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WITH ANY LC INSTRUMENT
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PEAK SHAPE
PERFORMANCE
HARDCORE
SUNSHELL
SUPERFICIALLY
POROUS SILICA
EFFICIENT

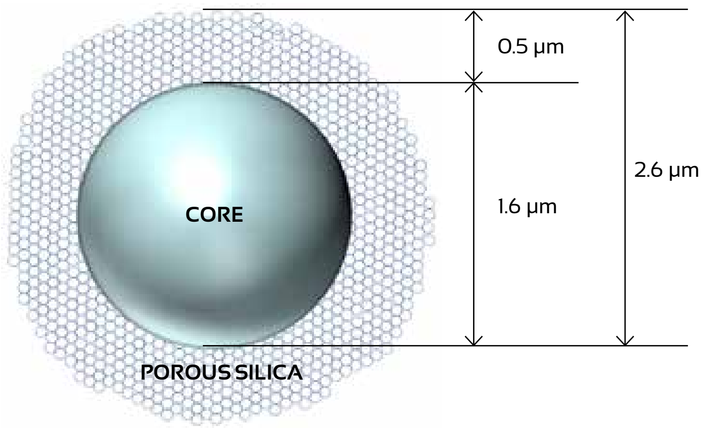
WHAT IS SUNSHELL?
THE NEXT GENERATION HARDCORE SHELL PARTICLE

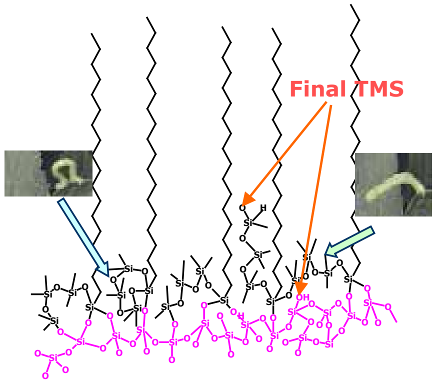
Secure your analysis with SunShell hardcore column technology

Unique bonding technology combined with core shell particles gives you faster performance and more reliable results. The SunShell technique assures top efficiency with all kinds of LC and UHPLC systems.

FEATURES OF SUNSHELL 2.6 µm AND 5 µm

. 1.6 µm and 3.4 µm of core and 0.5 µm and 0.6 µm of superficially porous silica layer.
. Same efficiency and high throughput as a Sub-2 µm and 3 µm particle.
. Same pressure as a 3 µm and 5 µm particles.
. Same chemistry as Sunniest technology (reference figure below).
. Good peak shape for all compounds such as basic, acidic and chelating compounds.
. High stability (pH range for SunShell C18, 1.5 to 10).
. Low bleeding.

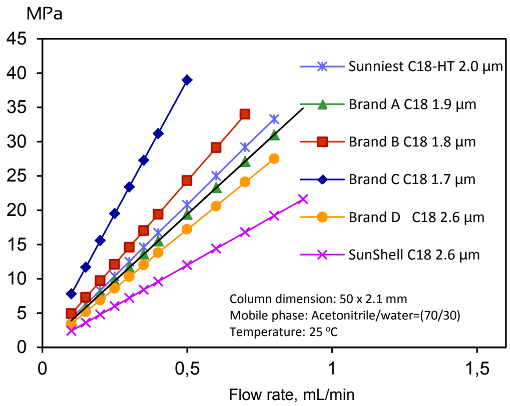




Schematic diagram of bonding of SunShell C18

SunShell C18 shows same efficiency as a Sub 2 µm C18. In comparison between fully porous 2.6 µm and core shell 2.6 µm (SunShell), SunShell shows lower values for A term, B term and C term of Van Deemter equation. The core shell structure leads to higher performance compared with the fully porous structure.

Furthermore back pressure of SunShell C18 is less than a half compared to Sub-2 µm C18s.



Comparison of back pressure for high throughput columns

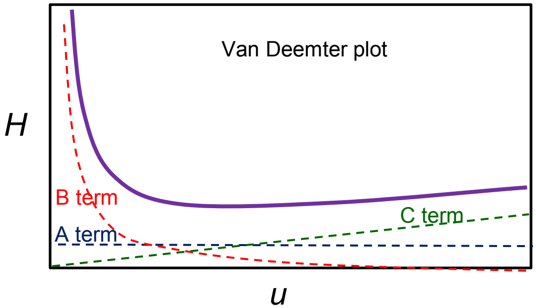
HOW DOES SUNSHELL WORK?
NARROW PARTICLE DISTRIBUTION

VAN DEEMTER **EQUATION**

Van Deemter Equation

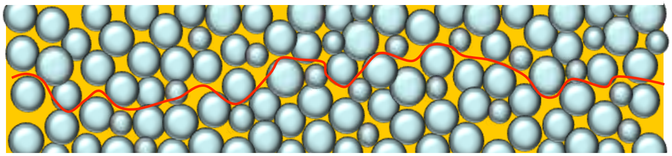
$$H = Ad_p + B\frac{D_m}{u} + C\frac{d_p^2}{D_m}u$$

A term : Eddy diffusion (dp is particle diameter)
B term : Longitudinal diffusion
(Dm is diffusion coefficient)
C term : Mass transfer

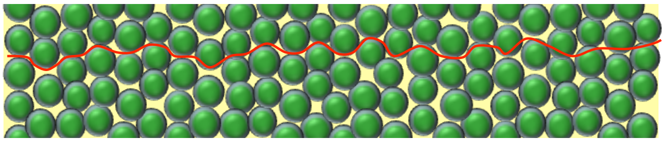


A TERM

The size distribution of a core shell (SunShell) particle is much narrower than that of a conventional totally porous particle, so that the space in between the particles in the column is reduced and efficiency increases by reducing Eddy Diffusion (multi-path diffusion) as the A term in Van Deemter Equation.



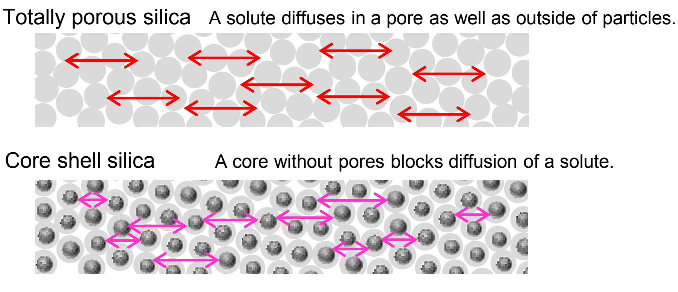
Wide particle distribution
(Conventional silica gel D_{90}/D_{10}=1.50)



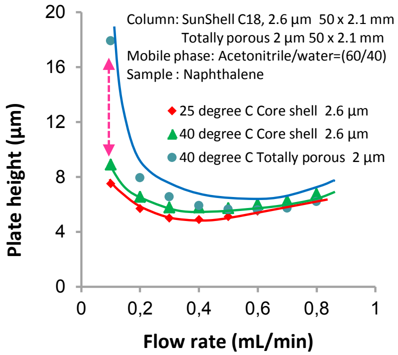
Narrow particle distribution
(Core Shell silicaD_{90}/D_{10}=1.15)

B TERM

Diffusion of a solute is blocked by the existence of a core, so that a solute diffuses less in a core shell silica column than in a totally porous silica column. Consequently B term in Van Deemter Equation reduces in the core shell silica column.

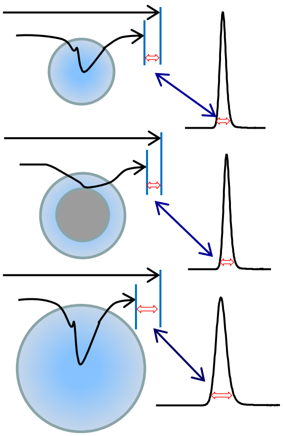


Difference in longitudinal diffusion



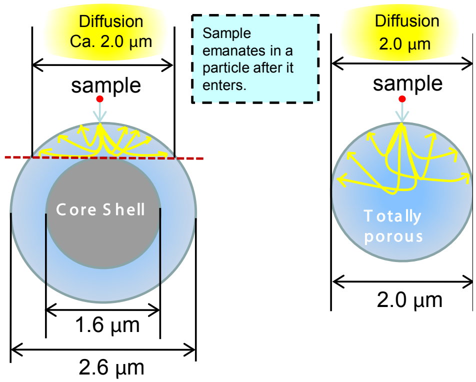
Plot of Plate height vs Flow rate

C TERM


Comparison of diffusion path

As shown in the left figure, a core shell particle has a core so that the diffusion path of samples shortens and mass transfer becomes fast. This means that the C term in Van Deemter Equation reduces. In other words, HETP (theoretical plate) is kept even if flow rate increases. A 2.6 µm core shell particle shows the same column efficiency as a totally porous Sub-2 µm particle.

The right figure shows the diffusion width of a sample in a 2.6 µm core shell particle and a 2 µm totally porous particle. Both diffusion widths are almost the same. The 2.6 µm core shell particle is superficially porous, so that the diffusion width becomes narrower than particle size. Same diffusion means same efficiency.



Diffusion of a sample in core shell and totally porous silica

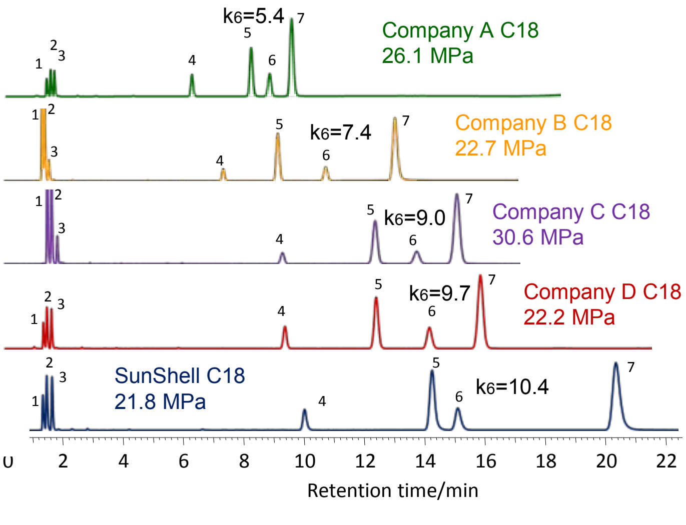
SUNSHELL

C18 - 2.6 µm

HIGHEST RETENTION / LARGEST STERIC SELECTIVITY / LOWEST BACKPRESSURE

Retention of standard samples and back pressure were compared for five kinds of core shell type C18s. Company A C18 showed only a half retention in comparison with SunShell C18. Steric selectivity becomes large when ligand density on the surface is high. SunShell C18 has the largest steric selectivity as well as the highest ligand density leading to the longest retention time.

SUNSHELL C18 **COMPARISON**

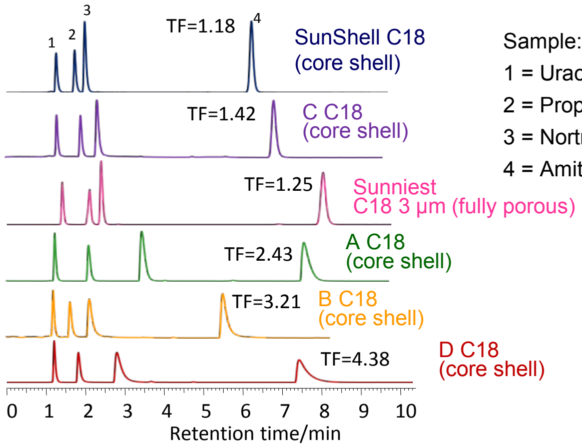


Mobile phase: CH_3OH/H_2O=75/25
Flow rate: 1.0 mL/min, Temperature: 40° C
Sample: 1 = Uracil, 2 = Caffeine, 3 = Phenol,
4 = Butylbenzene, 5 = o-Terphenyl,
6 = Amylbenzene, 7 = Triphenylene

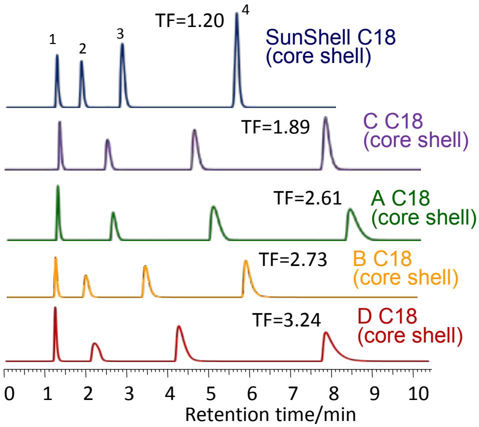
	Hydrogen bonding	Hydrophobicity	Steric selectivity
Company A C18	0.48	1.54	1.20
Company B C18	0.35	1.56	1.50
Company C C18	0.42	1.57	1.25
Company D C18	0.44	1.60	1.31
Sunshell C18	0.39	1.60	1.46

BEST PEAK SHAPE AVAILABLE

Amitriptyline overloads much more at acetonitrile/buffer mobile phase than methanol/buffer which causes tailing. Five kinds of core shell C18s were compared as refers to loading capacity of amitriptyline. Thanks to the unique bonding technology Sunshell gives extraordinary peak shape, which means better sensitivity and accuracy of the method.



Sample:
1 = Uracil (0.07µg)
2 = Propranolol (1.53µg)
3 = Nortriptyline (0.32µg)
4 = Amitriptyline (0.32µg)



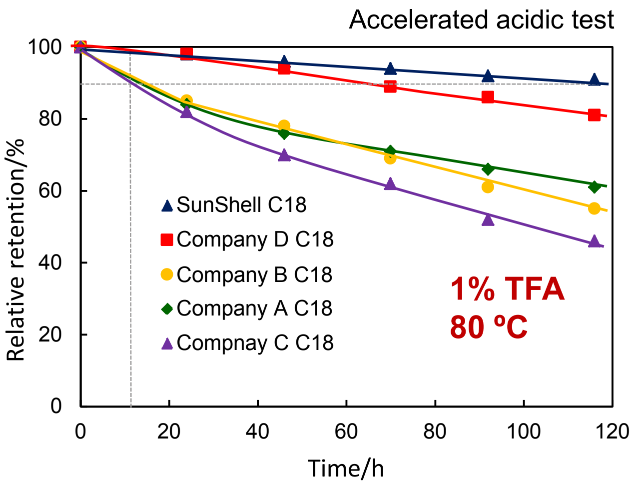
Mobile Phase:
• Acetonitrile/20 mM phosphate buffer pH 7.0 (60/40)

Mobile Phase:
• Acetonitrile/10 mM ammonium acetate pH 6.8 (40/60)

Company A C18: Kinetex C18
Company B C18: Accucore C18
Company C C18: PoroShell C18 EC
Company D C18: Ascentis Express C18

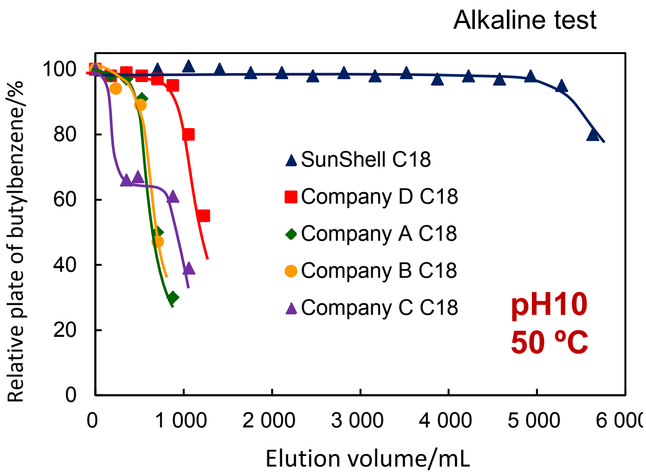
EXPANDED pH RANGE DUE TO THE SUNSHELL BONDING TECHNOLOGY

SUNSHELL C18 **STABILITY**



Durable test condition

Column size: 50 x 2.1 mm
Mobile phase: CH_3CN/1.0% TFA, pH1=10/90
Flow rate: 0.4 mL/min
Temperature: 80 ºC



Durable test condition

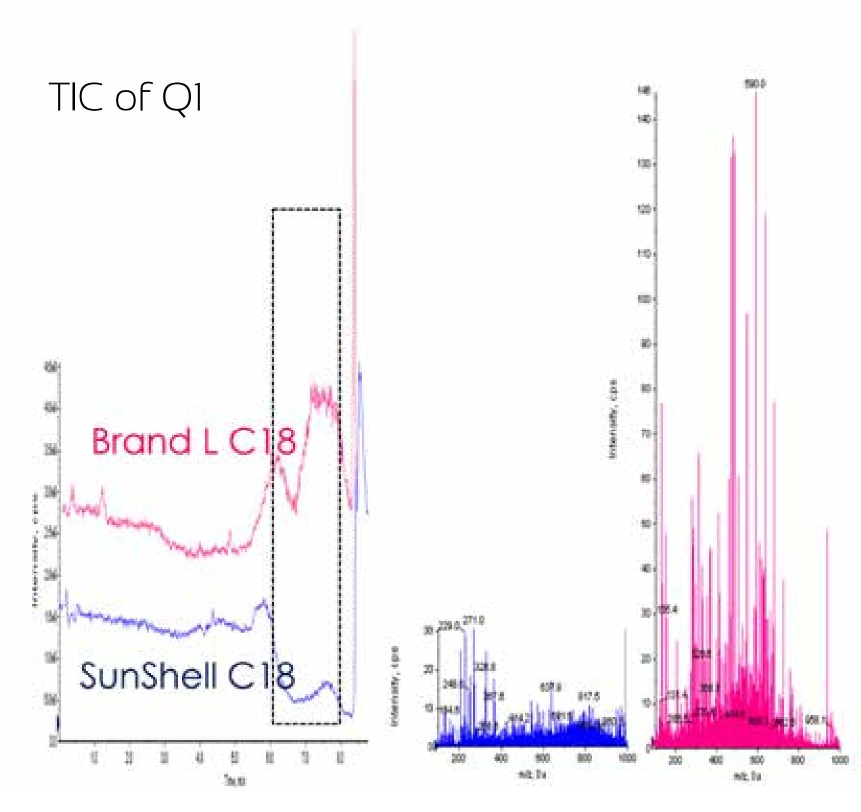
Column Size: 50 x 2.1 mm
Mobile phase:
CH_3OH/20mM Sodium borate/10mM NaOH=30/21/49 (pH10)
Flow rate: 0.4 mL/min
Temperature: 50 ºC

Stability under acidic pH condition was evaluated at 80°C using acetonitrile/1% trifluoroacetic acid solution (10:90) as mobile phase. 100% aqueous mobile phase expels from the pores of C18 packing materials by capillarity and packing materials do not deteriorate. Adding 10% acetonitrile to the mobile phase enables accurate evaluation.

Stability under basic pH condition was evaluated at 50°C using methanol/Sodium borate buffer pH 10 (30:70) as mobile phase. Sodium borate is used as an alkaline standard solution for pH meters, which allows for a high buffer capacity. Elevated temperature of 10°C reduces column life to one third. The other company shows stability when tested at ambient (room) temperature. If room temperature is 25°C, column life is sixteen times longer than at 50°C.

BLEEDING TEST USING LC/MS

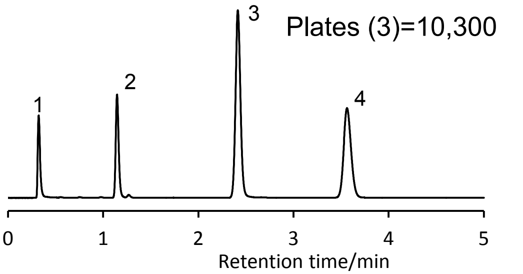
The high stability of the SunShell columns also means low bleeding in LC/MS analysis as shown here.



Column size: 50 x 2.1 mm
Mobile phase:
A) 0.1% Acetic acid
B) CH3CN
Gradient:
Time: 0min 1min 5min 7min
%B: 5% 5% 100% 100%
Flow rate: 0.4 mL/min
Temperature: 40 °C
MS: ABI API-4000 Ionization:
Turboionspray (cation)
Measurement mode:
Q1 Scan m/z 100-1000

SUNSHELL C18 **EFFICIENCY**

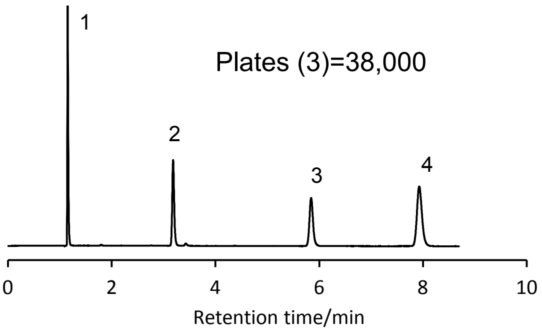
Column: SunShell C18, 2.6 µm 50 x 2.1 mm



Column: SunShell C18, 2.6 µm 50 x 2.1 mm
Mobile phase: CH_3CN/H_2O=60/40
Flow rate: 0.3 mL/min
Pressure: 7 MPa
Temperature: 23 °C
UHPLC: Jasco X-LC

Sample: 1 = Uracil
2 = Toluene
3 = Acenaphthene
4 = Butylbenzene

Column: SunShell C18, 2.6 µm 150 x 4.6 mm



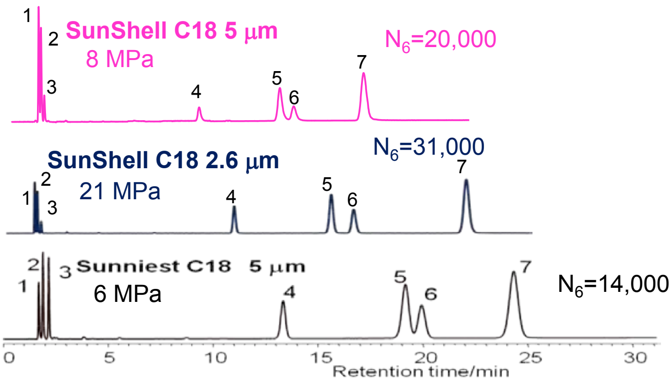
Column: SunShell C18, 2.6 µm 150 x 4.6 mm
Mobile phase: CH_3CN/H_2O=70/30
Flow rate: 1.0 mL/min
Pressure: 15.5MPa
Temperature: 25 °C
UHPLC: Jasco X-LC

EFFICIENCY = 253,000 plates/m

ORDERING INFO OF SUNSHELL	Inner diameter (mm)	1.0	2.1	3.0	4.6	USP category
	Length (mm)	Catalog no	Catalog no	Catalog no	Catalog no	Catalog no
Sunshell C18, 2.6 µm	30	---	CB6931	CB6331	CB6431	L1
	50	CB6141	CB6941	CB6341	CB6441	
	75	---	CB6951	CB6351	CB6451	
	100	CB6161	CB6961	CB6361	CB6461	
	150	CB6171	CB6971	CB6371	CB6471	
	250	---	---	CB6381	CB6481	

C18 - 5 µm

Can be used in any L1 method - but with improved performance.



Column size: 150 x 4.6 mm
Mobile phase: CH_3OH/H_2O=75/25
Flow rate: 1.0 mL/min
Temperature: 40° C
Sample: 1 = Uracil
2 = Caffeine
3 = Phenol
4 = Butylbenzene
5 = o-Terphenyl
6 = Amylbenzene
7 = Triphenylene
HPLC: Hitachi LaChrom ELITE (Tubing, 0.25 mm i.d.)

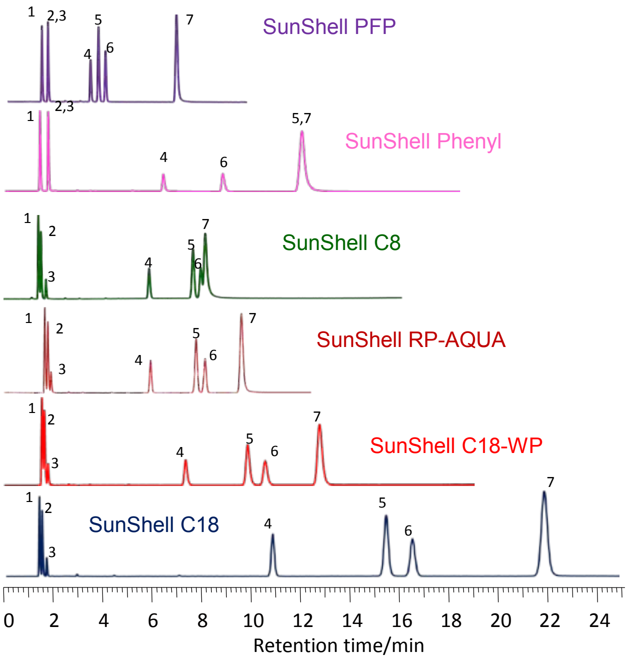
	Totally porous silica Sunniest C18, 5 µm		Core shell silica SunShell C18, 2.6 µm		Core shell silica SunShell C18, 5 µm	
Specific surface area	340 m²/g		150 m²/g		90 m²/g	
	Retention time (t_R)	Retention factor (k)	Retention time (t_R)	Retention factor (k)	Retention time (t_R)	Retention factor (k)
1) Uracil	1.70	0	1.34	0	1.30	0
6) Amylbenzene	19.96	10.74	16.56	11.36	13.43	9.33
Relative value of Amylbenzene	100%	100%	83%	106%	67%	87%

There is a small difference of k between totally porous and core shell particles.

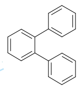
ORDERING INFO OF SUNSHELL	Inner diameter (mm)	1.0	2.1	3.0	4.6	USP category
	Length (mm)	Catalog no	Catalog no	Catalog no	Catalog no	Catalog no
Sunshell C18, 5 µm	150 250	--- ---	--- ---	CB3371 CB3381	CB3471 CB3481	L1

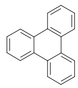
ULTIMATE SELECTIVITY
FOR YOUR ANALYSIS

C18 -WP / RP-AQUA / C8 / PHENYL / PFP - 2.6 µm



Column: SunShell C18, C18-WP, RP-AQUA, C8, Phenyl, PFP, 2.6 µm
150 x 4.6 mm
Mobile phase: CH_3OH/H_2O=75/25
Flow rate: 1.0 mL/min
Temperature: 40° C
Sample: 1 = Uracil
2 = Caffeine
3 = Phenol
4 = Butylbenzene
5 = o-Terphenyl
6 = Amylbenzene
7 = Triphenylene





	Hydrogen bonding	Hydrophobicity	Steric selectivity
PFP	1.00	1.31	2.38
Phenyl	1.00	1.48	1.01
C8	0.32	1.46	1.08
RP-AQUA	0.52	1.52	1.30
C18-WP	0.40	1.55	1.35
Sunshell C18	0.39	1.60	1.46

C18 -WP / RP-AQUA / C8 / PHENYL / PFP - 2.6 µm

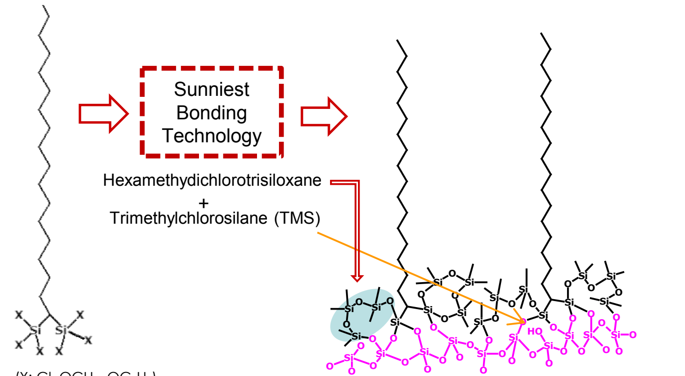
ORDERING INFO OF SUNSHELL	Inner diameter (mm)	1.0	2.1	3.0	4.6	USP category
	Length (mm)	Catalog no	Catalog no	Catalog no	Catalog no	Catalog no
Sunshell C8, 2.6 µm	30	---	CC6931	CC6331	CC6431	L7
	50	---	CC6941	CC6341	CC6441	
	75	---	CC6951	CC6351	CC6451	
	100	---	CC6961	CC6361	CC6461	
	150	---	CC6971	CC6371	CC6471	
Sunshell PFP, 2.6 µm	30	---	CF6931	CF6331	CF6431	L43
	50	---	CF6941	CF6341	CF6441	
	75	---	CF6951	CF6351	CF6451	
	100	---	CF6961	CF6361	CF6461	
	150	---	CF6971	CF6371	CF6471	
Sunshell C18-WP, 2.6 µm	30	---	CW6931	CW6331	CW6431	L1
	50	---	CW6941	CW6341	CW6441	
	75	---	CW6951	CW6351	CW6451	
	100	---	CW6961	CW6361	CW6461	
	150	---	CW6971	CW6371	CW6471	
Sunshell RP-AQUA, 2.6 µm	30	---	CR6931	CR6331	CR6431	Equivalent to L62
	50	CR6141	CR6941	CR6341	CR6441	
	75	---	CR6951	CR6351	CR6451	
	100	CR6161	CR6961	CR6361	CR6461	
	150	CR6171	CR6971	CR6371	CR6471	
Sunshell Phenyl, 2.6 µm	30	---	CP6931	CP6331	CP6431	L11
	50	---	CP6941	CP6341	CP6441	
	75	---	CP6951	CP6351	CP6451	
	100	---	CP6961	CP6361	CP6461	
	150	---	CP6971	CP6371	CP6471	

HFC18 - 16 / HFC18 - 30 - 2.6 µm

High speed separations of proteins and peptides.

What is HFC18? Hexa-Functional C18 has six functional groups.

The HFC18 is much more stable under acidic conditions.



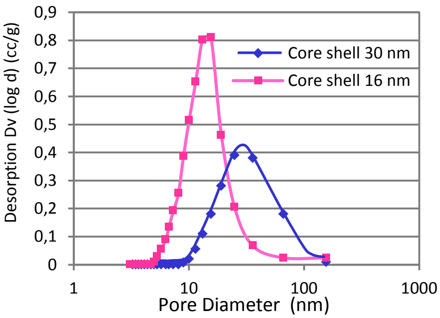
(X: Cl, OCH_3, OC_2H_5)

Schematic diagram of reagent

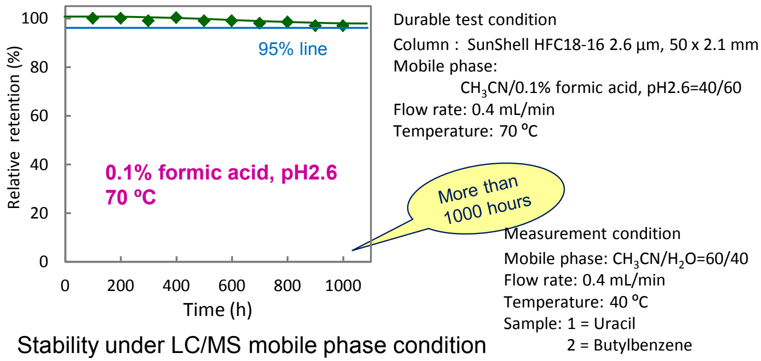
Schematic diagram of the state of bonding on silica surface

Proteins/peptides are often analysed at acidic pH. The wide pore SunShell phases are optimized for superior life time at extreme conditions.

HFC18 - 16 / HFC18 - 30 - 2.6 μm



Pore distribution of core shell particle



Stability under LC/MS mobile phase condition

ORDERING INFO OF SUNSHELL	Inner diameter (mm)	1.0	2.1	3.0	4.6	USP category
	Length (mm)	Catalog no	Catalog no	Catalog no	Catalog no	Catalog no
Sunshell HFC18-16, 2.6 μm	50 100 150	--- --- ---	CG6941 CG6961 CG6971	CG6341 CB6361 CB6371	CG6441 CG6461 CB6471	L1
Sunshell HFC18-30, 2.6 μm	50 100 150	--- --- ---	C46941 C46961 C46971	C46341 C46361 C46371	C46441 C46461 C46471	L1

HARDCORE SFC SEPARATIONS

2 -EP (ETHYLPYRIDINE) - 2.6 µm

The 2.6 µm core shell column shows only one third of back pressure in comparison with the 1.7 µm fully porous column. However, both show almost the same efficiency. By such low back pressure, a difference of density of supercritical fluid between an inlet and an outlet of the column is reduced. Consequently, 2.6 µm core shell column performs a superior separation for SFC.

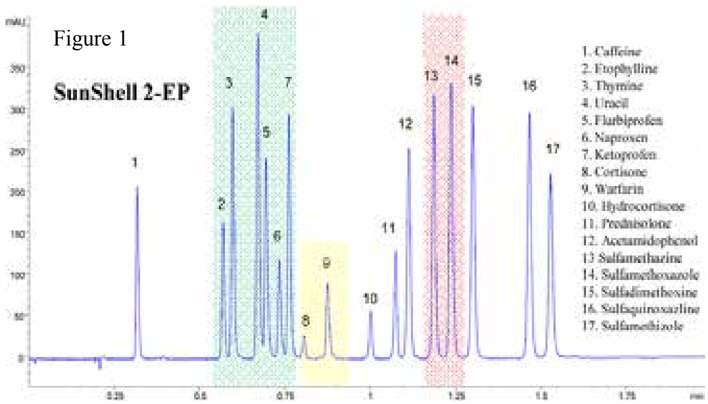


Figure 1: Chromatogram of the separation for the 17-components mix using the Sun Shell 2-EP 150 x 3.0 mm column. A methanol gradient of < 2 minutes was used on the Agilent 1260 Infinity SFC system. SFC conditions: flow rate: 4.0mL/min; outlet pressure 160 bar; column temperature 55°C. Gradient program: 5.0-7.5% in 0.20 min, then 7.5-20% in 1.3 min and held at 20% for 0.2 min.

2 -EP - 2.6 µm

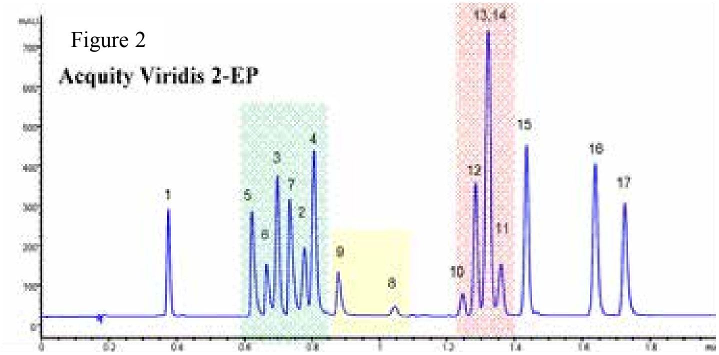


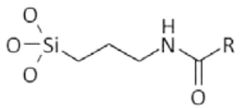
Figure 2: Chromatogram of the separation for the 17-components mix using Acquity UPC2 Viridis 2-EP 100 x 3.0 mm column. 16 of the 17 components were resolved. A methanol gradient of < 2 minutes was used on the Agilent 1260 Infinity SFC system. SFC conditions: flow rate 3.5 mL/min; outlet pressure 160 bar; and column temperature 70°C. Gradient program: 5.0-12.5% in 1.0 min, 12.5% for 0.25 min, then 12.5-20% in 0.75 min. Courtesy of Pfizer Inc.

ORDERING INFO OF SUNSHELL	Inner diameter (mm)	1.0	2.1	3.0	4.6	USP category
	Length (mm)	Catalog no	Catalog no	Catalog no	Catalog no	Catalog no
Sunshell 2-EP, 2.6 µm	30	---	CE6931	CE6331	CE6431	
	50	---	CE6941	CE6341	CE6441	
	75	---	CE6951	CE6351	CE6451	
	100	---	CE6961	CE6361	CE6461	
	150	---	CE6971	CE6371	CE6471	

HILIC -AMIDE - 2.6 µm

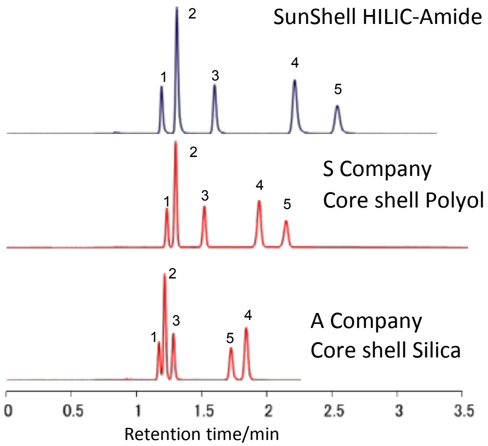
For Hydrophilic Interaction Chromatography.
Highly efficient separation of very polar compounds. Rapid equilibration.

Stationary phase of HILIC-Amide



R: Hydrophilic group

The stationary phase of SunShell HILIC-Amide consists of AMIDE and HYDROPHILIC GROUP, so that this stationary phase is more polar than an individual group. High speed separation is a result of core shell structure that derives high efficiency and fast equilibration.

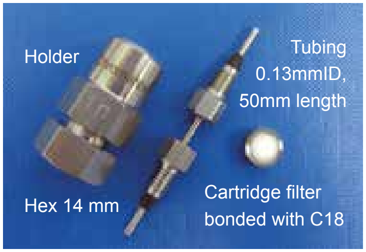


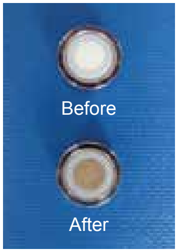
Column:
SunShell HILIC-Amide, 2.6 µm 100 x 4.6 mm,
Coreshell polyol, 2.7 µm 100 x 4.6 mm,
Core shell Silica, 2.7 µm 100 x 4.6 mm
Mobile phase:
Acetonitrile/20 mM ammonium acetate(pH4.7) = 8/2
Flow rate: 1.0 mL/min
Temperature: 40 °C
Detection: UV@250 nm
Sample: 1 = Thymine, 2 = Uracil, 3 = Uridine, 4 = Cytosine, 5 = Cytidine

Regarding retention of cytidine, SunShell HILIC-Amide showed 30% higher retention factor than S core shell polyol.

ORDERING INFO OF SUNSHELL	Inner diameter (mm)	1.0	2.1	3.0	4.6	USP category
	Length (mm)	Catalog no	Catalog no	Catalog no	Catalog no	Catalog no
Sunshell HILIC-Amide, 2.6 µm	30	---	CH6931	CH6331	CH6431	L68
	50	---	CH6941	CH6341	CH6441	
	75	---	CH6951	CH6351	CH6451	
	100	---	CH6961	CH6361	CH6461	
	150	---	CH6971	CH6371	CH6471	

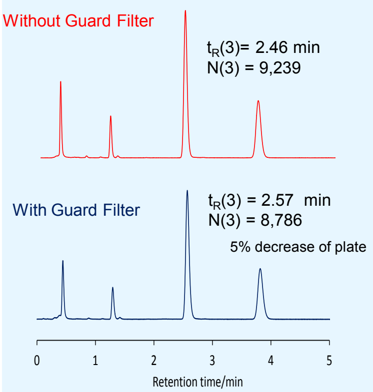
PROTECT YOUR COLUMNS
RP GUARD FILTER





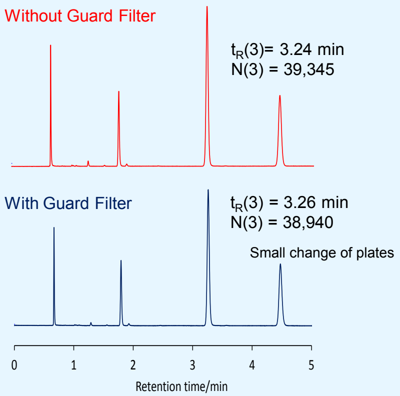
- The filter is made of porous glass sized 4 mm i.d. and 4 mm thickness
- Pore size is 2 µm
- Low dead volume structure
- Back pressure on glass filter is ca 0.1 MPa at 1.0 mL/min of flow rate
- Upper pressure limit is more than 60 MPa
- Available for 2.1 mm i.d to 4.6 mm i.d. columns

SunShell C18, 2.6 µm 50 x 2.1 mm



Mobile phase:
CH_3CN/H_2O=60/40 for 2.1 mm i.d.
CH_3CN/H_2O=70/30 for 4.6 mm i.d.
Flow rate:
0.3 mL/min for 2.1 mm i.d.
1.8 mL/min for 4.6 mm i.d.
Temperature: 25 °C
Detection: UV@250nm
Sample: 1 = Uracil
2 = Toluene
3 = Acenaphthene
4 = Butylbenzene

SunShell C18, 2.6 µm 150 x 4.6 mm



ORDERING INFO OF SUNSHELL RP GUARD FILTER	
(available as a guard column for reversed phase because of C18 bonding)	No
Sunshell RP Guard Filter Starter Kit (holder, cartridge, tubing)	CGGAAKN
Sunshell RP Guard Filter for exchange (5 pcs)	CBGAAC
Sunshell RP Guard Filter holder	CBGAAH

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