Usability of a core shell column using high performance liquid chromatograph for a routine analysis

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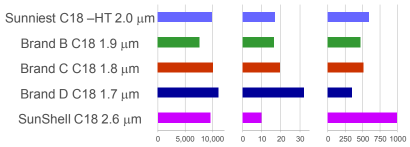
Abstract

Superficially porous particle (core shell particle) has been available as an alternative to using sub-2 µm particle for HPLC or UHPLC. Core shell particles are composed of a 1.2 to 1.9 µm solid core encircled a 0.25 µm to 0.5 µm porous layer. Especially a 2.6 µm core shell particle shows a half back pressure and the almost same efficiency to compare with sub-2 um particle because of a large particle and reducing mass transfer due to a thin porous silica layer. In this study, a 2.6 µm core shell silica with a non-porous core approximately 1.6 µm in diameter and a superficially porous layer of 0.5 µm was used as a based material. A core shell silica bonded with C18 and end-capped was evaluated for a routine analysis, which is done using conventional 5 µm particle column sized 150 or 250 x 4.6 mm i.d. A core shell C18 column size 100 x 4.6 mm and a conventional C18 column sized 250 x 4.6 mm were compared for an analysis of analgesics using Hitach LaChrom ELITE HPLC under a isocratic mode. Both columns showed the same efficiency and an analysis time by a core shell C18 columns decreased to one third to compare with a conventional C18 column without changing of conditions except for a column, a same instrument, a same flow rate, a same mobile phase. In case of gradient separation of catechins, the almost same result was obtained as well as under a isocratic mode.

Core shell vs Sub-2 µm fully porous

	Plates	Pressure (MPa)	Plate/pressure
Sunniest C18 –HT 2.0 µm	9,900	16.7	593
Brand B C18 1.9 µm	7,660	16.3	470
Brand C C18 1.8 µm	10,100	19.6	515
Brand D C18 1.7 µm	11,140	32.0	348
SunShell C18 2.6 µm	9,600	9.7	990



Column: 50 x 2.1 mm C18, Mobile phase: Acetonitrile/water=(70/30), Temperature: 25 °C

Figure. 6 Comparison of performance by plate/pressure

SunShell C18 used as core shell column showed **lower back pressure** than sub-2 µm fully porous column.

And SunShell column showed **similar theoretical plate** comparing with sub-2 µm fully porous column.

Plate/Pressure Valued of SunShell was twice or three times as high as sub-2 µm fully porous column

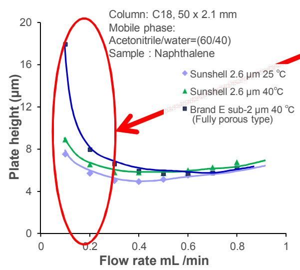


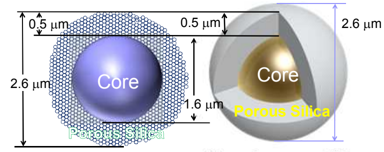
Figure. 7 Comparison of plate height

SunShell column kept the low plate height under the low flow rate conditions. But fully porous column couldn't keep

Comparing between SunShell and sub-2 µm column • • •
SunShell (core shell column) was

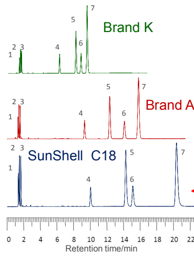
- Lower back pressure
- Similar theoretical plate
- High Plate/Pressure value
- lower plate height under low flow rate conditions

About SunShell



Pore volume: 0.30 mL/g, Specific surface area: 150 m^2/g,
Pore diameter: 9 nm
The ratio of porous silica volume: 77%

Figure 1. Schematic diagram of a core shell silica particle



Column: Brand K C18, 2.6 µm 150 x 4.6 mm; Brand A C18, 2.7 µm 150 x 4.6 mm; SunShell C18, 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

Different Selectivity from other brand columns

	Hydrogen bonding (Caffeine/Phenol)	Hydrophobicity (Amylbenzene/Butylbenzene)	Steric selectivity (Triphenylene/o-Terphenyl)
Brand K	0.48	1.54	1.20
Brand A	0.44	1.60	1.31
SunShell C18	0.40	1.59	1.47

Figure 2. Comparison of standard samples

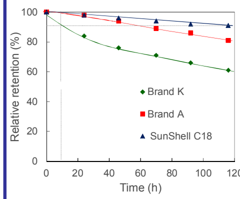


Figure 3. Stability under acidic pH condition

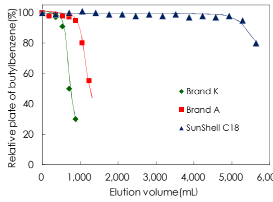


Figure 4. Stability under basic pH condition

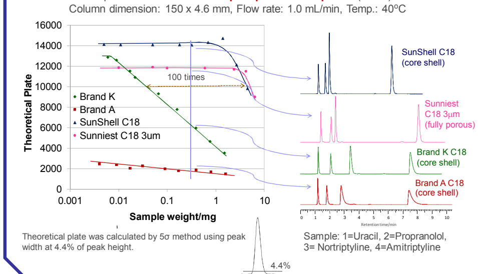
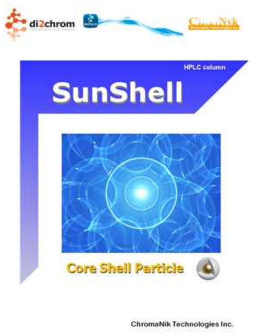


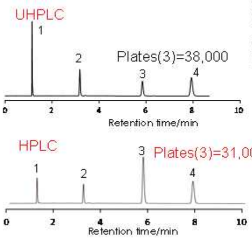
Figure 5. Loading capacity of amitriptyline

Comparing between SunShell and other brand columns • • •
SunShell has

- Different selectivity
- High stability under both acidic and basic pH conditions
- Good peak shape for amitriptyline
- High Loading capacity

Appling for HPLC

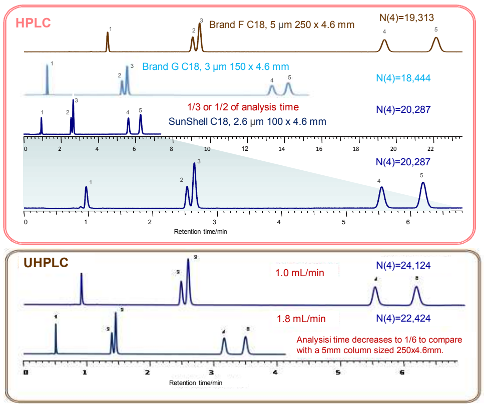




Column: SunShell C18, 2.6 µm 150 x 4.6 mm
Mobile phase: CH_3CN/H_2O=70/30
Flow rate: 1.0 mL/min
Pressure: 13.5 MPa
Temperature: 25 ºC
Sample:
1 = Uracil
2 = Toluene
3 = Acenaphthene
4 = Butylbenzene

80% performance to compare with UHPLC
Still 1.5 times more separation than that of a 3 µm column

Figure. 8 Comparison between HPLC and UHPLC

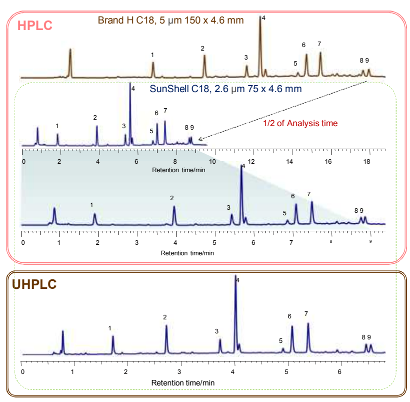


Column:
Brand F C18, 5 µm 250 x 4.6 mm
SunShell C18, 2.6 µm 100 x 4.6 mm
Mobile phase: CH_3CN/20mM Phosphoric acid = 45/55
Flow rate: 1.0 mL/min,
1.8 mL/min at the lowest chromatogram
Temperature: 25 ºC
Pressure: 9.5 MPa for Brand F C18 5 mm
13.4 MPa for SunShell C18 2.6 mm
Detection: UV@230 nm

Sample: 1 = Benzydamine
2 = Ketoprofen
3 = Naproxen
4 = Indomethacin
5 = Ibuprofen

HPLC: Hitachi LaChrom ELITE (using 0.25 mm i.d. tubing)
UHPLC: Jasco X-LC

Figure. 9 Examples of transfer (isocratic separation)



Column:
Brand H C18, 5 µm 150 x 4.6 mm
SunShell C18, 2.6 µm 75 x 4.6 mm
Mobile phase:
A) 0.1% Phosphoric acid
B) CH_3CN
Gradient program for Brand G C18

Time	0 min	15 min	20 min
%B	2%	25%	25%

for SunShell C18

Time	0 min	7.5 min	10 min
%B	2%	25%	25%

Flow rate: 1.0 mL/min,
Temperature: 25 ºC
Detection: UV@250 nm
Sample: Oolong tea
1 = Gallocatechin, 2 = Epigallocatechin, 3 = Catechin, 4 = Caffeine, 5 = Epicatechin,
6 = Epigallocatechin gallate, 7 = Gallocatechin gallate, 8 = Epicatechin gallate, 9 = Catechin gallate

HPLC: Hitachi LaChrom ELITE (using 0.25 mm i.d. tubing)
UHPLC: Jasco X-LC

Figure. 10 Examples of transfer (gradient separation)

Conclusions

100 × 4.6 size SunShell showed the same efficiency for 250 × 4.6 size 5 µm fully porous column under the isocratic mode.

An analysis time by a core shell C18 columns decreased to one third or half comparing with a conventional C18 columns without changing of analytical conditions.

In case of gradient separation of catechins, the almost same result was obtained as well as under a isocratic mode.

SunShell was a good tool for high-throughput analysis and environmental friendship.