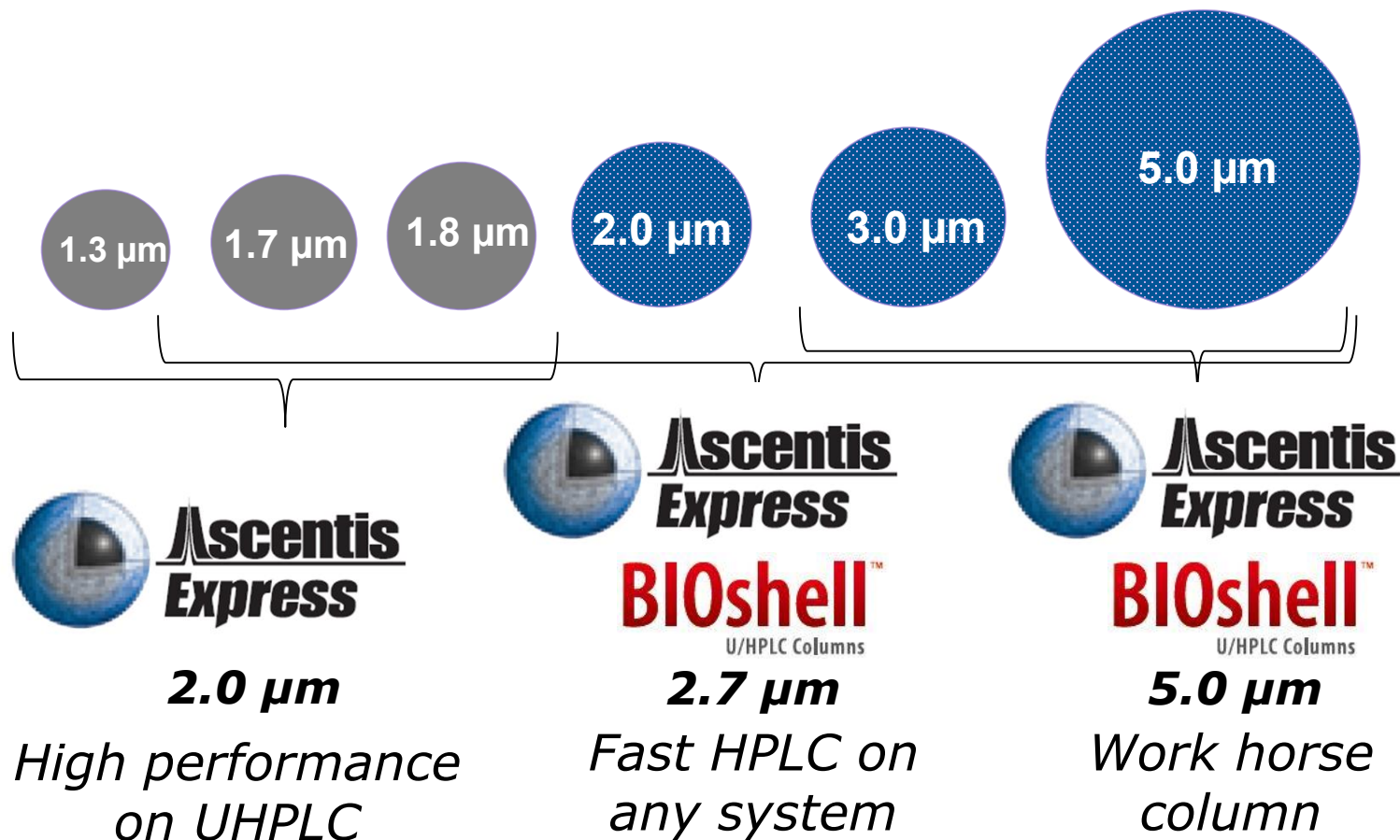
5 μm
Fused Core

Peptide C18 and CN

Which particle size for which approach?

UHPLC

HPLC



Ascentis Express Fused-Core HPLC Phases

5.0µm	2.7 µm	2.0 µm	Phase type
C18	C18	C18	Non-polar (RP)
C8	C8	C8	Non-polar (RP)
	Biphenyl		Non-polar (RP)
Phenyl-Hexyl	Phenyl-Hexyl	Phenyl-Hexyl	Non-polar (RP)
RP-Amide	RP-Amide	RP-Amide	Medium/high polarity
F5	F5	F5	Medium/high polarity
ES-Cyano	ES-Cyano	ES-Cyano	Medium/high polarity
OH5	OH5	OH5	HILIC
HILIC (silica)	HILIC (silica)	HILIC (silica)	HILIC

**Broadest offering of stationary phases
on Fused-core (and all core-shell) particles!**

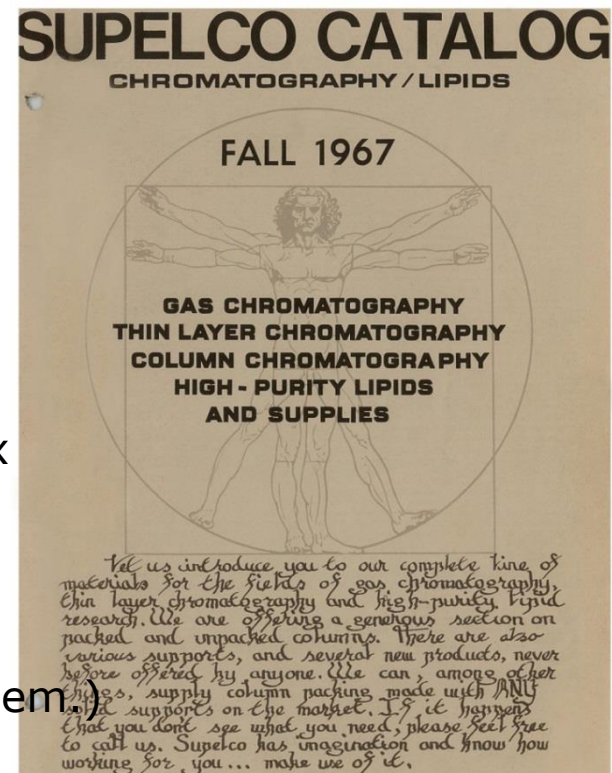
O2

GC

MERCK

Supelco GC Product History

- 1983 – SP-2560: 1. Special Column (FAMES)
- 1984 – SPB-608: 1. Special Column (Pesticide/PCBs)
- 1984 – SUPELCOWAX 10: 1. Column with bonded Wax
- 1985 – SP-2331: 1. Special Column (Dioxins)
- 1986 – VOCOL: 1. Special Column (VOCs)
- 1987 – Sup-Herb: 1. Special Column (Herbicides)
- 1988 – Petrocol DH: 1. Spec. Column (100 m, Petrochem)
- 1989 – Petrocol DH 150: 1. Column with 150 m
- 1989 – Petrocol 2887: 1. Special Column (ASTM D2887)
- 1990 – Omegawax: 1. Special Column (omega FAMES)
- 1991 – SPB-1 SULFUR: 1. Special Column (Sulfur comp.)
- 1993 – SAC-5: 1. Special Column (free sterols)
- 1994 – Carboxen-1006 PLOT: 1. Carboxen PLOT Column
- 2008 – SLB-IL100: 1. Column with ionic liquids
- 2010 – SLB-IL111: 1. Column with highest polarity



Supelcos Offering

GC Columns – Product Lines

- Over **80** different column chemistries (non-chiral and chiral)
- Each with a different combination of retention mechanisms (**selectivity**)
- Can serve many **industries** and **applications**
- Strengths
 - Highly polar columns
 - Application-specific columns
- Supelcos **Ionic Liquid GC columns** represent a new column platform
- Benefits
 - Unique **selectivity**
 - Better phase **stability**



Visit sigma-aldrich.com/gc-columns for more information.

Highlight GC Columns by Supelco

SLB-5ms

- General use, very low bleed column, but at a very competitive price

SP-2331

- SP-2331 is one of the benchmark columns for dioxin analysis

SPB-Octyl

- SPB-Octyl is one of the few columns that can separate most PCB congeners

Petrocol DH series

- Benchmark columns for this application
- Many retention index libraries are based on these columns

PLOT columns

- Supelco offers some of the best PLOT columns in the world
- In particular, the Carboxen-1010 PLOT (only column to separate oxygen, nitrogen, and carbon dioxide)

Highlight GC Columns by Supelco

SP-2560

- SP-2560 is the benchmark column for the separation of cis/trans FAME isomers

SUPELCOWAX 10

- Highest maximum temperature (280 °C) of any PEG phase column

Omegawax

- Omegawax is the benchmark column for the separation of omega 3 and omega 6 FAMES

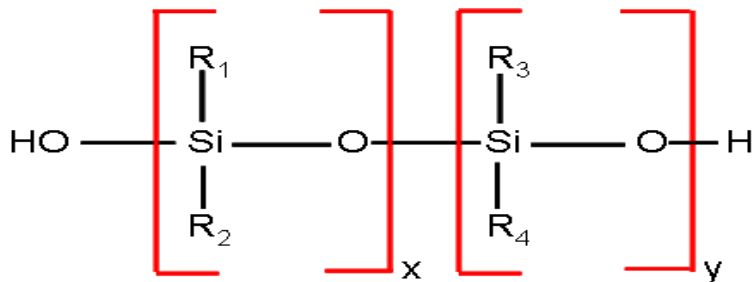
Astec CHIRALDEX, Supelco DEX

- For separation of enantiomers
- 25 unique specialized phases that incorporate derivatized cyclodextrins
 - Broad range of selectivities
 - Likely we offer a column to perform any enantiomeric GC separation

Overview

Example Structures of Non-Ionic Liquid Phases

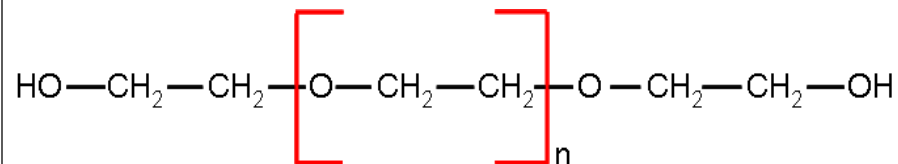
Polysiloxane Polymers (1952)



Drawbacks

- Active hydroxyl (-OH) groups at polymer termini allow a back-biting reaction
 - Results in phase degradation
 - Contributes to column bleed
- Chemistry modifications are limited to pendent group changes

Polyethylene Glycols (~1956)



Drawbacks

- Active hydroxyl (-OH) groups at polymer termini allow a back-biting reaction
 - Results in phase degradation
 - Contributes to column bleed
- Very limited chemical modifications possible
- Limited to 280 °C maximum temperature

R = methyl, phenyl, fluoropropyl, and/or cyanopropyl (listed from least polar to most polar).


x,y = percentage in the overall polymer composition.

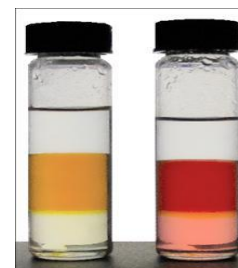
n = number of monomer repetitions to make the overall polymer.

Most recent technology development

Ionic Liquid (IL) GC Columns

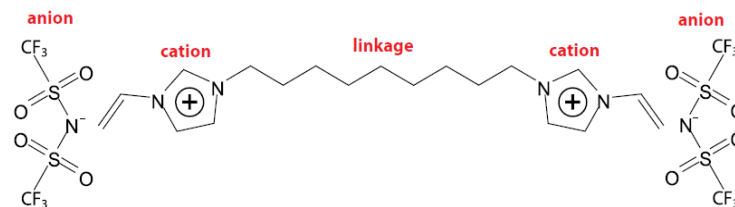
- Ionic Liquids are the **newest phase type** in GC
- They are **unique** to Merck/Sigma-Aldrich
- Properties that make them desirable as GC stationary phases
 - remain **liquid over a wide temperature range** (Room Temperature→350°C)
 - **highly polar** nature (exceed polarity range of common polymeric phases)
 - **broadest range of solvation interactions** of any known solvent
 - good **thermal stability**
 - easily tailored to provide **different polarities/selectivities**
- **Unique selectivity & polarity** enabling separations not possible with traditional phases

- Product line: 
 - **SLB-IL** columns
 - **Newest addition, Option for GC**
 - Watercol – GC columns for water determination
 - i-Series – selectivity & inertness



Water
Ionic Liquid
CHCl₃

Source: Prof. Jared Anderson, University of Toledo, USA



Example: SLB-IL100
1,9-di-(3-vinyl-imidazolium) nonane bis(trifluoromethyl) sulfonyl imidate

- SLB-IL59 - (3)
- SLB-IL60 - (7)
- SLB-IL61 - (3)
- SLB-IL76 - (3)
- SLB-IL82 - (3)
- SLB-IL100 - (7)
- SLB-IL111 - (6)
- SLB-ILD3606 - (3)

GC Column Polarity Scale

Description of our Procedure

- Each column is characterized with a series of five probes plus several n-alkane markers to determine the retention index for each probe
 - Benzene
 - Butanol
 - 2-Pentanone
 - Nitropropane
 - Pyridine
- McReynolds Constants are then calculated using the retention index data of the column relative to the retention index data for the same five probes on squalane, the most non-polar GC stationary phase
- The five McReynolds Constants are summed to obtain Polarity (P) values, which are then normalized to SLB-IL100 (set at P=100) to obtain Polarity Number (P.N.) values

Our procedure was proposed by Prof. Luigi Mondello (University of Messina, Italy).

GC Column Polarity Scale

Experimentally Determined Polarity Numbers

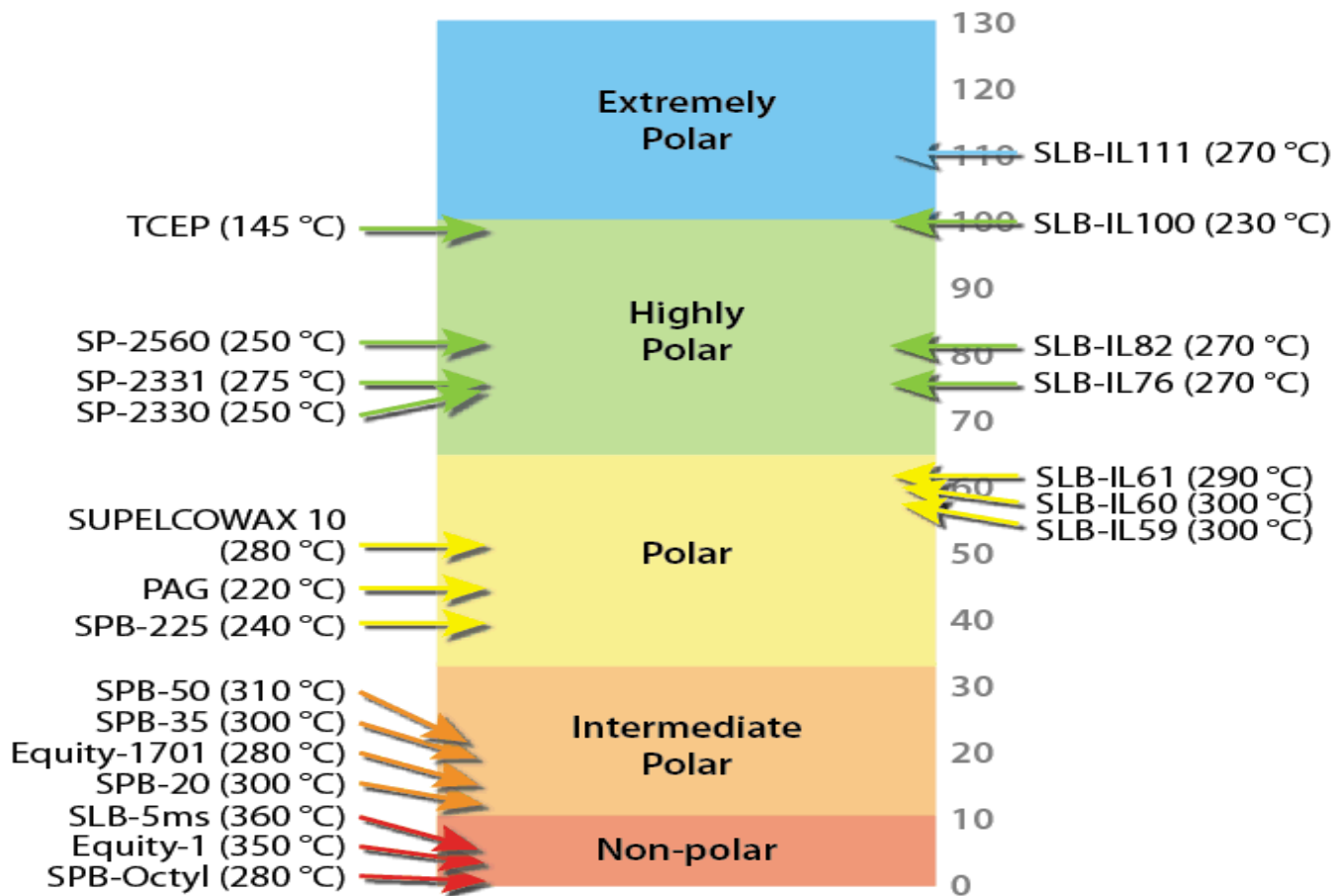
Column	McReynolds Constants					P	P.N.
	Benzene	n-Butanol	2-Pentanone	Nitropropane	Pyridine		
SPB-Octyl	17	-20	6	19	6	28	1
Equity-1	11	10	33	60	16	130	3
SLB-5ms	33	30	55	91	43	252	6
SPB-20	76	79	104	167	109	535	12
Equity-1701	82	131	150	233	136	732	16
SPB-35	175	113	151	225	175	839	19
SPB-50	154	134	176	266	218	948	21
SPB-225	233	342	342	501	375	1793	40
PAG	276	459	320	508	428	1991	45
SUPELCOWAX 10	334	509	375	601	505	2324	52
SLB-IL59	338	505	549	649	583	2624	59
SLB-IL60	362	492	525	679	564	2622	59
SLB-IL61	371	551	516	624	648	2710	61
SP-2330	469	663	608	859	712	3311	75
SLB-IL76	456	690	643	845	745	3379	76
SP-2331	495	674	622	856	735	3382	76
SP-2560	510	724	652	913	773	3572	81
SLB-IL82	532	676	701	921	808	3638	82
TCEP	622	871	772	1072	957	4294	97
SLB-IL100	602	853	884	1017	1081	4437	100
SLB-IL111	766	930	957	1192	1093	4938	111

P (Polarity) = sum of the first 5 McReynolds Constants.

P.N. (Polarity Number) = Polarity (P) normalized to SLB-IL100 (set at P=100).

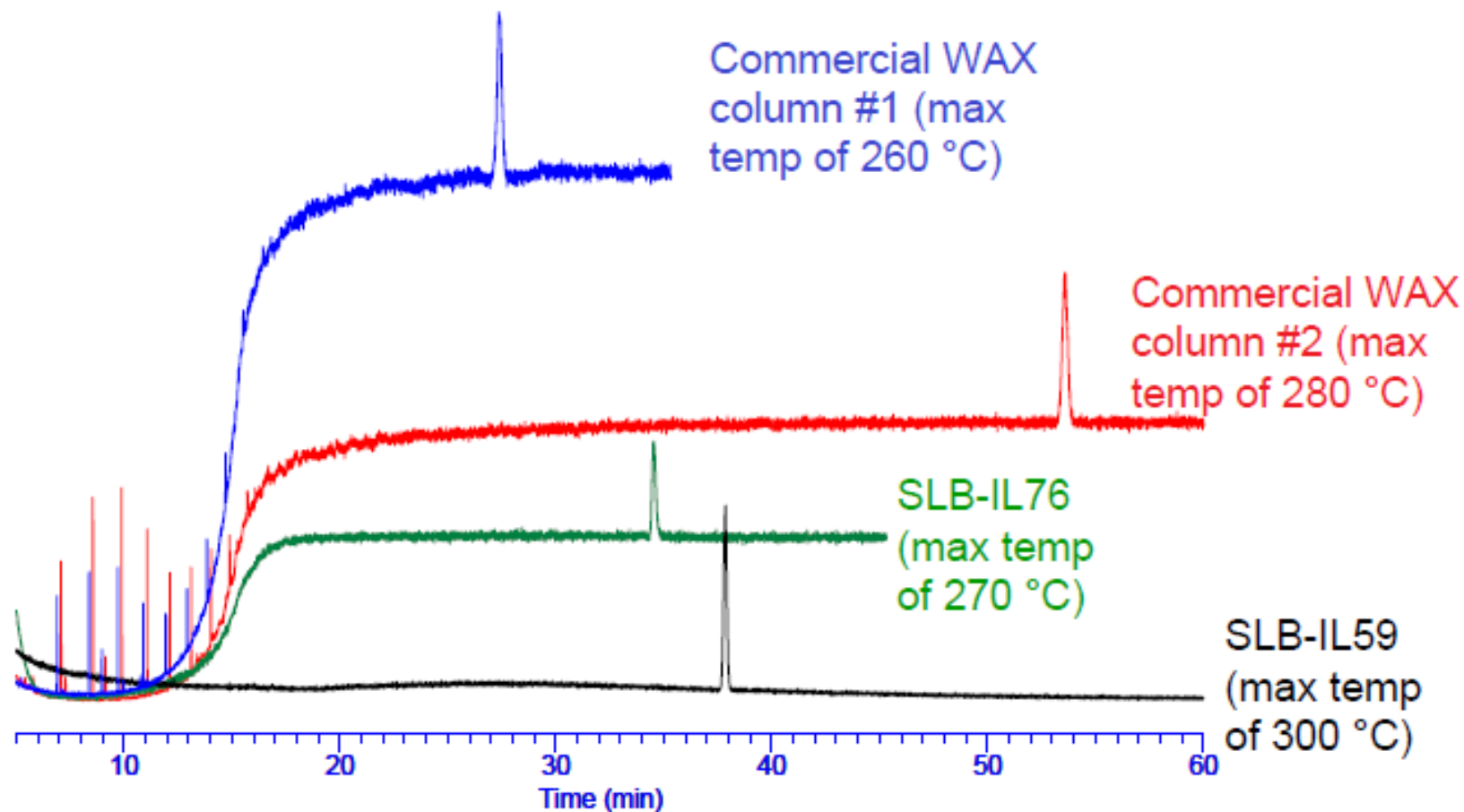
GC Column Polarity Scale

Visual Representation



**On the left: Position/Maximum temperature classical GC phases.
On the right: Position/Maximum temperature of Ionic Liquid GC phases.**

Comparison of GC-MS TIC Bleed



All TICs are on the same Y-scale

Mass Spectrum of Chrysene

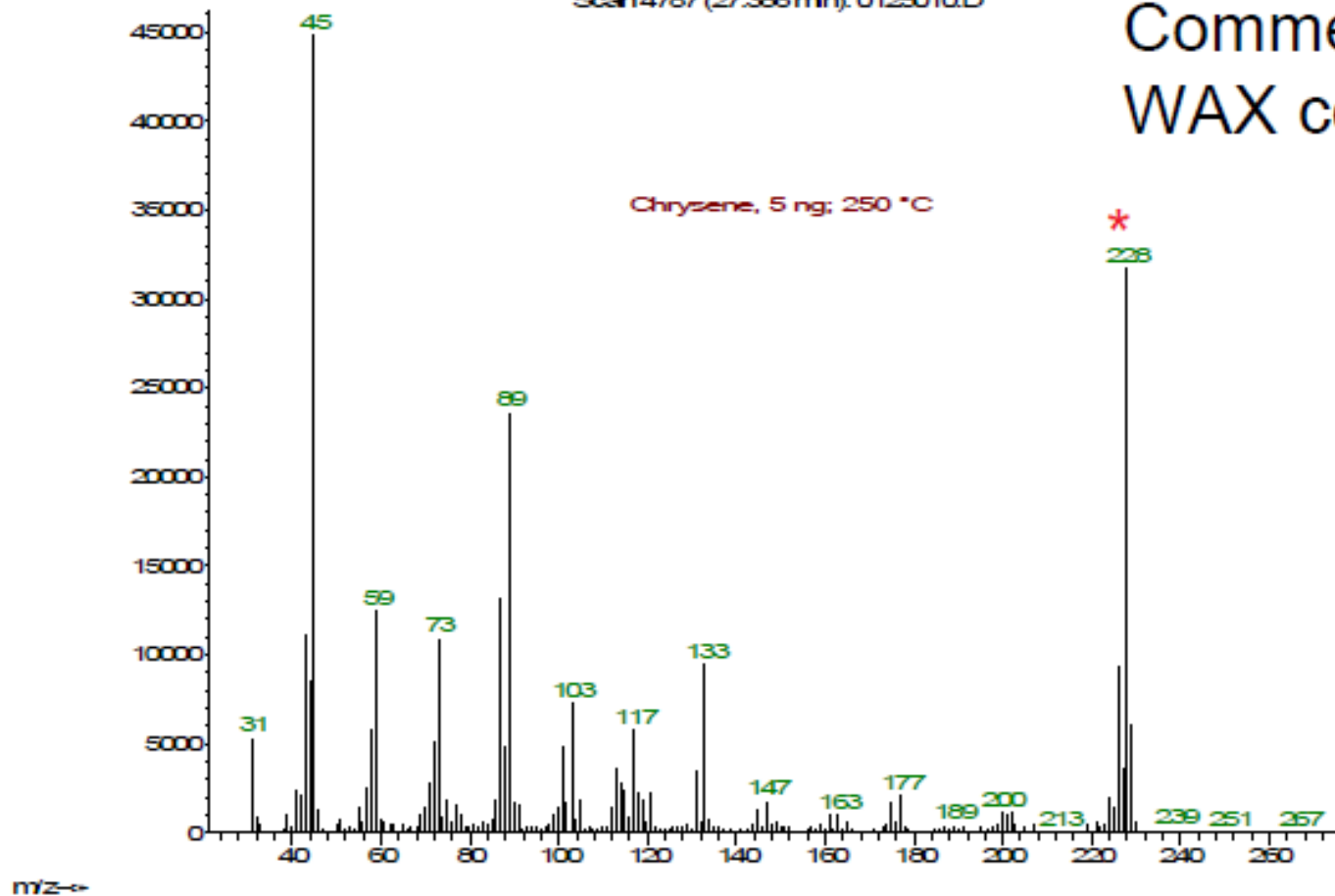
5 ng on-column, Wax column, 250 °C

Abundance

Scan 4787 (27.386 min): 0125010.D

Commercial
WAX column #1

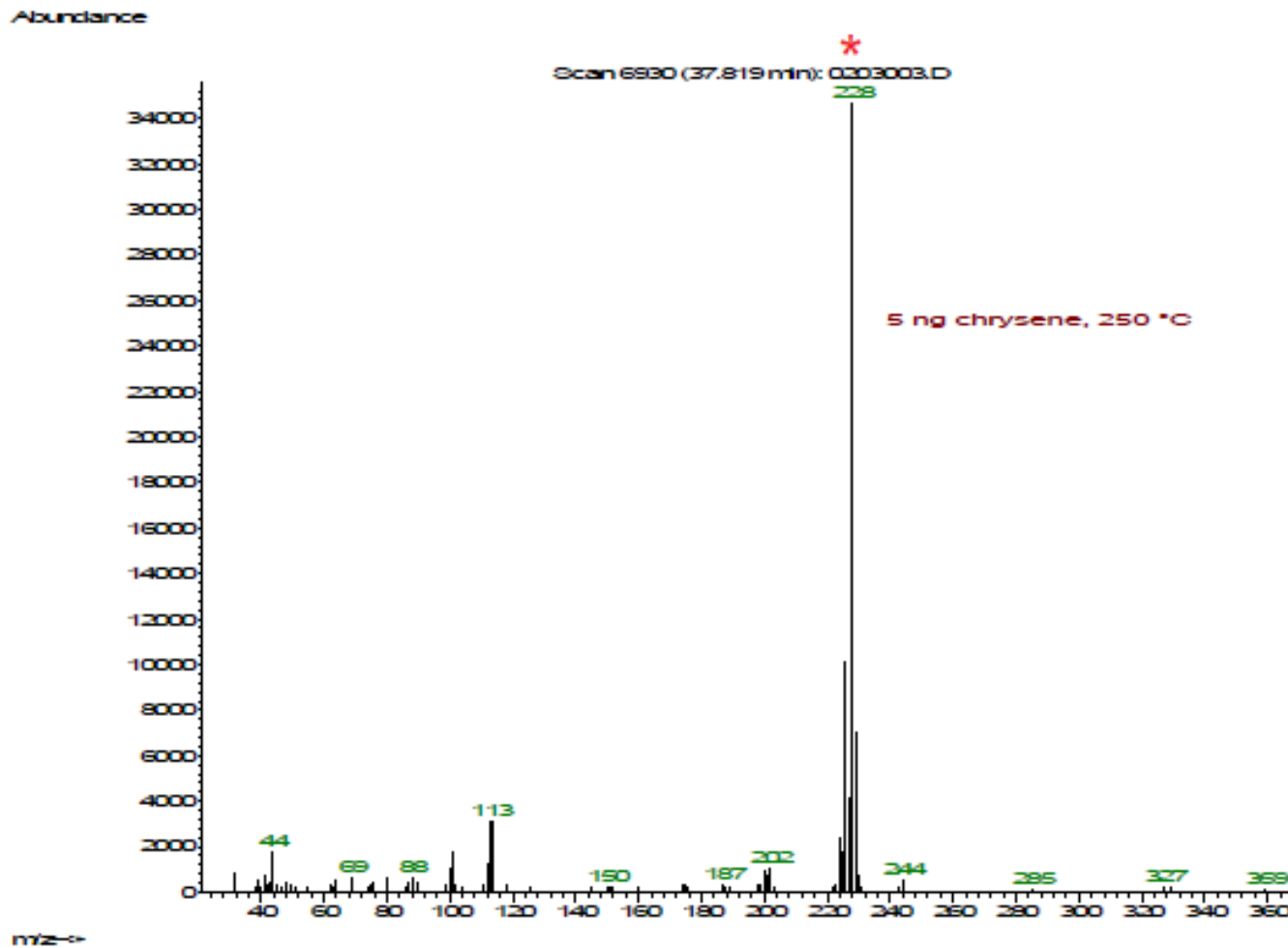
Chrysene, 5 ng; 250 °C



* Base peak in spectrum of chrysene

Mass Spectrum of Chrysene

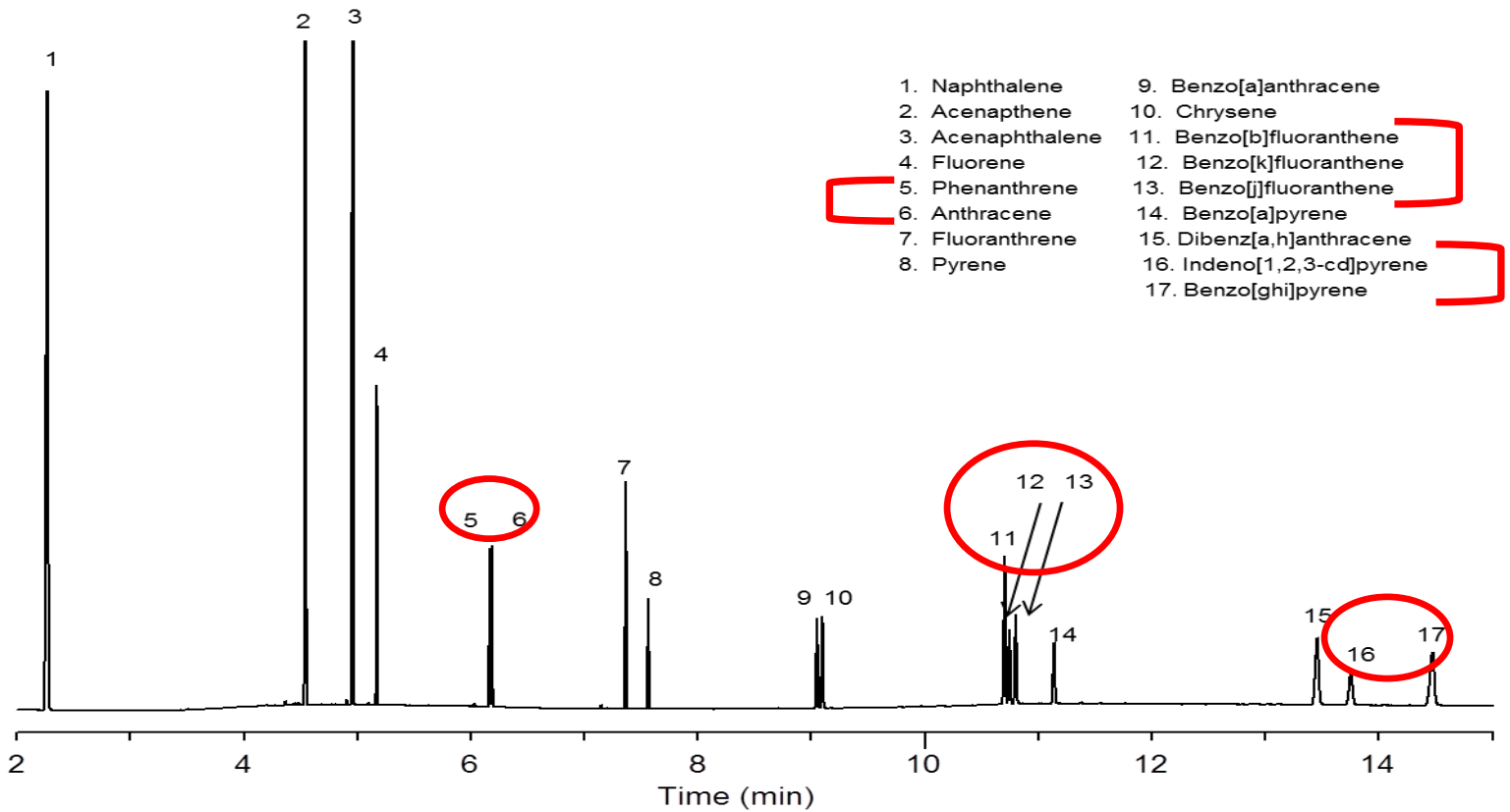
5 ng on-column, SLB-IL59, 300 °C



* Base peak in spectrum of chrysene

SLB IL-PAH

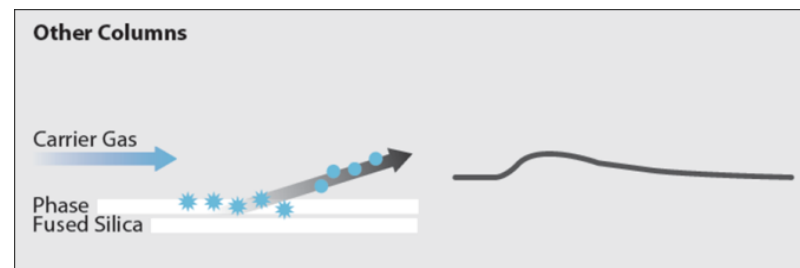
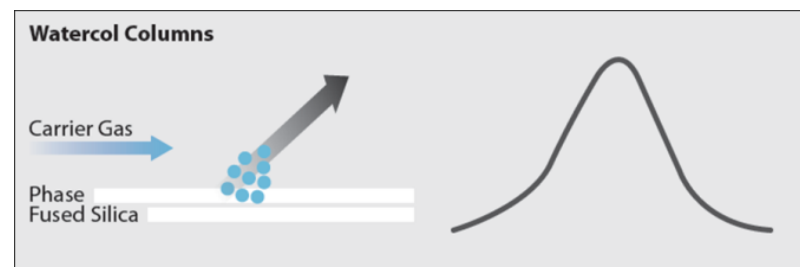
Selectivity and inertness to separate the PAHs specified under EFSA PAH4 with faster analysis time



Watercol™ -GC Columns



- Contain innovative ionic liquid stationary phases
 - highly polar but stable vs. water
 - produce a **sharp peak shape for water** providing:
- **Qualitative and Quantitative Measurement of Water with GC** (With appropriate detector like TCD, BID, MS, VUV)
- Show narrow peak widths and optimal peak heights also for many other small polar analytes.



Water determination with a GC is a new routine use option of a GC Instrument

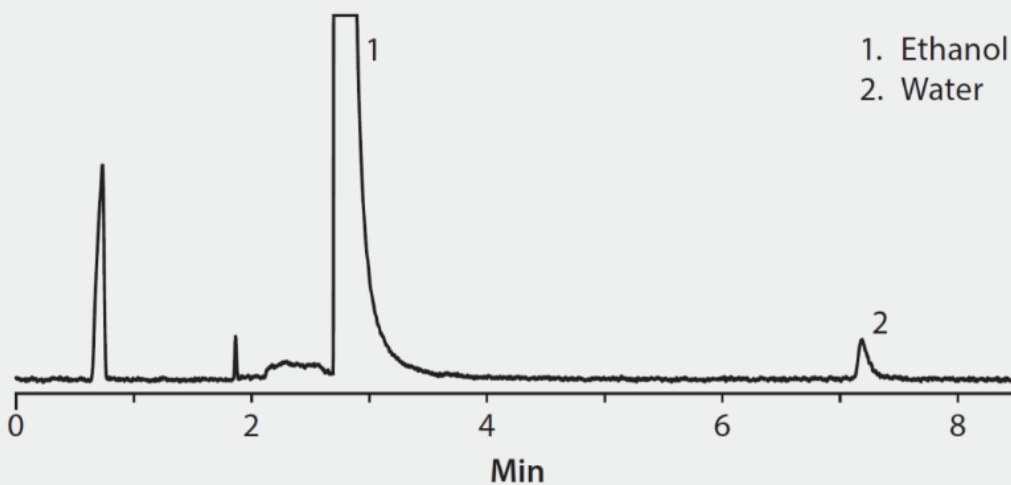
sigma-aldrich.com/watercol

Water Determination with Watercol 1910

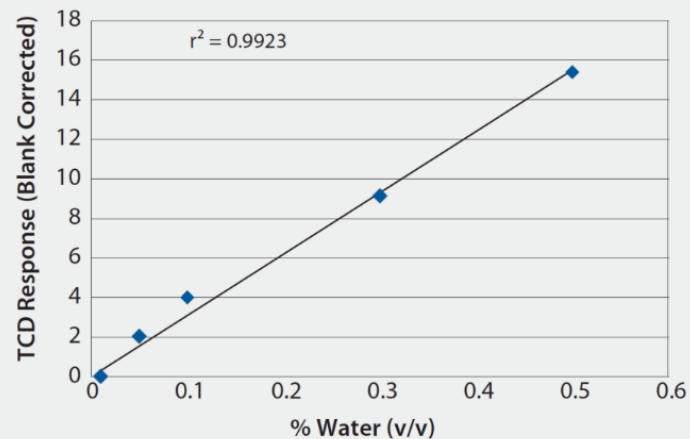
Watercol – Water determination with GC



column: Watercol 1910, 30 m × 0.25 mm I.D., 0.20 μm (29711-U)
oven: 80 °C (10 min)
inj. temp.: 250 °C
detector: TCD, 200 °C
carrier gas: helium, 26 cm/sec
injection: 0.5 μL, 100:1 split
liner: 4 mm I.D., split type, cup design
sample: water at 0.05% (v/v) in ethanol



sample: 5 standards, water
at 0.01, 0.05, 0.1, 0.3, and 0.5% (v/v), in ethanol



Watercol Series Capillary GC Columns

Key Benefits of a Sharp Water Peak Shape

- Measurement of water
 - qualitative and quantitative
- Linear response over a very wide range (0.01% water to 100% water)
- Great sensitivity
 - 100 ppm using a thermal conductivity detector (TCD)
 - Anticipate much better sensitivity with
 - A mass spectrometer (MS) operated in the SIM mode
 - Vacuum ultraviolet (VUV) absorption spectroscopy
 - A barrier discharge ionization detector (BID)
- Reproducibility, virtually no change in column performance over time



NOTE: The detector being used must be able to detect water.

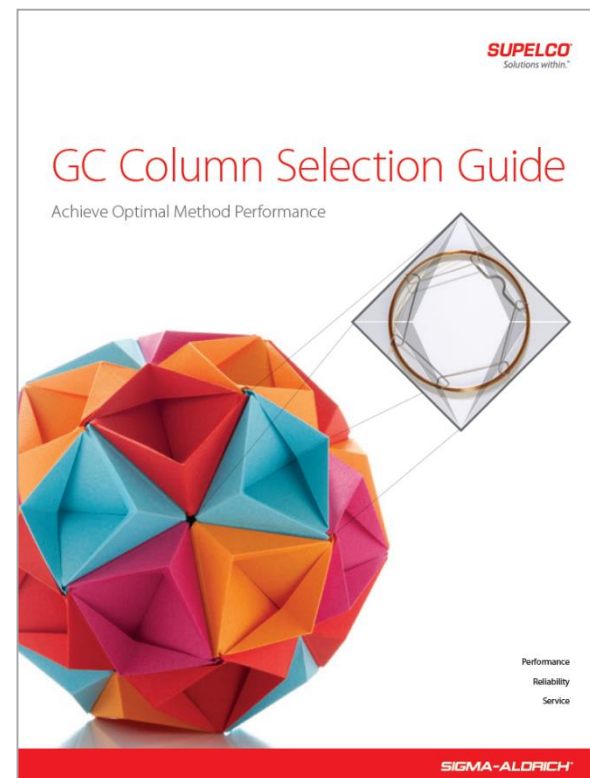
sigma-aldrich.com/watercol

Column Selection Guide (KCX)

Recommendation Page

Supelco Capillary GC Columns with Comparable Columns from Other Manufacturers

Supelco	Agilent*	Grace	Macherey-Nagel	Phenomenex*	Restek	SGE	Varian
Traditional (phases by increasing phase polarity)							
Petrocol® DH Octyl	—	—	—	—	—	—	—
SPB®-Octyl	—	—	—	—	—	—	CP-Sil 2 CB
SPB-HAP	—	—	—	—	—	—	—
Petrocol DH 50.2	DB-Petro, HP-PONA	—	—	—	—	BP1 PONA	—
Petrocol DH	DB-Petro	AT-Petro	—	—	Rtx-1PONA	BP1 PONA	CP-Sil PONA CB
Petrocol DH 150	—	—	—	—	—	—	—
Petrocol 2887, Petrocol EX2887	DB-2887	AT-2887	—	—	Rtx-2887	—	CP-SimDist
SPB-1 SULFUR	—	AT-Sulfur	—	—	—	—	CP-Sil 5 CB for Sulfur
Equity-1, SPB-1	DB-1, HP-1	AT-1	Optima-1	ZB-1	Rtx-1	BP1	CP-Sil 5 CB
SLB-5ms	DB-5ms, HP-5ms	AT-5ms	Optima-5 HS	ZB-5ms	Rtx-5Sil HS	BPX5	VF-5ms
NET-Biodiesel	—	—	—	—	HXT- BiodieselTG	—	Select Biodiesel for Triglycerides
HT-5 (aluminum clad)	DB-5ht	—	—	ZB-5ht	—	HT-5	VF-5ht
PTA-5	—	AT-Amine	—	—	Rtx-5 Amine	—	CP-Sil 8 CB for Amines
SAC™-5	—	—	—	—	—	—	—
Equity-5, SPB-5	DB-5, HP-5	AT-5	Optima-5	ZB-5	Rtx-5	BP5	CP-Sil 8 CB
SPB-6.24	DB-6.24, DB-VRX	AT-6.24	Optima-6.24	ZB-6.24	Rtx-6.24	BP6.24	CP-Select 6.24 CB
OVI-G43	HP-Fast Residual Solvent	—	—	—	Rtx-G43	—	—



Column Selection Guide (KCX)

Recommendation Page


Food and Beverage Industry

	SPB [®] -Octyl	SPB-1 SULFUR	Equity [®] -1	SLB [®] -5m.s	MET-Biodiesel	SAC [™] -5	SPB-624	VOCOL [®]	SPB-20	Equity-1701	SPB-608	SPB-35	SPB-50	SPB-225	SPB-PUFA	Nukol [™]	SPB-1000	Omegawax [®]	SUPELCO WAX [®] 10	SLB-IL59	SLB-IL60	SP [™] -2331	SP-2380	SP-2560	SLB-IL111	Chiral [†]	Carboxen [®] -1010 PLOT	Carboxen-1006 PLOT	Supel-Q [™] PLOT	Alumina sulfate PLOT	Alumina chloride PLOT	Mol Sieve 5A PLOT			
Sugars as Alditol Acetates							•		•																										
Free Fatty Acids																•	•																		
FAMES by Boiling Point Elution			•																																
FAMES by Degree of Unsaturation															•			•		•	•														
Omega 3 and Omega 6 FAMES															•			•		•	•														
cis/trans FAME Isomers																								•	•	•									
Fatty Acid Ethyl Esters (FAEEs)				•														•		•	•		•	•	•										
Mono-, Di-, Triglycerides					•																														
Sterols, Aliphatic Alcohols, Waxes					•	•																													
Amino Acids				•																							•								
Nutraceuticals, Antioxidants				•																															
Organic Acids				•												•	•		•		•														
Flavors & Fragrances, Aroma			•	•																•		•						•							
Preservatives				•																															
Pesticide Residues				•						•	•																	•							
Veterinary Drug Residues				•						•	•																								
Allergens				•																															
Dioxins, Furans, PCBs	•			•										•									•												
Phthalate Esters				•																															

Resources

Complementary Pieces

- “Applications”
 - Includes multiple chromatograms across many industry types
 - Analyte IDs and GC conditions are included in the speaker notes for most
- “Bibliography”
 - Peer-reviewed journal articles leading up to and beyond the seminal 2005 JACS (Journal of the American Chemical Society) article
 - Updated periodically



Supelco Ionic Liquid GC Columns
Applications

Updated: February 19, 2014

SUPELCO
Solutions within.

Agenda
Chromatograms
Summary / Related Products / Resources

A colorful, faceted geometric shape, possibly representing a crystal or a molecular structure, is centered on the page.



SIGMA-ALDRICH™

sigma-aldrich.com
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Tel: (800) 247-6628 (814) 359-3441 Fax: (800) 447-3044 (814) 359-3044

Supelco Ionic Liquid GC Columns: Bibliography

Updated: 5-Jan-2013

1999

1. D.W. Armstrong, L. He, and Y-S. Liu, "Examination of Ionic Liquids and Their Interaction with Molecules, When Used as Stationary Phases in Gas Chromatography" *Anal. Chem.* 71 (1999) p. 3873.

2001

2. A. Berthod, L. He, and D.W. Armstrong, "Ionic Liquids as Stationary Phase Solvents for Methylated Cyclodextrins in Gas Chromatography" *Chromatographia* 53 (2001) p. 63.

2002

3. J.L. Anderson, J. Ding, T. Welton, and D.W. Armstrong, "Characterizing Ionic Liquids on the Basis of Multiple Solvation Interactions" *J. Am. Chem. Soc.* 124 (2002) p. 14247.

2003

4. J.L. Anderson and D.W. Armstrong, "High-Stability Ionic Liquids. A New Class of Stationary Phases for Gas Chromatography" *Anal. Chem.* 75 (2003) p. 4851.

2004

5. J. Ding, T. Welton, and D.W. Armstrong, "Chiral Ionic Liquids as Stationary Phases in Gas Chromatography" *Anal. Chem.* 76 (2004) p. 6819.

2005

6. J.L. Anderson and D.W. Armstrong, "Immobilized Ionic Liquids as High-Selectivity/High-Temperature/High-Stability Gas Chromatography Stationary Phases" *Anal. Chem.* 77 (2005) p. 6453.
7. M. Koel, "Ionic Liquids in Chemical Analysis" *Crit. Rev. Anal. Chem.* 35 (2005) p. 177.

Both pieces can be downloaded from <sigma-aldrich.com/il-gc-lit>.

Summary Ionic Liquid GC

GC phases based on Ionic Liquids:

- have a different selectivity compared to conventional phases
- allow for shorter analysis times
- provide lower bleeding and long lifetime
- Offer a broader temperature range compared to conventional polar phases
- Improve multidimensional separations (orthogonal selectivity and high thermal stability of polar phase)

03

ACCESSORIES

GC Accessories

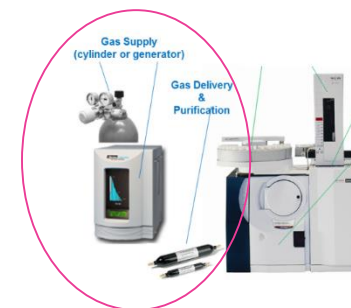
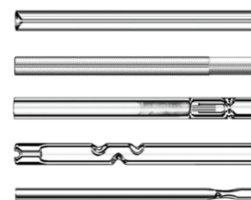
Besides packed and capillary GC columns we offer a **comprehensive range of GC accessories** around the instruments:

GC Instrument Accessories

- Liner, Injector Septa, Ferrules, Fittings
- Syringes, Vials

Gas Management

- Gas Generators, Gas Purifiers
- Tubing, Valves & Pressure Regulators, Flow Meter



sigma-aldrich.com/gc

Accessories: Syringes from Leading Manufactures

- Syringe is the introduction of the sample into the GC Injector port

Syringes from Leading Manufactures

- Hamilton
- SGE
- VICI Precision Sampling



In Supelco Catalog are more than 30 pages for syringes and spare parts

Vials: Compatibility with Autosampler

<http://www.sigmaaldrich.com/analytical-chromatography/analytical-products.html?TablePage=17533773>

Popular Autosampler Vials by Instrument

	Glass	Features	Cat. No.	Pk. Size	Page	Agilent 1050/1090	Agilent 1100	Agilent 7673A, Series I, II	CTC LC PAL	CTC GC PAL	Merck/Hitachi, AS/4000	PerkinElmer Autosystem and Clarus 500	PE ISS-100, 200, Integral 4000 and Series 200	Shimadzu GC Autosamplers
Crimp Top Vials														
6 x 32 mm	clear	tapered bottom	27283	100	19			✓		✓				
7 x 30 mm	amber	conical	27312	200	19			✓						
7 x 32 mm	amber	round bottom	27314	100	19			✓						
7 x 40 mm	amber	conical bottom	24744	100	19									
8 x 40 mm	clear	flat bottom	33321U	200	20									
12 x 32 mm	clear	PTFE/red rubber	29124-U	100	17	✓	✓	✓	✓	✓	✓	✓	✓	✓
	clear	PTFE/silicone	29125-U	100	17	✓	✓	✓	✓	✓	✓	✓	✓	✓
	amber	PTFE/red rubber	29127-U	100	17	✓	✓	✓	✓	✓	✓	✓	✓	✓
	amber	PTFE/silicone	29128-U	100	17	✓	✓	✓	✓	✓	✓	✓	✓	✓
Screw Thread, 12 x 32 mm														
Certified Vials, 9 mm thread	clear	PTFE/silicone	29381-U	100	6	✓	✓	✓	✓	✓	✓			✓
	clear	PTFE/Silicone w/slit	29384-U	100	6	✓	✓	✓	✓	✓	✓			✓
	amber	PTFE/silicone	29386-U	100	10	✓	✓	✓	✓	✓	✓			✓
	amber	PTFE/Silicone w/slit	29387-U	100	10	✓	✓	✓	✓	✓	✓			✓
Center Drain Vials	clear	PTFE/silicone	29307-U	100	13	✓	✓	✓	✓	✓	✓			✓
	clear	PTFE/Silicone w/slit	29309-U	100	13	✓	✓	✓	✓	✓	✓			✓
	clear	PTFE/silicone/PTFE	29308-U	100	13	✓	✓	✓	✓	✓	✓			✓
	amber	PTFE/silicone	29313-U	100	13	✓	✓	✓	✓	✓	✓			✓

Accessories: Vial Accessories

- There are always some easy to sell items coming with this product group:



CRIMP the vials!



Glass „Magnet“ Holder –
Don't work without it!



Take the cap off the vial!



Stack and Store them!

Gas Supply

Product Areas

- **Gas generation**

- Gas generators, air compressors

- **Gas delivery**

- **Gas purification**

- Polishing purifiers, contaminant traps (remove hydrocarbons, moisture, oxygen, carbon dioxide), gas purifiers (clean helium), filters (remove particles, oil)

- **Gas management & delivery**

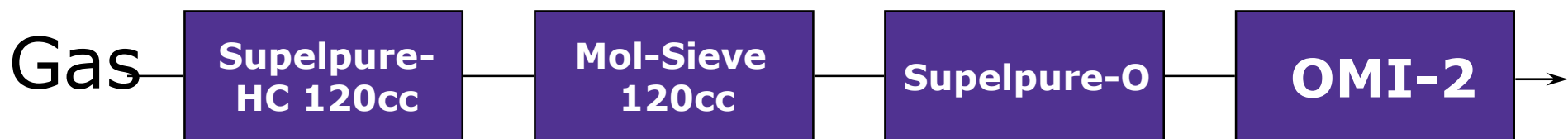
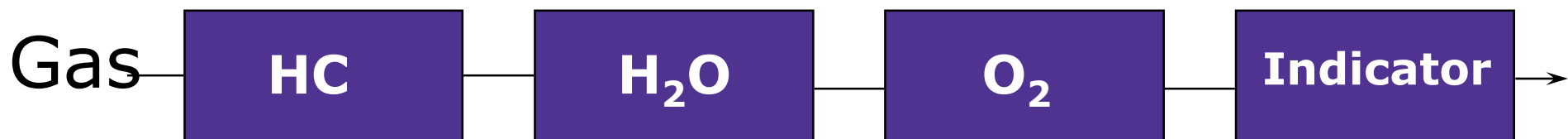
- Pressure regulators, flow regulators, leak detectors,
- Tubing, cutters, reamers, benders, fittings, shutoff valves



Visit sigma-aldrich.com/gaspurifiers for more information.

sigma-aldrich.com/gc

Carrier gas: What needs to be removed? Which order?



Purifier types – In Line

Gas Supply



HC Supelpure
Hydrocarbon Traps



O₂ Supelpure-O
Oxygen /Water Trap HC

O₂
H₂O
Indic.

OMI Indicating



Oxygen
Moisture
Indicator

High Capacity Purifier
Moisture, Oxygen, CO, CO₂

O₂
H₂O



Alternatively
instead of
Supelpure-O
& Molecular
Sieve 5A

H₂O Molecular Sieve 5A
Water Vapor Traps



GC Accessories Maximize Performance! Brochure

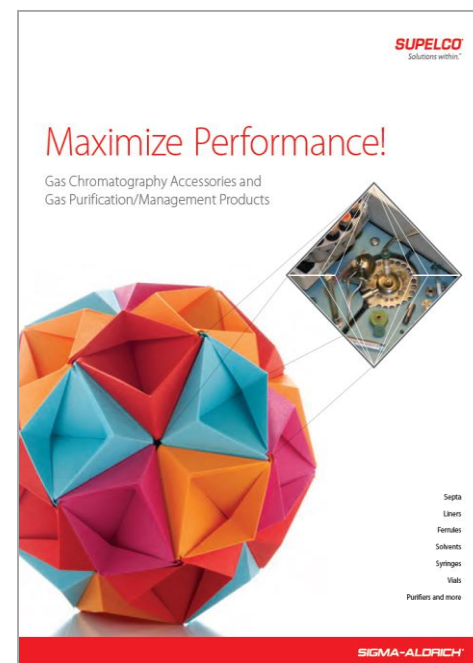
28-page, 4-color, bundling brochure

Lists common replacement items...

- Septa, liners, ferrules, solvents, syringes, vials, purifiers, and much more

for several GC makes/models

- Agilent/HP, PerkinElmer, Shimadzu, Thermo, and Varian



(JWE, T407103C)

A 'must-have' for all GC labs!

You can request hard copies through the Sigma-Aldrich literature houses.

Summary GC by product type

- GC Columns

- Packed
- Capillary
 - Common phases (e.g. SLB-5ms, SLB-35ms)
 - Special Purpose (e.g. SP-2560, SP-23131, Petrocol)
 - Ionic Liquid (Newest Technology)
 - i-Series
 - Watercol

- Accessories

- Fittings, Septa, Flow Meters, Column Installation
- Vials & Syringes
- Gas Supply & Gas Purification

- Applications

- Various fields of work (Envi, Food&Bev, Petrochem...)

Complementary products

- GC Solvents
- Sample Preparation
 - SPE, SPME, Extraction
- Standards
 - (Certified) Reference Materials
 - Proficiency testing

Thank you for your attention!



Thank you for your attention!

