Versatile Hybrid Silica Based HPLC Column

YMC

YMC-Triart

UHPLC & HPLC Columns

- 6 chemistries for different selectivity
- Great chemical and thermal durability
- UHPLC (up to 100 MPa) and HPLC columns
- Available in high durability semi-preparative columns

Particle size
1.9 µm
3 µm
5 µm

YMC-Triart C18
Suitable as a first choice column with excellent durability

YMC-Triart C18 ExRS
Alternative selectivity to standard C18 columns

YMC-Triart C8
Effective for fast analysis of compounds with low polarity or for separation of isomers

YMC-Triart Phenyl
Effective for separation of compounds with long conjugated system by utilizing π-π interaction

YMC-Triart PFP
Effective for separation of polar compounds or isomers by polar interaction

YMC-Triart Diol-HILIC
Effective for separation of highly polar compounds

YMC CO., LTD.
http://www.ymc.co.jp

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www.chromspec.com

1-800-267-8103 • sales@chromspec.com • tech@chromspec.com

YMC-Triart

YMC-Triart is next-generation organic hybrid silica based columns, emphasizing versatility. The main features are superior durability, peak shape across all kind of compounds and reproducibility.
Having the same selectivity across different particle sizes, smooth method transfer between UHPLC and HPLC can be performed. Moreover, various bonded phases supplement performance of C18 phase, and allow separations which C18 columns cannot achieve.

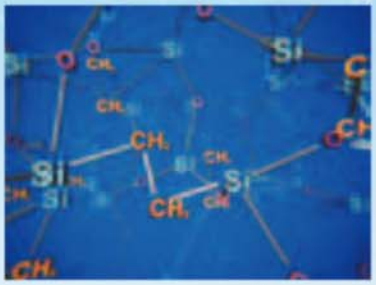
Various product lineup enables wide range of separation from UHPLC to HPLC analysis and even to preparative separation.

Features

- Effective for method screening with various chemistries
- Great chemical durability provided by hybrid particles
- Superior peak shapes for a wide range of compounds and in various conditions
- UHPLC compatible column with operating pressure up to 100 MPa packed with 1.9 µm particle
- Available in highly-durable semi-preparative column
- Smooth method transfer from UHPLC to HPLC analysis and even to HPLC purification

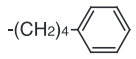
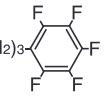
Versatile hybrid base material

YMC-Triart is based on novel organic/inorganic hybrid particles. The particle combines high mechanical stability and high efficiency derived from silica based packing material and high chemical stability derived from polymer based packing material. The granulation process utilizing microreactor technology enables continuous and highly controlled production of hybrid particles. The particle has uniform pore size distribution and smooth surface as well as uniform particle size. This feature greatly contributes to excellent peak shape and separation reproducibility.



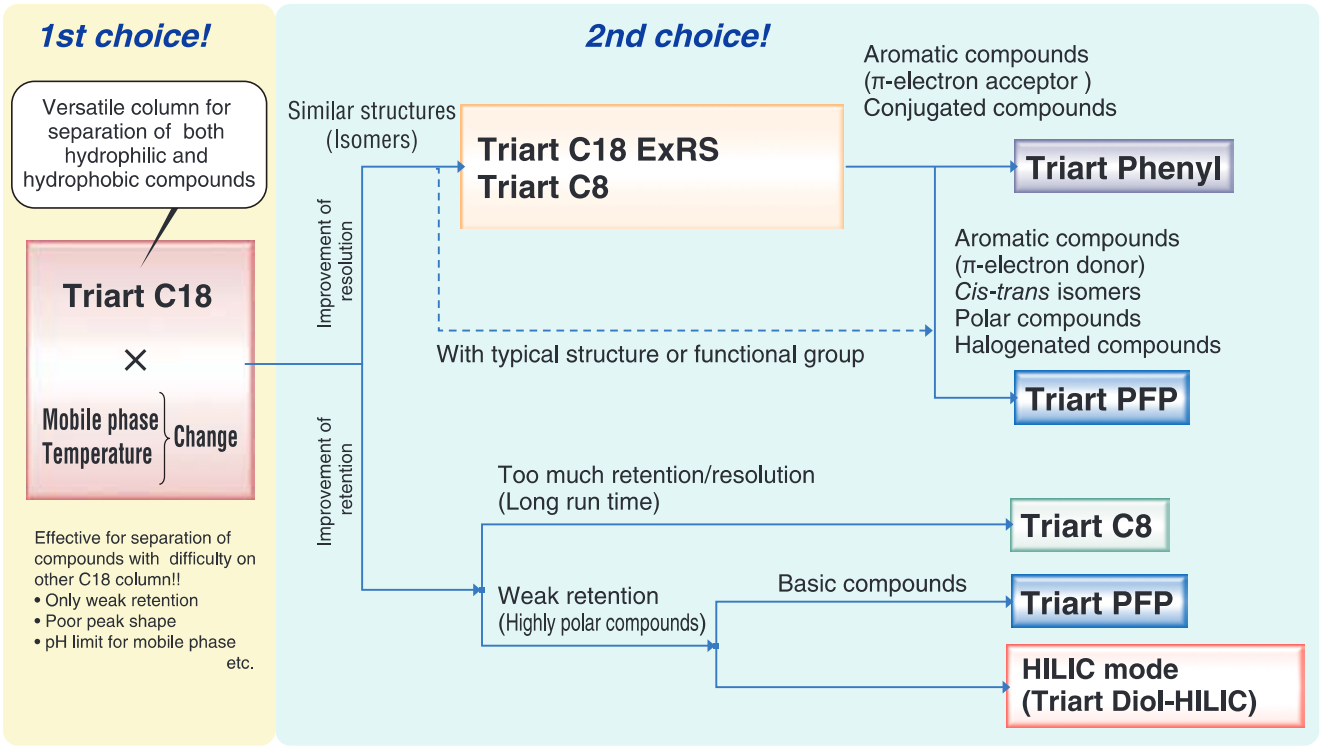
Contents

Specifications

Product name	Triart C18	Triart C18 ExRS	Triart C8	Triart Phenyl	Triaty PFP	Triart Diol-HILIC
Functional group	-$C_{18}H_{37}$ (Standard type)	-$C_{18}H_{37}$ (high density bonding)	-C_8H_{17}	-$(CH_2)_4$- 	-$(CH_2)_3$- 	-CH_2CHCH_2 OH OH
Separation mode	Reversed-phase					HILIC
Base	Organic/inorganic hybrid silica					
Particle size (μm)	1.9, 3, 5					
Pore size (nm)	12	8	12			
Bonding	Trifunctional					
Carbon content (%) ※	20	25	17	17	15	12
Endcapping	Yes				No	
Usable pH range	1.0~12.0	1.0~12.0	1.0~12.0	1.0~10.0	1.0~8.0	2.0~10.0
100% aqueous compatibility	○	×	×	○	○	–
USP Classification	L1	L1	L7	L11	L43	L20

※ Containing 8% for hybrid silica base material.

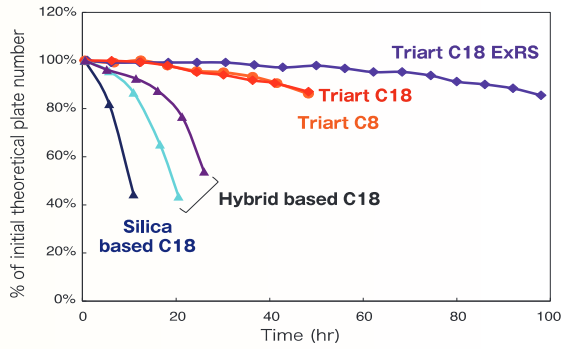
YMC-Triart column selection guide



Excellent durability

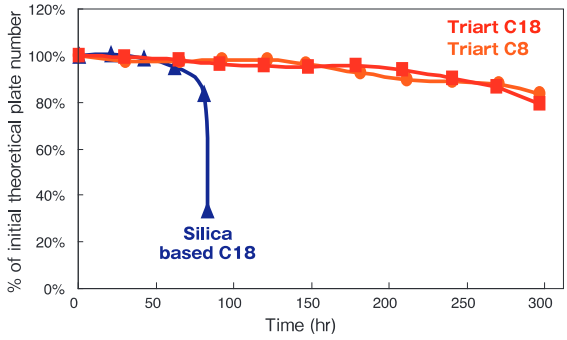
[Durability in high pH]

Phosphate buffer (pH 11.5), 40℃



Column	: 5 µm, 150 X 4.6 mmI.D.
Eluent	: 50 mM K_2HPO_4-K_3PO_4 (pH 11.5)/methanol (90/10)
Flow rate	: 1.0 mL/min
Temperature	: 40℃
Sample	: benzyl alcohol

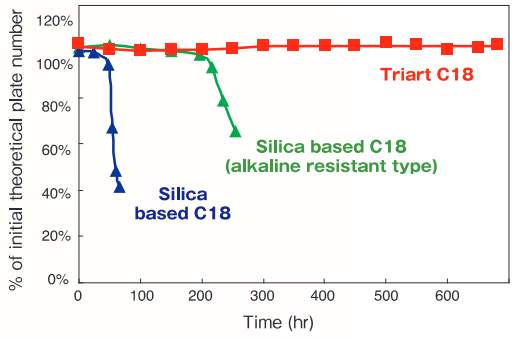
Triethylamine (pH 11.5), 40℃



Column	: 5 µm, 150 X 4.6 mmI.D.
Eluent	: 50 mM triethylamine (pH 11.5)/methanol (90/10)
Flow rate	: 1.0 mL/min
Temperature	: 40℃
Sample	: benzyl alcohol

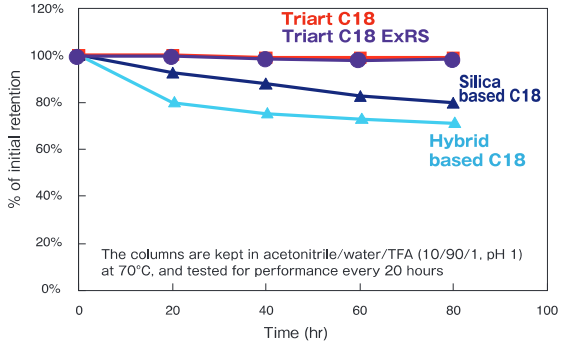
[Durability in high temperature]

pH 6.9, 70℃



Column	: 5 µm, 50 X 2.0 mmI.D.
Eluent	: 20 mM KH_2PO_4-K_2HPO_4 (pH 6.9)/acetonitrile (90/10)
Flow rate	: 0.2 mL/min
Temperature	: 70℃
Sample	: phenol

pH 1, 70℃

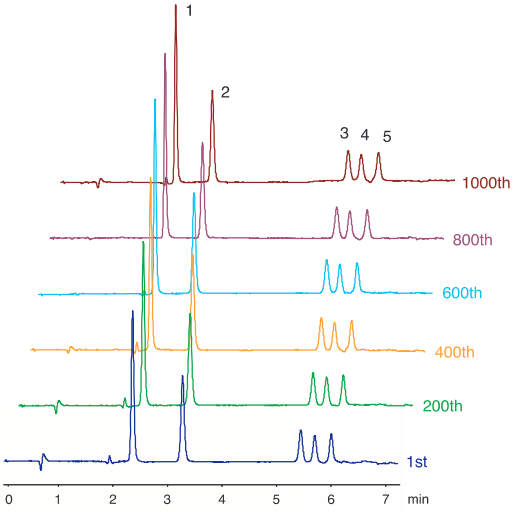


Test conditions	Column	: 5 µm, 50 X 2.0 mmI.D.
	Eluent	: acetonitrile/water (60/40)
	Flow rate	: 0.2 mL/min
	Temperature	: 37℃
	Sample	: butyl benzoate

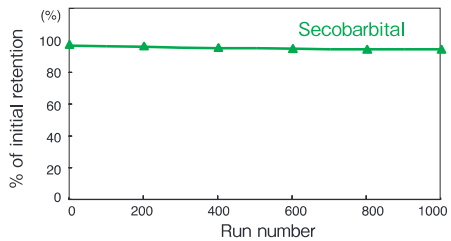
With innovative surface modification on organic hybrid silica, Triart columns show great chemical durability and they can be used over a wide pH range. Even at high-pH or high-temperature conditions, the lifetime of Triart C18, C18 ExRS and C8 is more than 10 times greater than that of conventional C18 columns and a few times greater than commercially available high alkaline-resistant C18 columns. When using under alkaline condition, organic buffers such as triethylamine make the column life longer than phosphate buffer. In addition, Triart is ideally suited for preparative purifications of various compounds or peptide analysis in the cases where trifluoroacetic acid (TFA) is frequently used, because it has high resistance to acids.

[Long column lifetime under chemically harsh conditions]

Continuous analysis with alkaline mobile phase (pH 9.5)



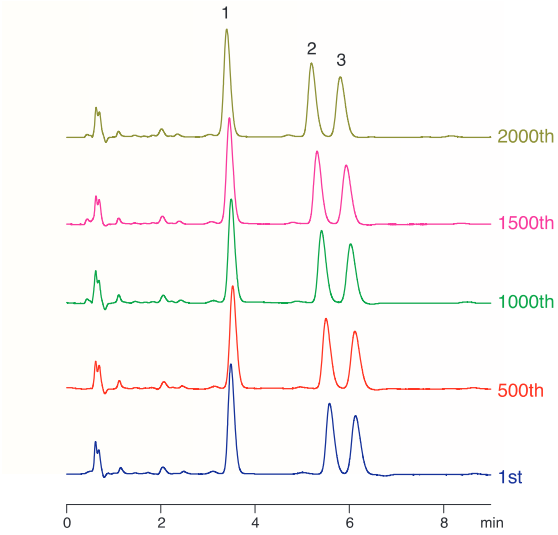
Barbiturates
1. Barbital
2. Phenobarbital
3. Hexobarbital
4. Pentobarbital
5. Secobarbital

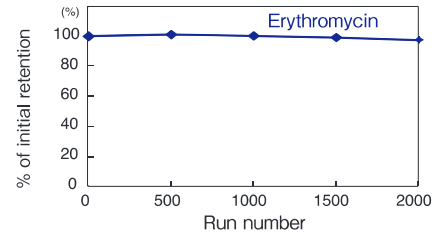


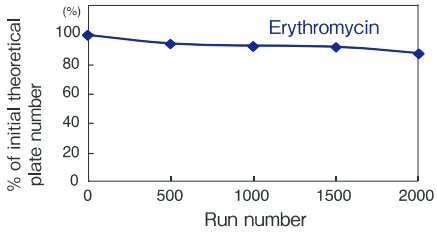
Column	: YMC-Triart C18 5 µm, 50 X 2.0 mmI.D.
Eluent	: A) 20 mM $HCOONH_4$-NH_3 (pH 9.5)
	B) methanol
	0-90%B (0-7 min)
Flow rate	: 0.2 mL/min
Temperature	: 25℃
Detection	: UV at 240 nm
Injection	: 1 µL

Triart shows great durability under alkaline mobile phase conditions, which is difficult for conventional silica columns. This assures stable analysis over a long period of time.

Continuous analysis at pH 7.9, 70℃ -Erythromycin antibiotics-





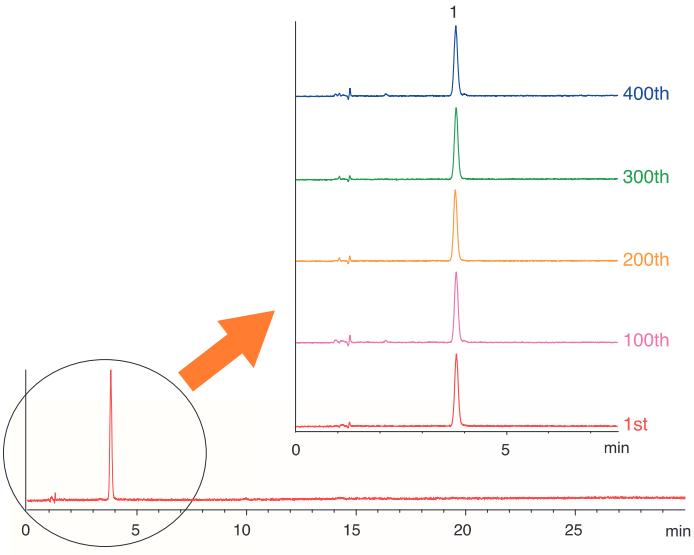


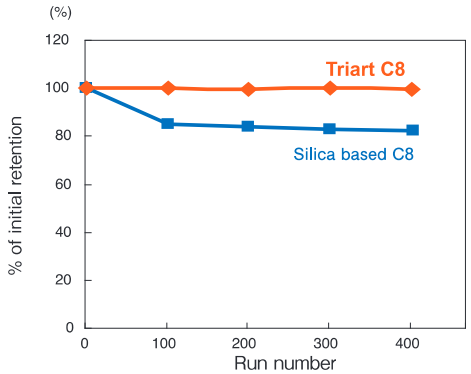
1. Erythromycin
2. Erythromycin ethylsuccinate
3. Erythromycin estolate

Erythromycins are shown to be easily degraded under acidic (< pH 6.5) condition. Higher pH is preferable. In addition, higher temperature tends to show better peak shape. Enhanced chemical durability of Triart C18 enables highly reproducible analysis under high pH and high temperature.

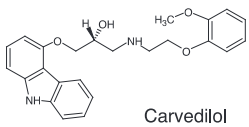
Column	: YMC-Triart C18 3 µm 50 X 2.0 mmI.D.
Eluent	: 20 mM KH_2PO_4-K_2HPO_4 (pH 7.9)/acetonitrile/methanol (40/45/15)
Flow rate	: 0.2 mL/min
Temperature	: 70℃
Detection	: UV at 210 nm
Injection	: 1 µL

Continuous analysis at pH 2.0, 55℃ -Carvedilol-





1.



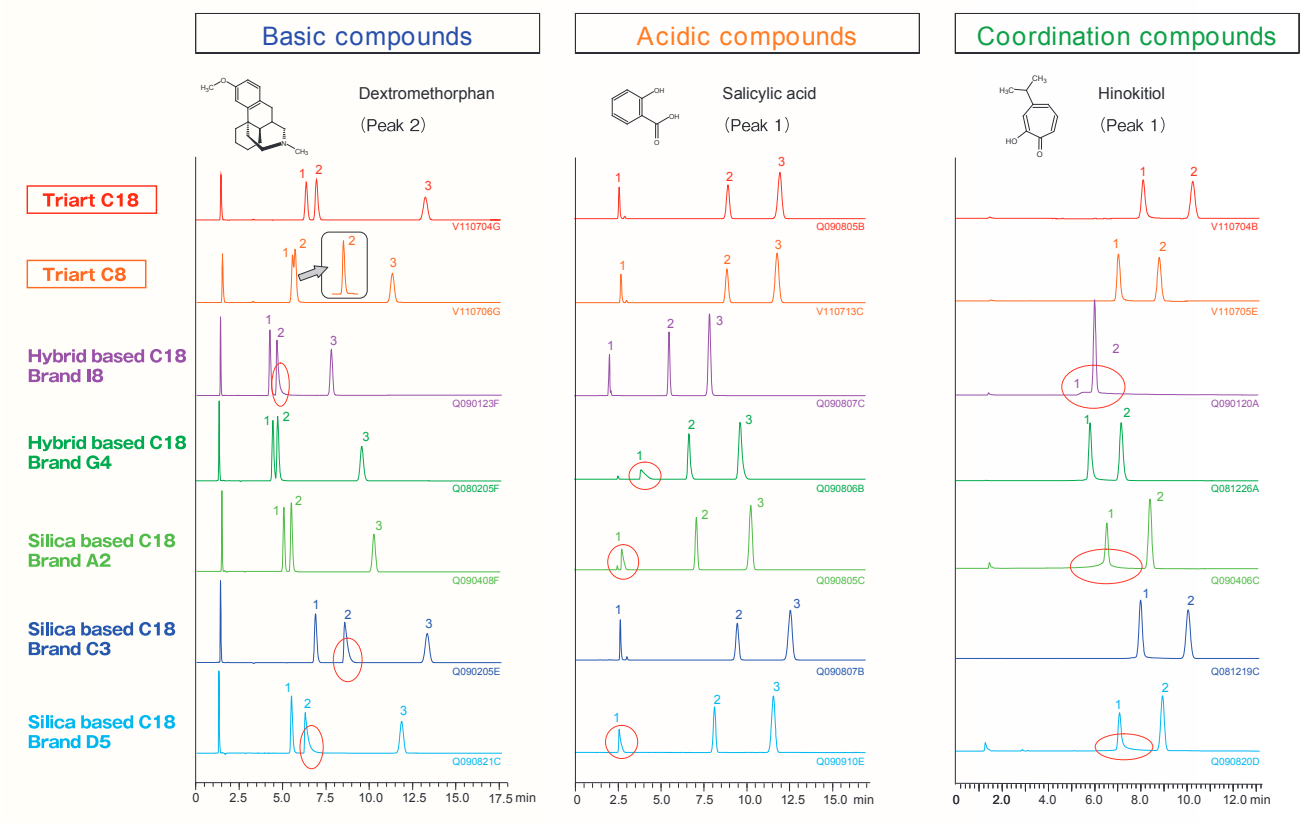
Carvedilol

Analyses of carvedilol are performed continuously, referring the Japanese Pharmacopoeia 16th Edition which specifies to use a C8 column. Under severe condition of pH 2 for mobile phase and 55℃ for column temperature, the retention time is decreased over analyses on a conventional silica based monomeric C8 column. On the other hand, no change is observed in retention time of Triart C8 even after 400 injections (200 hours). Triart C8 provides stable analysis under harsh conditions just as same as Triart C18.

Column	: YMC-Triart C8 5 µm 150 X 2.0 mmI.D.
Eluent	: phosphate buffer (pH 2.0)* /acetonitrile (65/35) ** Dissolve 2.72 g of KH_2PO_4 in 900 mL water, adjust pH 2.0 with H_3PO_4 , and add water to make 1000 mL*
Flow rate	: 0.28 mL/min *(adjust the flow rate so that the retention time of carvedilol is about 4 min)*
Temperature	: 55℃
Detection	: UV at 240 nm
Injection	: 4 µL
(The Japanese Pharmacopoeia 16th; Related substances)	

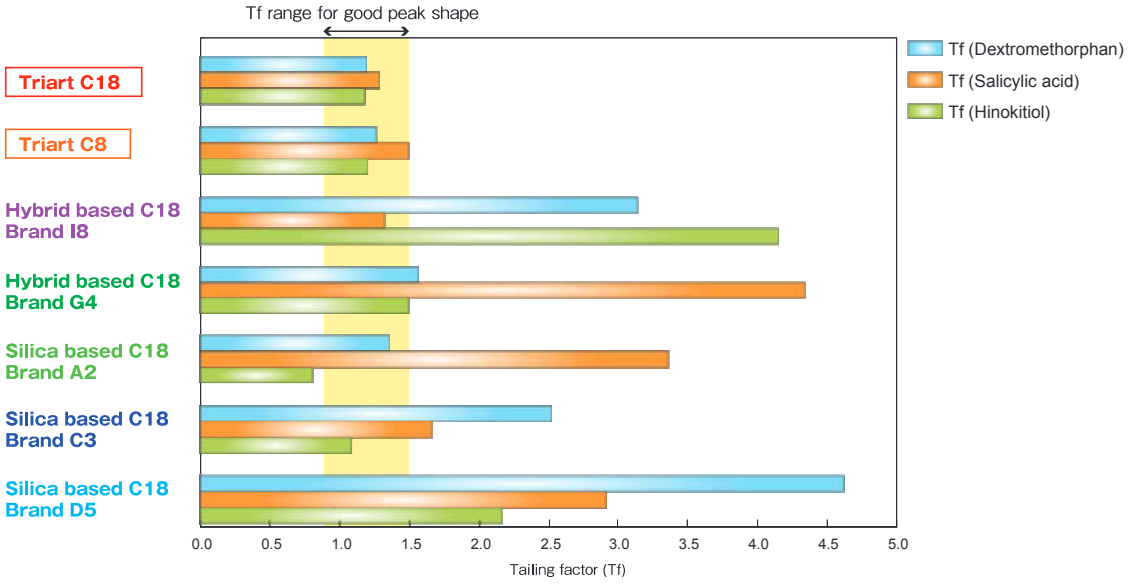
Great peak shapes without adsorption/peak tailing

[Comparison of chromatographic behavior]



Basic compounds	Acidic compounds	Coordination compounds
Column : 150 X 3.0 mmI.D. or 150 X 4.6 mmI.D.	Column : 150 X 3.0 mmI.D. or 150 X 4.6 mmI.D.	Column : 150 X 3.0 mmI.D. or 150 X 4.6 mmI.D.
Eluent : 20 mM KH_2PO_4-K_2HPO_4 (pH 6.9)/acetonitrile (65/35)	Eluent : 10 mM CH_3COOH-CH_3COONH_4 (pH 4.2)/acetonitrile (75/25)	Eluent : acetonitrile/0.1% H_3PO_4 (40/60)
Flow rate : 0.425 mL/min for 3.0 mmI.D., 1.0 mL/min for 4.6 mmI.D.	Flow rate : 0.425 mL/min for 3.0 mmI.D., 1.0 mL/min for 4.6 mmI.D.	Flow rate : 0.425 mL/min for 3.0 mmI.D., 1.0 mL/min for 4.6 mmI.D.
Temperature : 40℃	Temperature : 40℃	Temperature : 40℃
Detection : UV at 235 nm	Detection : UV at 254 nm	Detection : UV at 254 nm
Sample : 1. Chlorpheniramine 2. Dextromethorphan 3. Propyl paraben (I.S.)	Sample : 1. Salicylic acid 2. Methyl paraben (I.S.) 3. Cinnamic acid	Sample : 1. Hinokitiol 2. Methyl benzoate (I.S.)

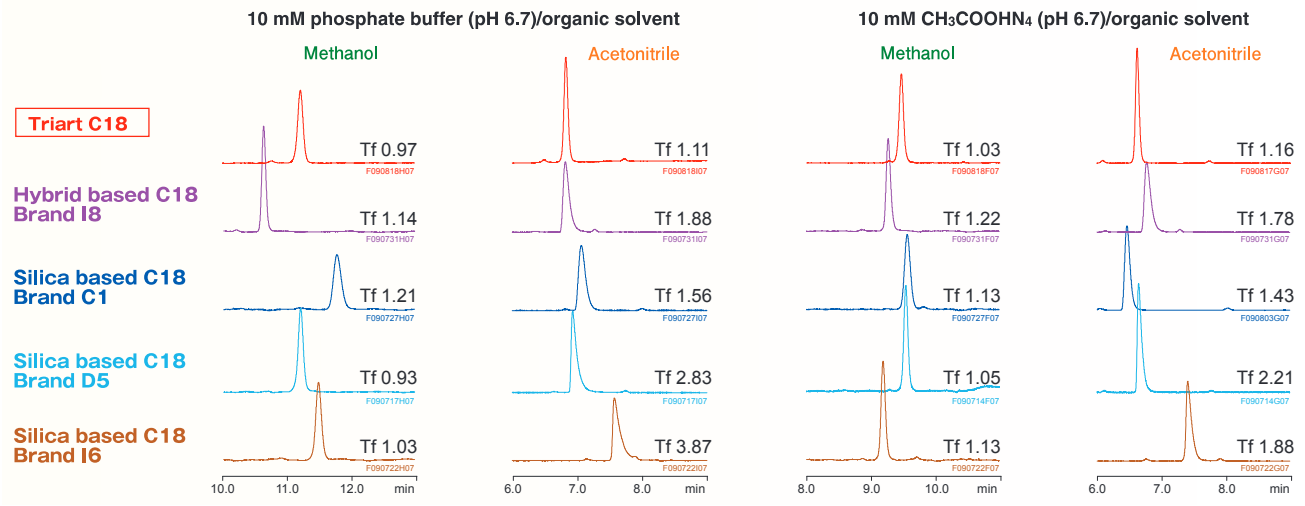
[Comparison of tailing factor]

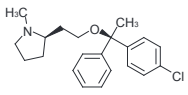


The peak tailing or fronting of ionic compounds are often caused by adsorption to residual silanol groups and/or surface impurities resulting from base materials or manufacturing process. Triart, based on hybrid silica material with little metal impurities and rigorously endcapped, provides symmetrical peak shapes for all types of compounds.

Superior peak shapes across various mobile phases

【Peak shape comparison of basic compound】



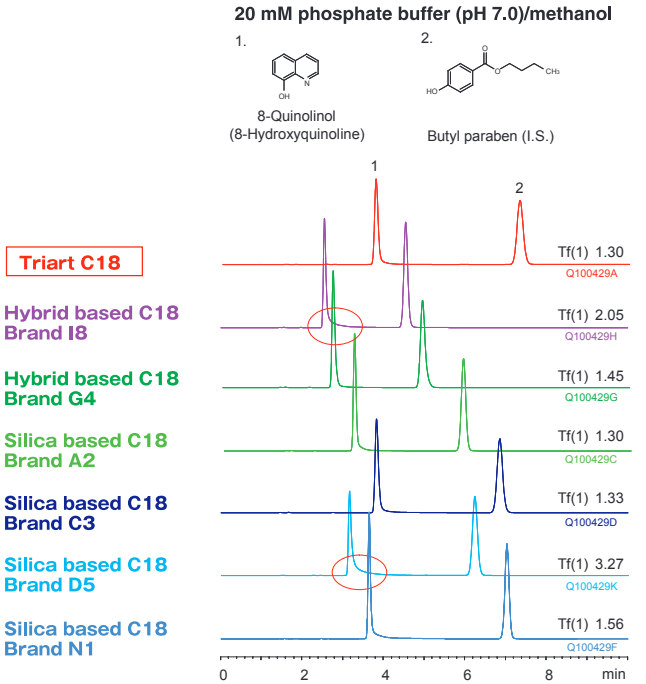


Clemastine

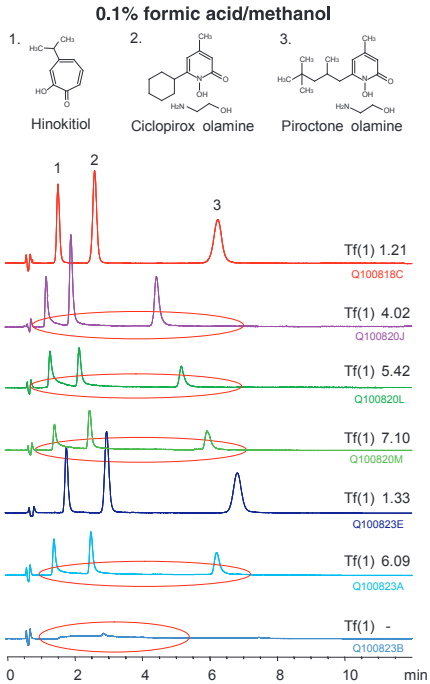
Column	: 5 µm, 50 X 2.0 mmI.D. or 50 X 2.1 mmI.D.
Eluent	: A) 10 mM KH_2PO_4-K_2HPO_4 (pH 6.7) or 10 mM CH_3COONH_4 (pH 6.7) B) methanol or acetonitrile 5-90%B (0-10 min), 90%B (10-15 min)
Flow rate	: 0.2 mL/min
Temperature	: 25℃
Detection	: UV at 230 nm

Clemastine is a well known basic compound which can easily tail on conventional ODS columns. Triart C18 can analyze clemastine without any peak deterioration with any kinds of buffer/solvent combinations.

【Peak shape comparison of coordination compounds】



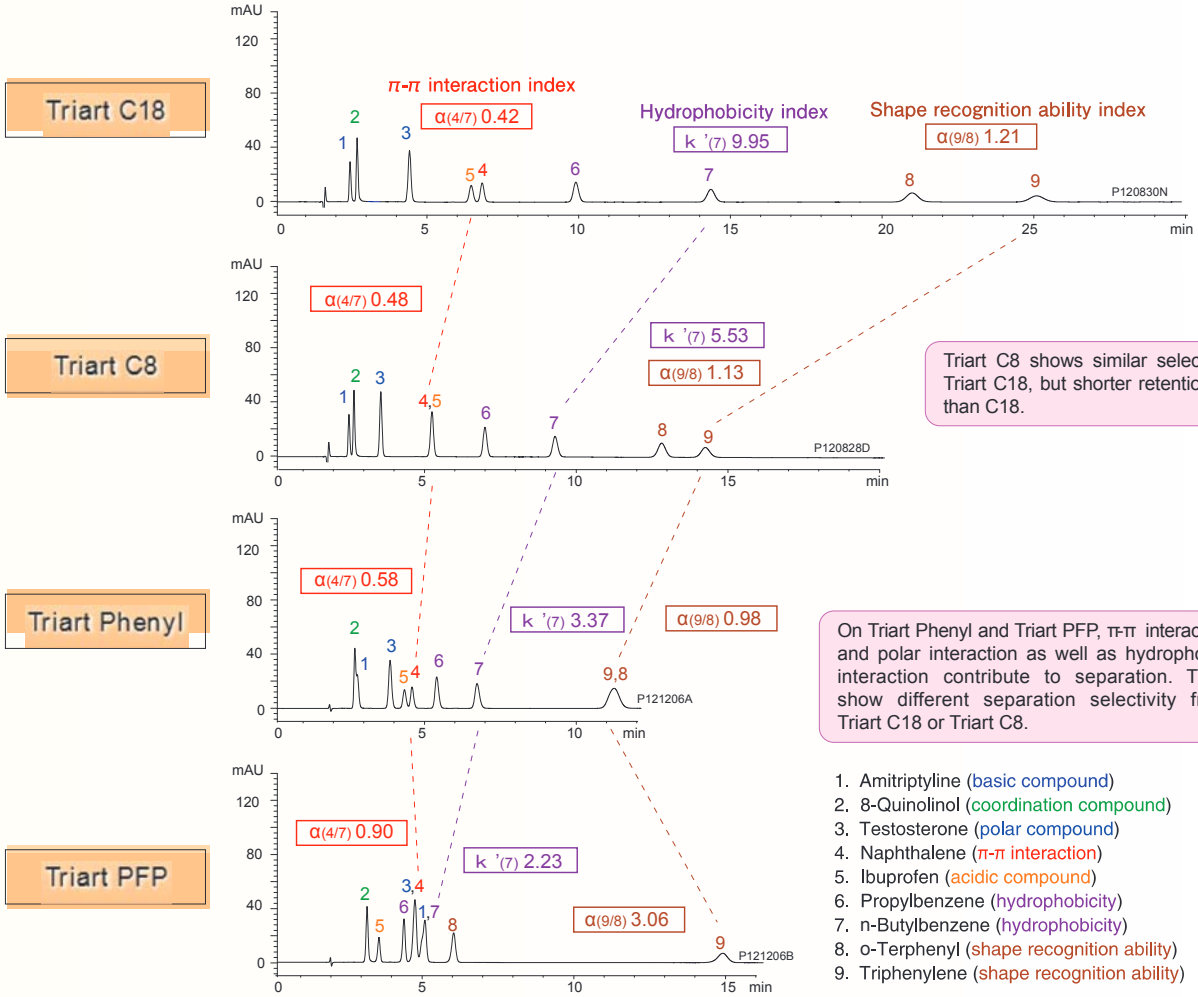
Column	: 5 µm or 3 µm, 150 X 4.6 mmI.D
Eluent	: 20 mM KH_2PO_4-K_2HPO_4 (pH 7.0)/ methanol (35/65)
Flow rate	: 1.0 mL/min
Temperature	: 40℃
Detection	: UV at 254 nm
Injection	: 10 µL



Column	: 5 µm or 3 µm, 50 X 2.0 mmI.D. or 50 X 2.1 mmI.D
Eluent	: methanol/water/formic acid (65/35/0.1)
Flow rate	: 0.2 mL/min
Temperature	: 40℃
Detection	: UV at 310 nm
Injection	: 1 µL

Triart C18 is able to provide excellent peak shapes for coordination compounds which are often absorbed to a column, resulting from a strong interaction with impurities such as metal ion.

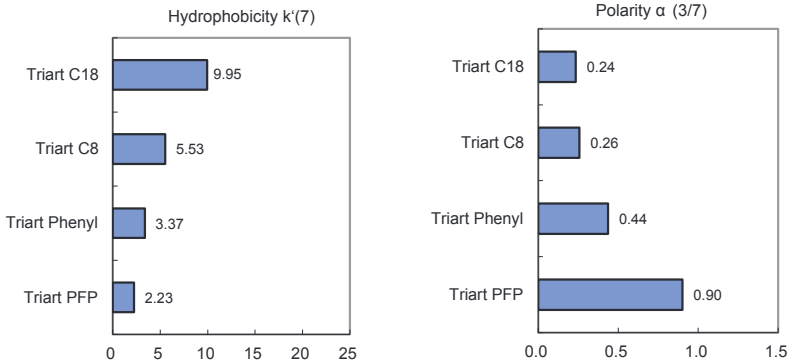
Comparison of separation selectivity among YMC-Triart

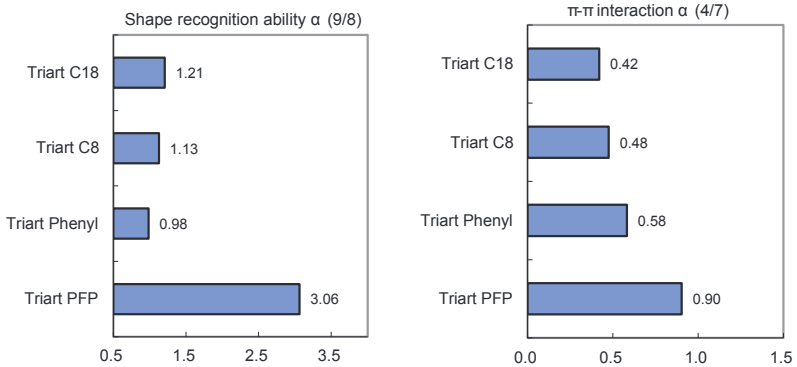


Triart C8 shows similar selectivity to Triart C18, but shorter retention times than C18.

On Triart Phenyl and Triart PFP, π-π interaction and polar interaction as well as hydrophobic interaction contribute to separation. They show different separation selectivity from Triart C18 or Triart C8.

1. Amitriptyline (basic compound)
2. 8-Quinolinol (coordination compound)
3. Testosterone (polar compound)
4. Naphthalene (π-π interaction)
5. Ibuprofen (acidic compound)
6. Propylbenzene (hydrophobicity)
7. n-Butylbenzene (hydrophobicity)
8. o-Terphenyl (shape recognition ability)
9. Triphenylene (shape recognition ability)





Column	: 5 µm, 150 X 3.0 mmI.D.
Eluent	: 20 mM H_3PO_4-KH_2PO_4 (pH3.1)/ methanol (25/75)
Flow rate	: 0.425 mL/min
Temperature	: 40℃
Detection	: UV at 265 nm
Injection	: 4 µL

A mixture that consists of compounds with various characteristics is analyzed with reversed-phase Triart columns. In addition to hydrophobic interaction, secondary interactions such as π-π interaction and polar interaction are different from column to column. Those parameters have great impact on retention capacity (k') and separation factor (α). By utilizing the difference in separation characteristics, wide range of compounds can be well-separated with Triart.

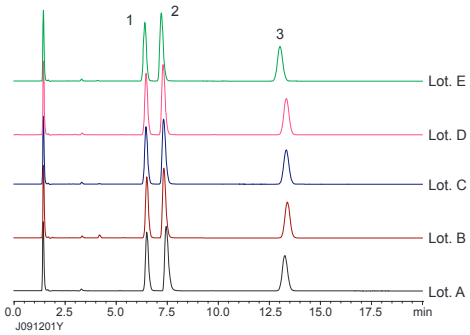
Quality control

【Excellent reproducibility】

Packing material

Triart C18 exhibits excellent lot-to-lot reproducibility for all types of compounds including basic and coordination compounds that often exhibits peak tailing or adsorption onto packing material.

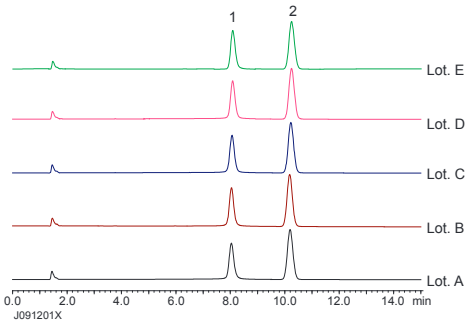
Basic compounds



1. Chlorpheniramine
2. Dextromethorphan
3. Propyl paraben（I.S.）

Column	: YMC-Triart C18 5 μm, 150 X 3.0 mmI.D.
Eluent	: 20 mM KH_2PO_4-K_2HPO_4 (pH 6.9)/acetonitrile (65/35)
Flow rate	: 0.425 mL/min
Temperature	: 40℃
Detection	: UV at 235 nm

Coordination compound

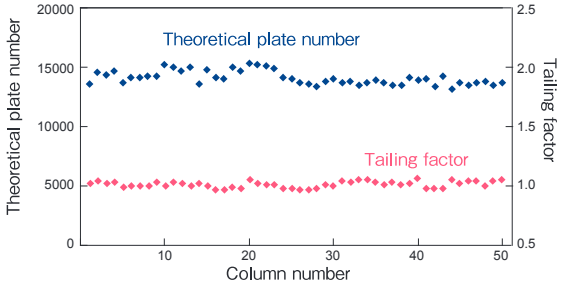


1. Hinokitiol
2. Methyl benzoate（I.S.）

Column	: YMC-Triart C18 5 μm, 150 X 3.0 mmI.D.
Eluent	: acetonitrile/0.1% H_3PO_4 (40/60)
Flow rate	: 0.425 mL/min
Temperature	: 40℃
Detection	: UV at 254 nm

Packed column

Rigorous control of theoretical plate number (N) and tailing factor (Tf) is performed on Triart C18 packed column.

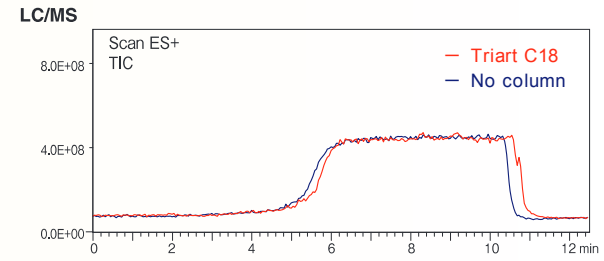


Column	: YMC-Triart C18 5 μm 150 X 4.6 mmI.D.
Eluent	: acetonitrile/water (60/40)
Flow rate	: 1.0 mL/min
Temperature	: ambient
Sample	: butyl benzoate

Effective for high-sensitive analysis using LC/MS

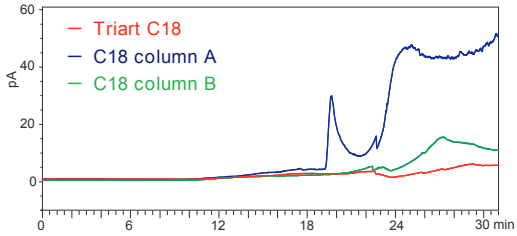
【Low bleeding】

LC/MS



Column	: 5 μm, 50 X 2.0 mmI.D.
Eluent	: A) water/formic acid (100/0.1) B) acetonitrile/formic acid (100/0.1) 5%B (0-1 min), 5-100%B (1-5 min), 100%B (5-10 min), 100-5%B (10-10.1 min), 5%B (10.1-12.5 min)
Flow rate	: 0.4 mL/min
Temperature	: 40℃
Detection	: ESI positive, TIC (Mass Range: 50-1000)

Corona* CAD*



Column	: 5 μm, 250 X 4.6 mmI.D.
Eluent	: A) water/formic acid (100/0.1) B) acetonitrile/formic acid (100/0.1) 5%B (0-5 min), 5-100%B (5-20 min), 100%B (20-30 min)
Flow rate	: 1.0 mL/min
Temperature	: 40℃
Detection	: Corona CAD

On Triart column, very low level of bleeding (leaching) is achieved thanks to the improvement of production procedure and of durability. Background noise of Triart C18 on LC/MS (TIC) is almost the same as blank run with no column. Also, baseline is almost stable on Corona CAD (Charged Aerosol Detector). These results prove that there is little bleeding from Triart C18 column. Very low background noise and high S/N ratio even with high-sensitive detectors are expected on Triart columns.

* Corona and CAD is a registered trademark of Thermo Fisher Scientific.

Highly durable column suitable as a first choice

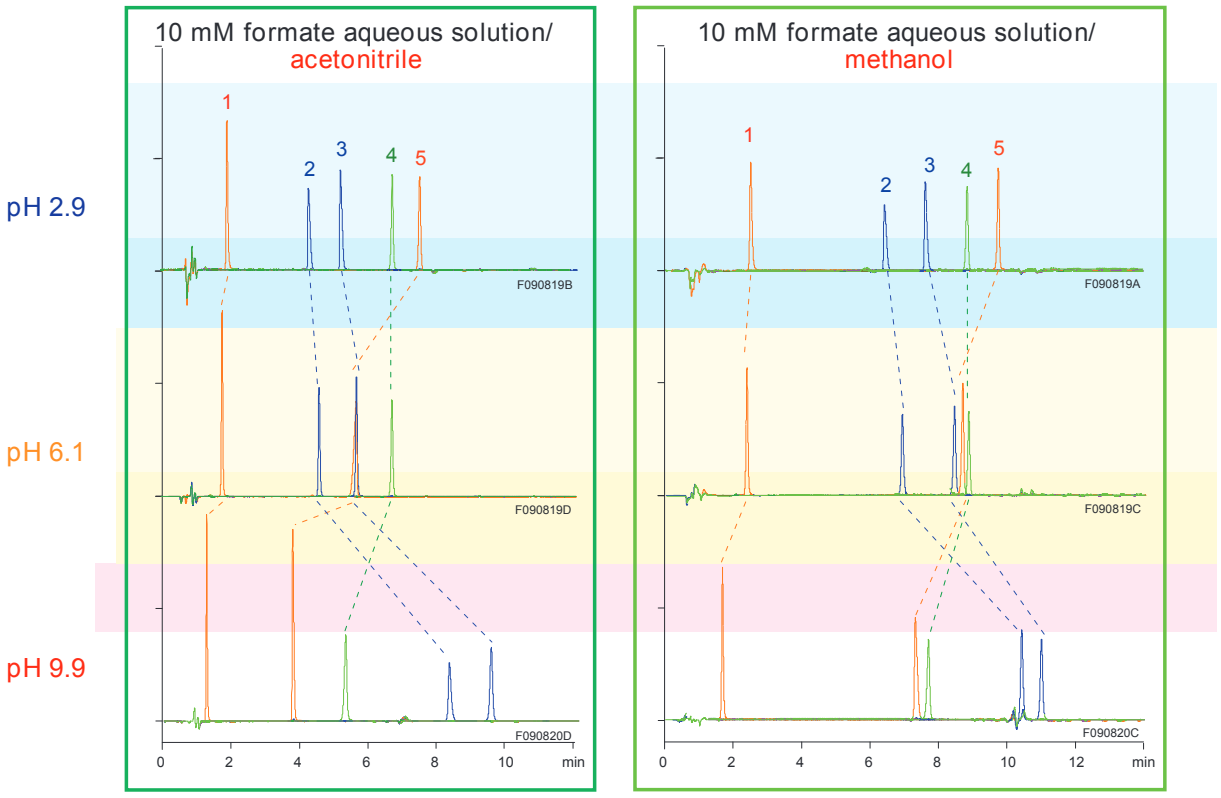
YMC-Triart C18

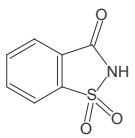
- Pore size : 12 nm
- Carbon content : 20%
- Usable pH range : 1.0~12.0
- USP L1

- Superior peak shape
- Usable over wide range of pH and temperature
- Usable with 100% aqueous mobile phase

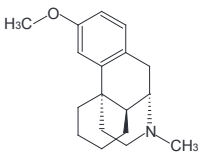
Flexibility in method development

【Efficient mobile phase screening for ionic compounds】

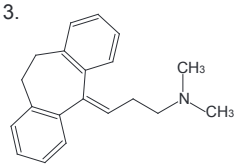


1. 

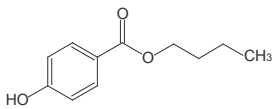
Saccharin
(Acidic compound)
pka=2.2

2. 

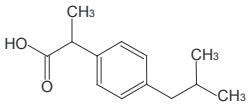
Dextromethorphan
(Basic compound)
pka=8.3

3. 

Amitriptyline
(Basic compound)
pka=9.4

4. 

n-Butylparaben
(Weakly acidic compound)
pka=8.3

5. 

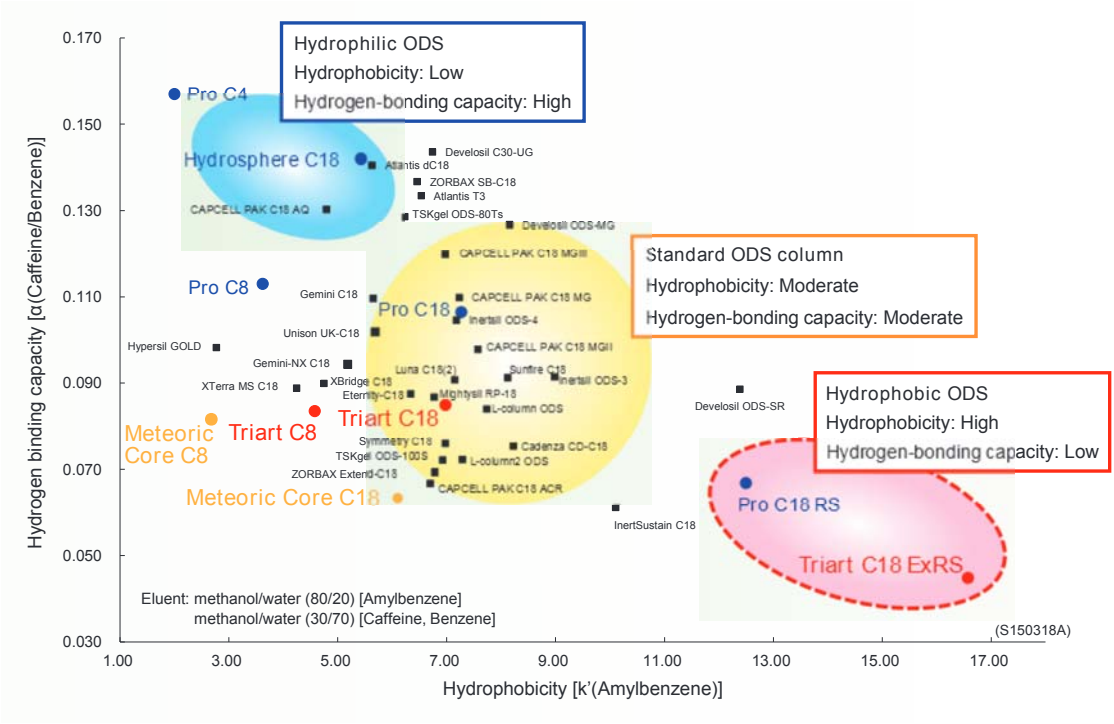
Ibuprofen
(Acidic compound)
pka=4.4

Column	: YMC-Triart C18 5 μm 50 X 2.0 mmI.D.
Eluent	: A) 10 mM HCOOH for pH 2.9 10 mM $HCOONH_4$ for pH 6.1 10 mM $HCOONH_4$-NH_3 for pH 9.9 B) organic solvent 5-90%B (0-10 min), 90%B (10-15 min)
Flow rate	: 0.2 mL/min
Temperature	: 25℃
Detection	: UV at 230 nm

On reversed-phase HPLC, pH and organic solvent are the most important factors to control retention and selectivity. Triart C18 with wide usable pH range offers significant advantage in selection of mobile phase condition. Triart C18 delivers symmetrical peak shapes for all types of compounds. Moreover, this feature is independent from mobile phase pH and mobile phase condition. Chromatographers can choose the most optimal condition by combining various mobile phase conditions such as mobile phase pH, and types of organic solvent/buffer system.

Suitable as a first choice column

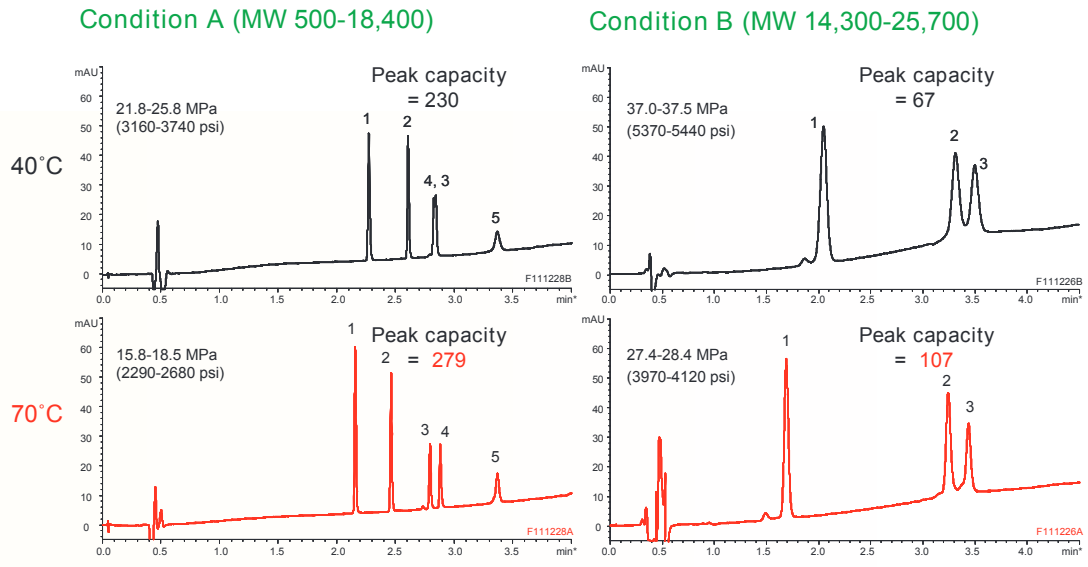
[Comparison of hydrophobicity and hydrogen-bonding capacity of various columns]



Triart C18 has a favorable balance of hydrophobicity and hydrogen bonding capacity, and is used as a versatile first-choice column for method development. In contrast, conventional hybrid silica based ODS columns tend to have low hydrophobicity than conventional silica based columns.

Highly efficient RP-HPLC separation of proteins and peptides using high temperature

[Comparison of separation of peptides and proteins at between 40℃ and 70℃]



Analytes	MW	Peak width ½(min)	
		40°C	70°C
Condition A			
1. Oxytocin	1,007	0.017	0.014
2. Leu-Enkephalin	556	0.015	0.015
3. β -Endorphin	3,465	–	0.016
4. Insulin	5,733	–	0.015
5. β -Lactoglobulin A	18,400	0.043	0.030
Condition B			
1. Lysozyme	14,300	0.069	0.044
2. α -Chymotrypsinogen	25,700	0.080	0.049
3. β -Lactoglobulin A	18,400	0.080	0.048

Column	: YMC-Triart C18 (1.9 µm, 12 nm) , 50 X 2.0 mmI.D.
Eluent	: A) water/TFA (100/0.1) B) acetonitrile/TFA (100/0.1) - condition A B) acetonitrile/2-propanol/TFA (50/50/0.1) - condition B
Gradient	: 10-80%B (0-5 min) - condition A 30-60%B (0-5 min) - condition B
Flow rate	: 0.4 mL/min
Detection	: UV at 220 nm
Injection	: 1 µL (50 µg/mL) - condition A 1 µL (250 µg/mL) - condition B
System	: Agilent 1200SL

PC (peak capacity) = 1 + (gradient time/peak width*)
*peak width = $2W_{0.5h}$ average

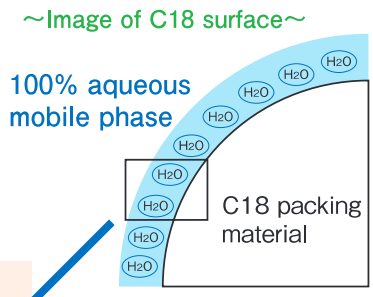
The effect of temperature on separation of peptides and proteins with a variety of molecular weight (MW) is estimated. The separations at 40°C and 70°C are compared. By increasing column temperature to 70°C, selectivity change is observed, and peaks become sharper. Thus, improved resolution especially for larger molecules is obtained. Generally, larger molecules diffuse very slowly compared to small molecules. An elevated temperature can improve efficiency and peak shape by lowering mobile phase viscosity and improving mass transfer.
Temperature is a simple and effective tool to increase resolution in separation of proteins and peptides.

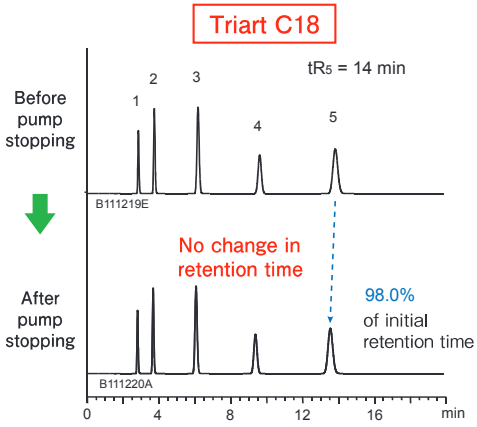
Effective for an analysis of highly polar compounds using 100% aqueous condition

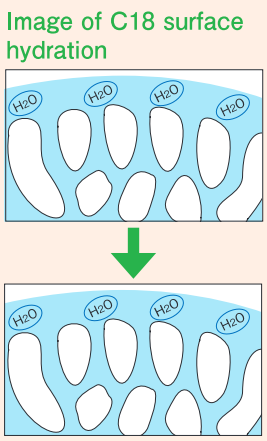
[Retention stability under 100% aqueous mobile phase]

Nucleic bases

1. Cytosine
2. Uracil
3. Guanine
4. Thymine
5. Adenine

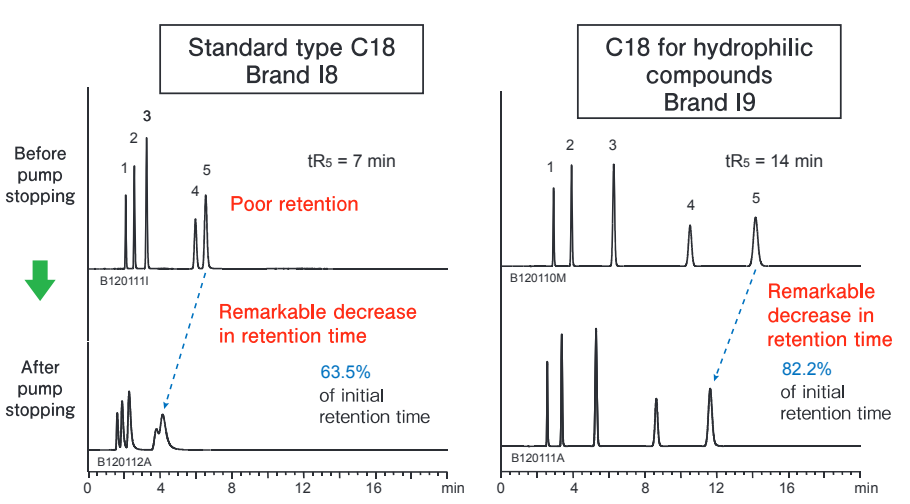


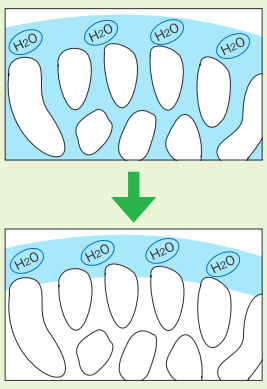




Column	: 5 µm, 150 X 4.6 mmI.D.
Eluent	: 20 mM KH_2PO_4-K_2HPO_4 (pH 6.9)
Flow rate	: 1.0 mL/min
Temperature	: 37℃
Detection	: UV at 254 nm

The surface of Triart C18 is well-hydrated even after stopping pump.
This provides longer and stable retention time of polar nucleic bases.





The surface of packing material is not fully hydrated. Compounds are not partitioned between mobile phase and stationary phase, and therefore its retention becomes shorter.

Under the 100% aqueous mobile phase, conventional C18 columns generally show poorer performance (retention and peak shape) due to low surface hydration caused by repulsion between aqueous mobile phase and hydrophobic bonded phase. There are several C18 columns that are compatible with 100% aqueous mobile phase in the market. Such columns exhibit excellent reproducibility and good retention ability of polar compounds achieved by sufficient surface hydration. On the other hand, classical silica base resin and bonded phase are easily degraded under such highly aqueous condition. Those aqueous compatible columns tend to have short lifetime.

To overcome the shortcomings of classical silica-based columns designed for highly aqueous compatibility, Triart C18 is a highly durable C18 column with trifunctional bonding. C18 phase on the organic/inorganic hybrid silica. Triart C18 is designed to retain both moderate hydrogen bonding capacity and hydrophobicity on the surface by optimizing bonded density of C18 phase. Its versatility is ideal for the first choice ODS column, and also applicable to analyses of polar compounds with 100% aqueous mobile phase condition.

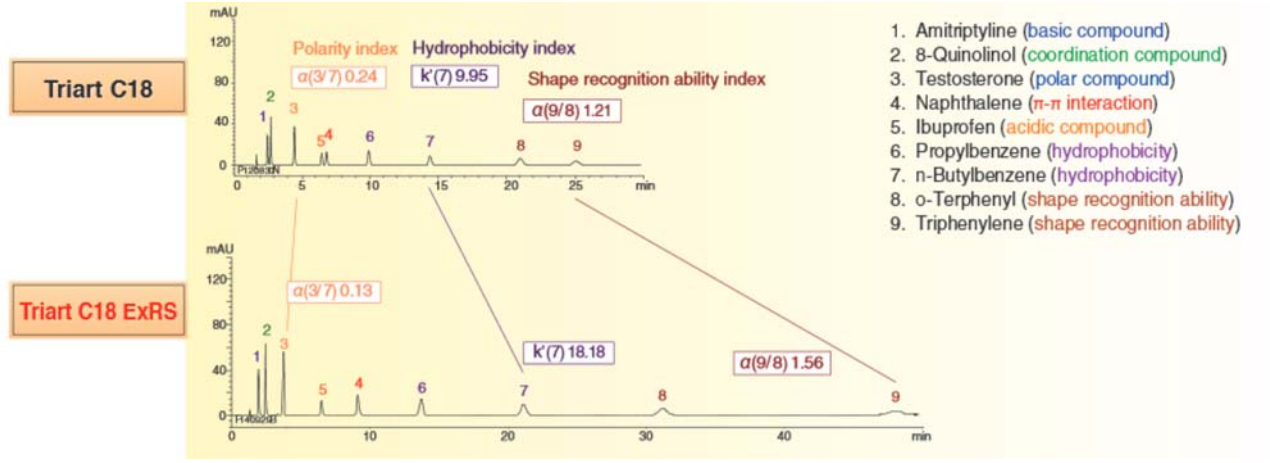
Alternative selectivity to standard C18 columns

YMC-Triart C18 ExRS

- Pore size : 8 nm
- Carbon content : 25%
- Usable pH range : 1.0~12.0
- USP L1

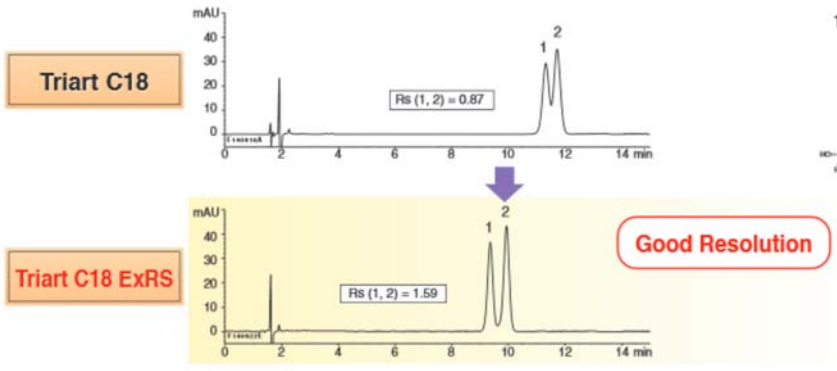
- C18 phase with high density bonding on organic/inorganic hybrid silica gel
- Excellent selectivity of isomers and structural analogs
- Superior chemical durability

Comparison of fundamental separation selectivity

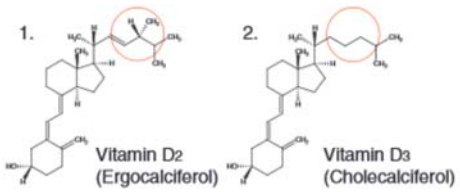


A mixture that consists of compounds with various characteristics is analyzed with Triart C18 and Triart C18 ExRS. Triart C18 ExRS has lower polarity and higher hydrophobicity than the standard Triart C18 column. It also shows improved planar cognitive ability.

Ideal for separations of structural analogs



Good Resolution

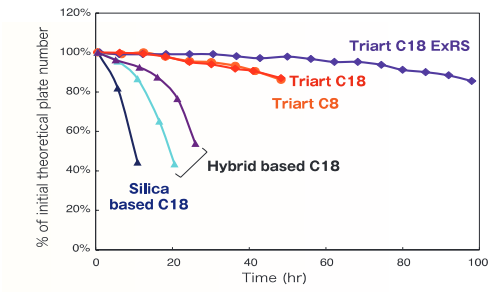


Column	: 5 µm, 150 X 3.0 mmI.D.
Eluent	: THF/acetonitrile (10/90)
Flow rate	: 0.425 mL/min
Temperature	: 30℃
Detection	: UV at 265 nm
Injection	: 4.25 µL (10 µg/mL)

Triart C18 ExRS is effective for separating of structural analogs. This feature is especially useful for separating pharmaceuticals with structurally similar impurities.

Improved durability

Phosphate buffer (pH 11.5), 40℃



Column	: 5 µm, 150 X 4.6 mmI.D.
Eluent	: 50 mM K_2HPO_4-K_3PO_4 (pH 11.5)/ methanol (90/10)
Flow rate	: 1.0 mL/min
Temperature	: 40℃
Sample	: benzyl alcohol

High density bonding of C18 greatly contributes to improved chemical durability.

Effective for fast analysis of compounds with low polarity or for separation of isomers

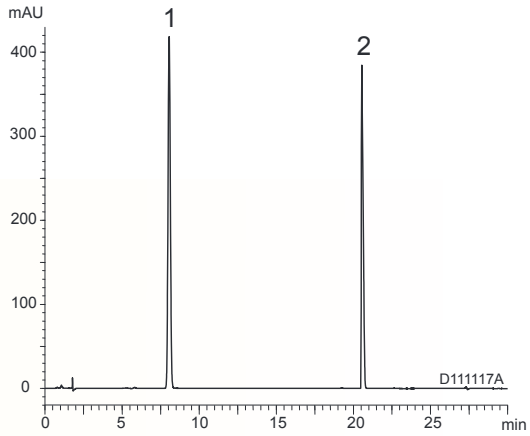
YMC-Triart C8

- Pore size : 12 nm
- Carbon content : 17%
- Usable pH range : 1.0~12.0
- USP L7

- Alternative to the more widely-used C18
- Usable over wide range of pH and temperature
- Ideal for separations of isomers or structural analogs

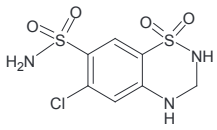
Comparable versatility to C18

【Analysis of drugs】



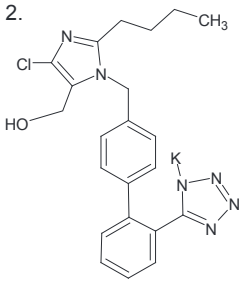
Losartan potassium / hydrochlorothiazide

1.



Hydrochlorothiazide

2.



Losartan potassium

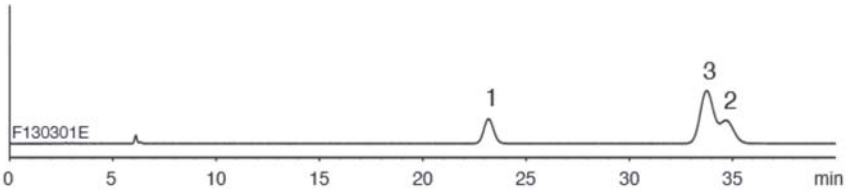
Column	: YMC-Triart C8 5 µm, 150 X 4.0 mmI.D.
Eluent	: A) phosphate buffer (pH 6.7)*/acetonitrile (93/7) B) acetonitrile 0-8%B (0-12 min), 8-62%B (12-28 min) * Dissolve 1.25 g of KH_2PO_4 and 2.01 g of $Na_2HPO_4 \cdot 12H_2O$ in 1000 mL of water
Flow rate	: 1.0 mL/min
Temperature	: 35℃
Detection	: UV at 280 nm
Injection	: 20 µL
(The United States Pharmacopeia 34th; Assay)	

Triart C8 has good chemical durability and peak shapes as good as Triart C18. It is useful in various fields including pharmaceutical products, food and natural products.

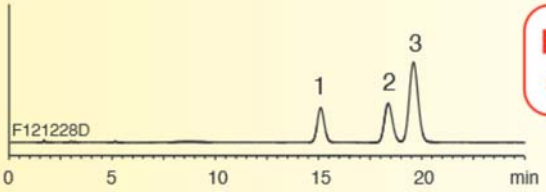
Ideal for separations of isomers or structural analogs

【Separation of positional isomers】

Triart C18



Triart C8

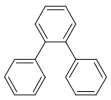


Baseline resolution in shorter analysis time

Column	: 5 µm, 150 X 3.0 mmI.D.
Eluent	: methanol/water (75/25)
Flow rate	: 0.425 mL/min
Temperature	: 30℃
Detection	: UV at 254 nm

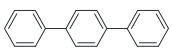
Terphenyl isomers

1.



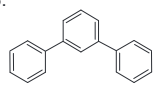
o-Terphenyl

2.



p-Terphenyl

3.



m-Terphenyl

Triart C8 provides superior resolution of Terphenyl isomers to Triart C18. The higher bonded density of C8 contributes to recognition of small difference in structure though the elution profile is similar between C18 and C8. Additionally, C8 phase offers shorter retention time than C18 phase thanks to the low hydrophobicity. These unique characteristics are effective for fast analysis of isomers and compounds with low polarity.

Effective for separation of compounds having long conjugated system by utilizing π-π interaction

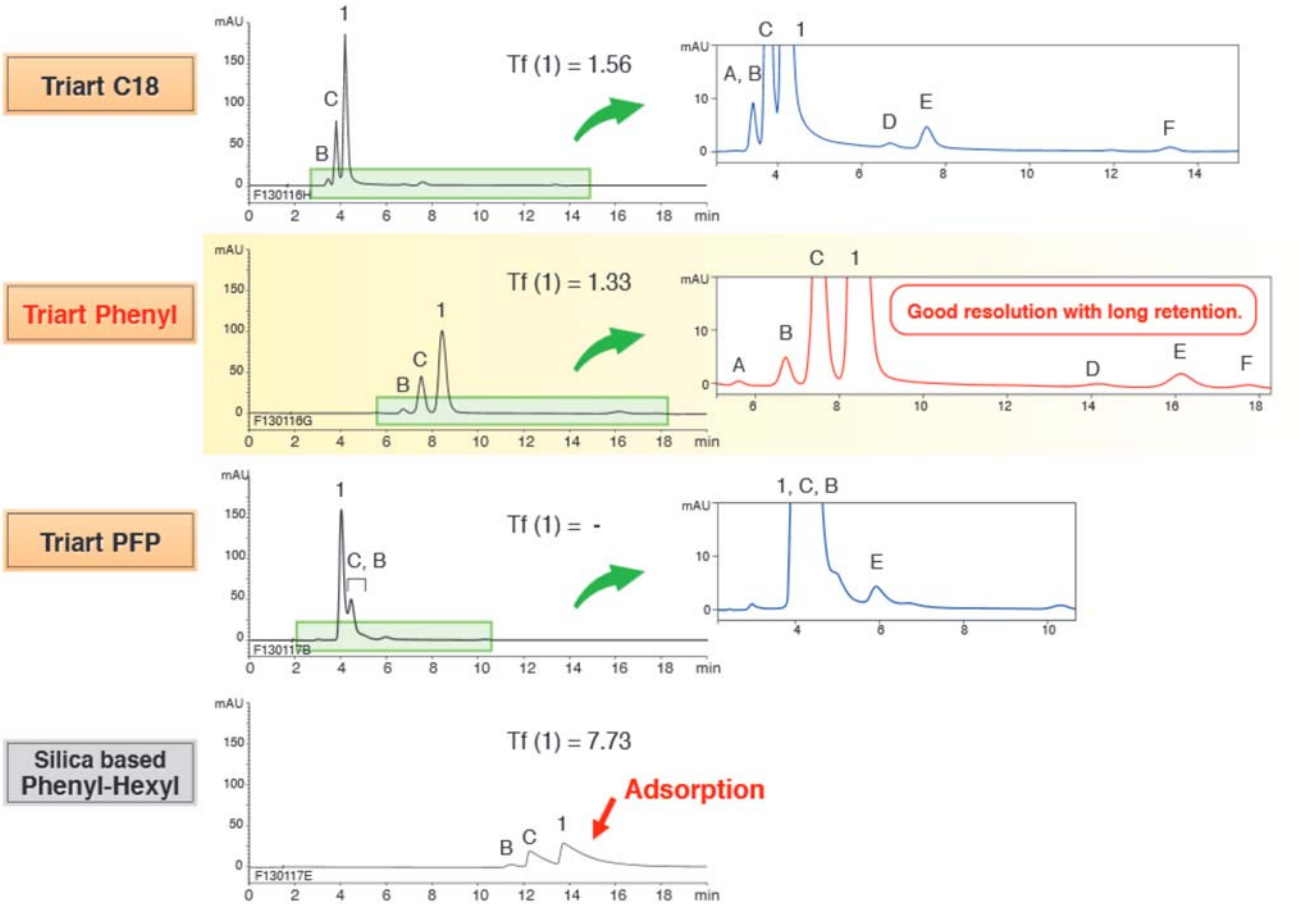
YMC-Triart Phenyl

- Pore size : 12 nm
- Carbon content : 17%
- Usable pH range : 1.0~10.0
- USP L11

- Unique selectivity due π-π interaction
- Ideal for separations of aromatic compounds or compounds having long conjugated system
- Excellent resolution without adsorption and tailing

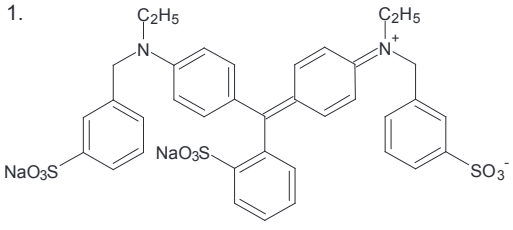
Unique selectivity due to π-π interaction and superior peak shape without adsorption

[Ideal for aromatic compounds and compounds having long conjugated system]



Brilliant Blue FCF and its impurities

1.



Brilliant blue FCF

A - F : Structural analogs in Brilliant Blue FCF reagent

Column	: 5 µm, 150 X 3.0 or 4.6 mmI.D.
Eluent	: methanol/0.1% H_3PO_4 (45/55)
Flow rate	: 0.425 mL/min for 3.0 mmI.D. 1.0 mL/min for 4.6 mmI.D.
Temperature	: 40℃
Detection	: UV at 630 nm

Brilliant blue FCF of acidic triphenylmethane dye and its impurities (presumed to be by-products having similar structure) can not be separated well with Triart C18. On the other hand, they are retained well on Triart Phenyl, and excellent separation and peak shape are obtained. Strong adsorption and poor resolution is observed on a commercially available phenylhexyl column. When it comes to separations of aromatic compounds or compounds with long conjugated system, Triart Phenyl is more suitable than C18 due to strong retention by π-π interaction.

Effective for separation of polar compounds or isomers provided by unique polar interaction

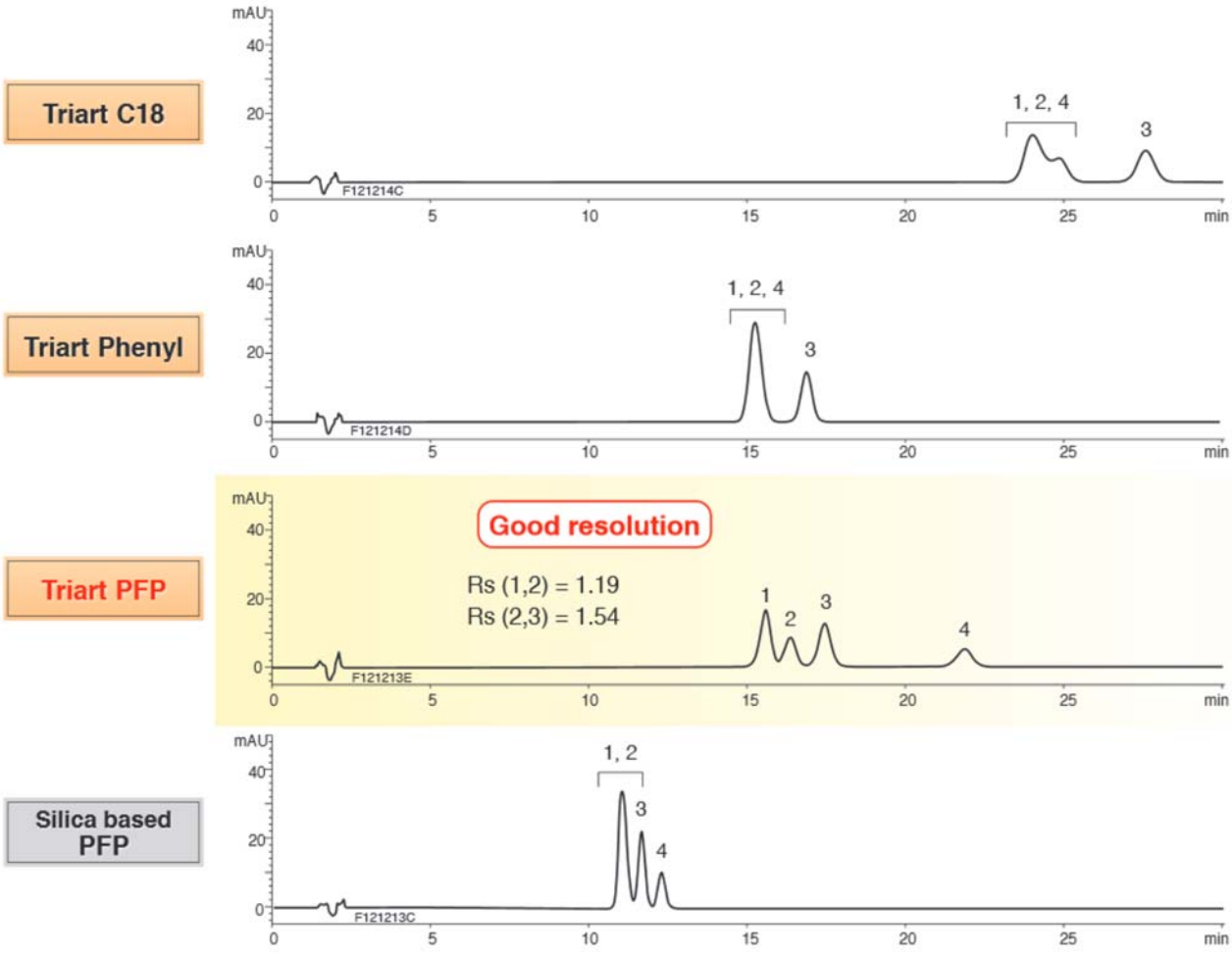
YMC-Triart PFP

- Pore size : 12 nm
- Carbon content : 15%
- Usable pH range : 1.0~8.0
- USP L43

- Alternative selectivity to C18/C8 due to unique polar interaction
- Superior shape recognition ability / steric selectivity
- Ideal for separations of polar compounds or isomers

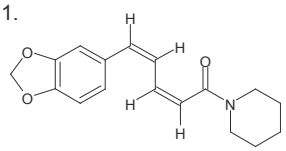
Effective for separation of polar compounds or isomers

[Unique separation provided by various interactions]

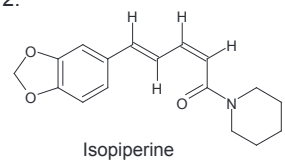


Piperine *cis-trans* isomers

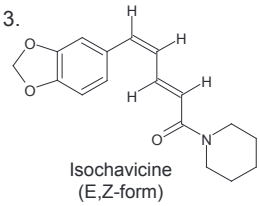
1. Chavicine (Z,Z-form)



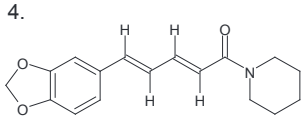
2. Isopiperine (Z,E-form)



3. Isochavicine (E,Z-form)



4. Piperine (E,E-form)



Column	: 5 µm, 150 X 3.0 or 4.6 mmI.D.
Eluent	: acetonitrile/0.1% formic acid (40/60)
Flow rate	: 0.425 mL/min for 3.0 mmI.D. 1.0 mL/min for 4.6 mmI.D.
Temperature	: 25℃
Detection	: UV at 280 nm

Since the differences in hydrophobicity of *cis-trans* isomers of piperine, which is a pungent component contained in pepper, are small, commonly used reversed phase columns are not able to separate them. However Triart PFP can work well because Triart PFP can recognize minor charge localization in a molecule due to various interactions such as π-π and dipole-dipole. It shows high selectivity for compounds with small structural difference.

Effective for separation of highly polar compounds

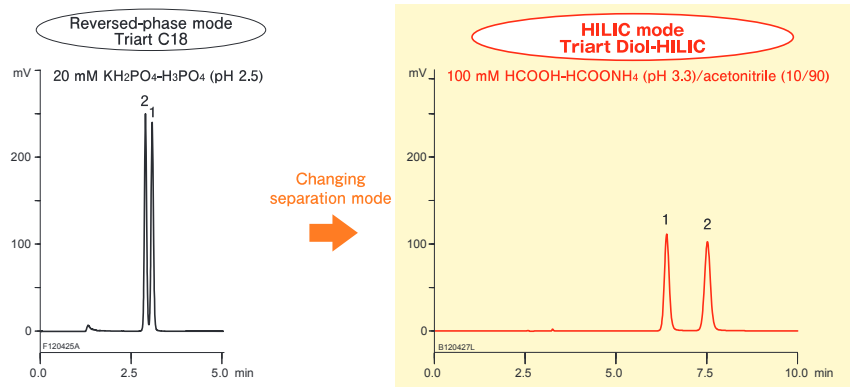
YMC-Triart Diol-HILIC

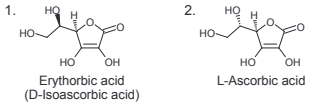
- Pore size : 12 nm
- Carbon content : 12%
- Usable pH range : 2.0~10.0
- USP L20

- Ideal for separations of highly polar compounds, which are hardly retained on a reversed-phase column
- Superior durability and usable under wide range of mobile phase conditions
- Excellent reproducibility with less ionic adsorption

Ideal for separation of highly polar compounds which are hardly retained on a reversed-phase column

【Comparison of reversed-phase and HILIC separations】



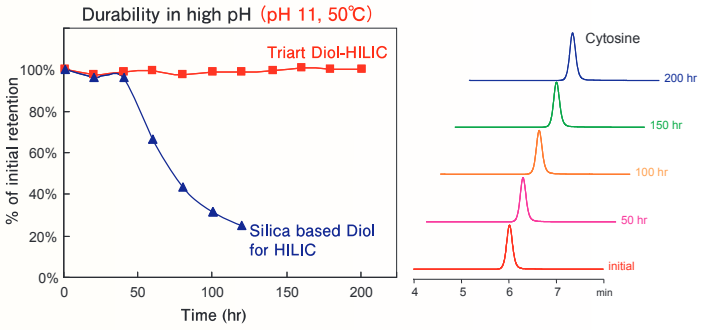


Column	: 5 µm, 150 X 3.0 mmI.D.
Flow rate	: 0.425 mL/min
Temperature	: 40℃
Detection	: UV at 254 nm
Injection	: 4 µL

Triart C18 (reversed-phase) shows very weak retention and poor resolution of L-ascorbic acid and its stereoisomer (erythorbic acid) even with a 100% aqueous mobile phase. On the other hand, Triart Diol-HILIC shows strong retention and better resolution of these compounds with a mobile phase containing 90% organic solvent.

Excellent durability and reproducibility in wide range of conditions

【Extended lifetime in chemically challenging condition】

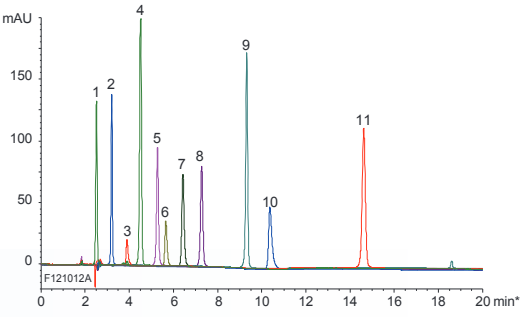


Column	: 5 µm, 150 X 4.6 mmI.D.
Eluent	: acetonitrile/water/NH_3 (90/10/0.1) pH 11.3
Temperature	: 50℃
Flow rate	: 1.0 mL/min
Sample	: cytosine

Triart Diol-HILC provides highly reproducible separations even in high pH (pH 11) and at high temperature (50℃). Triart Diol-HILIC shows extremely long column lifetime even in such chemically harsh condition compared to conventional silica-based Diol column.

Application

【Water soluble vitamins】



1. Caffeine
2. Nicotinamide
3. Pyridoxine hydrochloride
4. Riboflavin
5. Orotic acid
6. Erythorbic acid (D-Isoascorbic acid)
7. L-Ascorbic acid
8. Nicotinic acid
9. 2-O-α-D-Glucopyranosyl-L-ascorbic acid (Ascorbic acid 2-glucoside)
10. Thiamine hydrochloride
11. Cyanocobalamin

Column	: YMC-Triant Diol-HILIC (5 µm, 12 nm), 150 X 3.0 mmI.D.
Eluent	: A) acetonitrile/200mM HCOOH-HCOONH4 (pH 3.6)/water (90/5/5)
	B) acetonitrile/200mM HCOOH-HCOONH4 (pH 3.6)/water (50/5/45)
	0-75%B (0-20 min)
Flow rate	: 0.425 mL/min
Temperature	: 40℃
Detection	: UV at 254 nm
injection	: 4 µL (50 µg/mL)

UHPLC column for ultra-fast separation and high resolution analysis

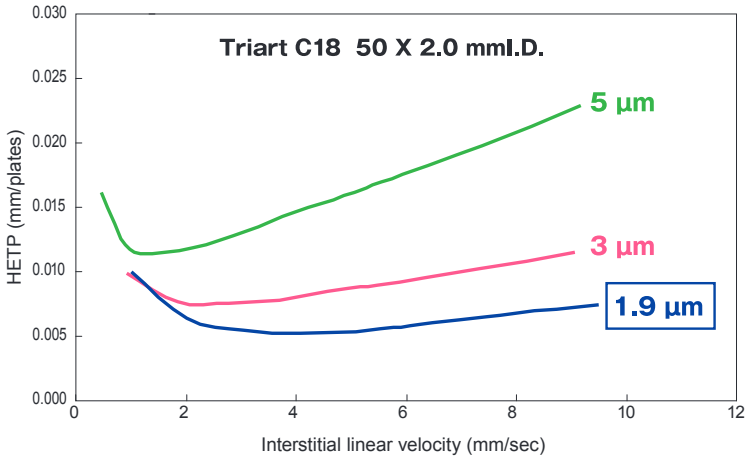
YMC-Triart 1.9 µm

- 1.9 µm column for UHPLC with operating pressure up to 100 MPa
- Same separation/selectivity as 3 µm and 5 µm
- Simple method transfer between conventional HPLC and UHPLC

Ideal for UHPLC analysis

[Correlation between linear velocity and column efficiency]

Van Deemter curves

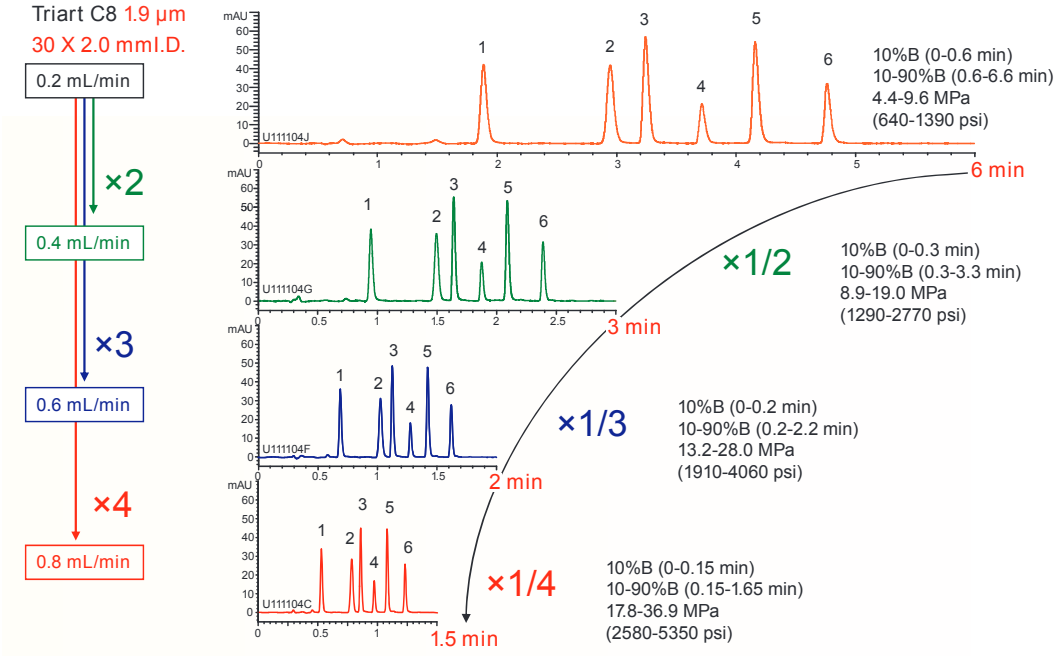


Eluent	: acetonitrile/water (60/40)
Temperature	: 25℃
Sample	: butyl benzoate

Triart 1.9 µm columns exhibit higher efficiency and maintain efficiency over a wide range of flow rate compared to 5 µm and 3 µm columns.

X axis : Interstitial linear velocity (Obtained by dividing column length by dead time (t0); the larger number means faster flow rate.)
Y axis : height equivalent of a theoretical plate (HETP; Obtained by dividing theoretical plate number by column length; the smaller number means higher column efficiency.)

[Increasing throughput]



Drug substances

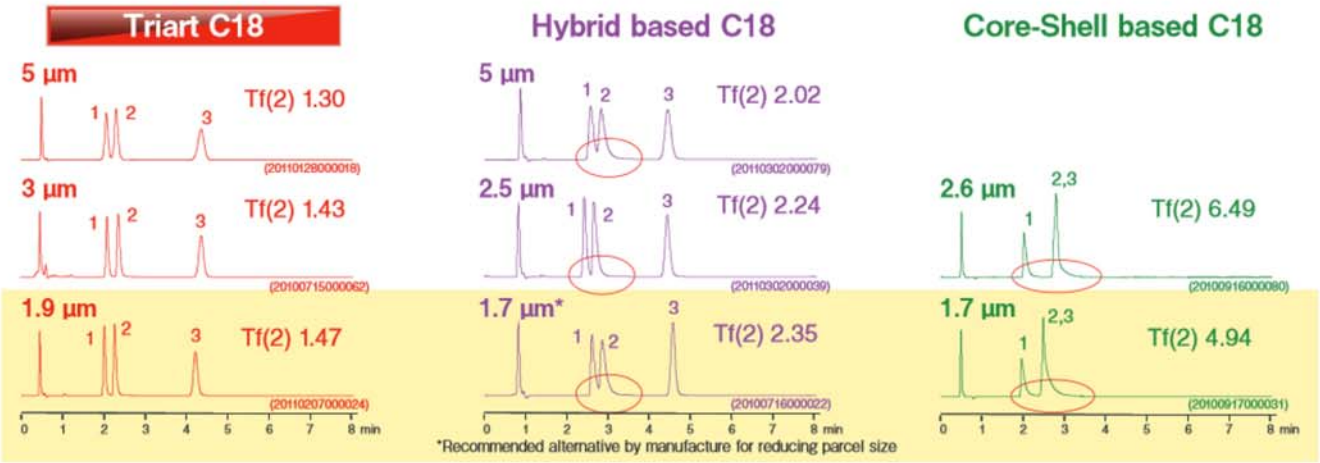
1. Hydrochlorothiazide
2. Valsartan
3. Losartan potassium
4. Amlodipine besilate
5. Atorvastatin calcium hydrate
6. Candesartan cilexetil

Eluent	: A) 10 mM CH_3COONH_4-CH_3COOH (pH 5.5)
	B) acetonitrile
Temperature	: 30℃
Detection	: UV at 254 nm
Injection	: 4 µL
System	: Agilent 1200SL

Triart C8 1.9 µm provides an ultrafast separation of six drug substances which are different in polarity and hydrophobicity within 1.5 minutes by using short column and increasing flow rate.

Seamless method transfer between HPLC and UHPLC

【Identical selectivity across various particle sizes】



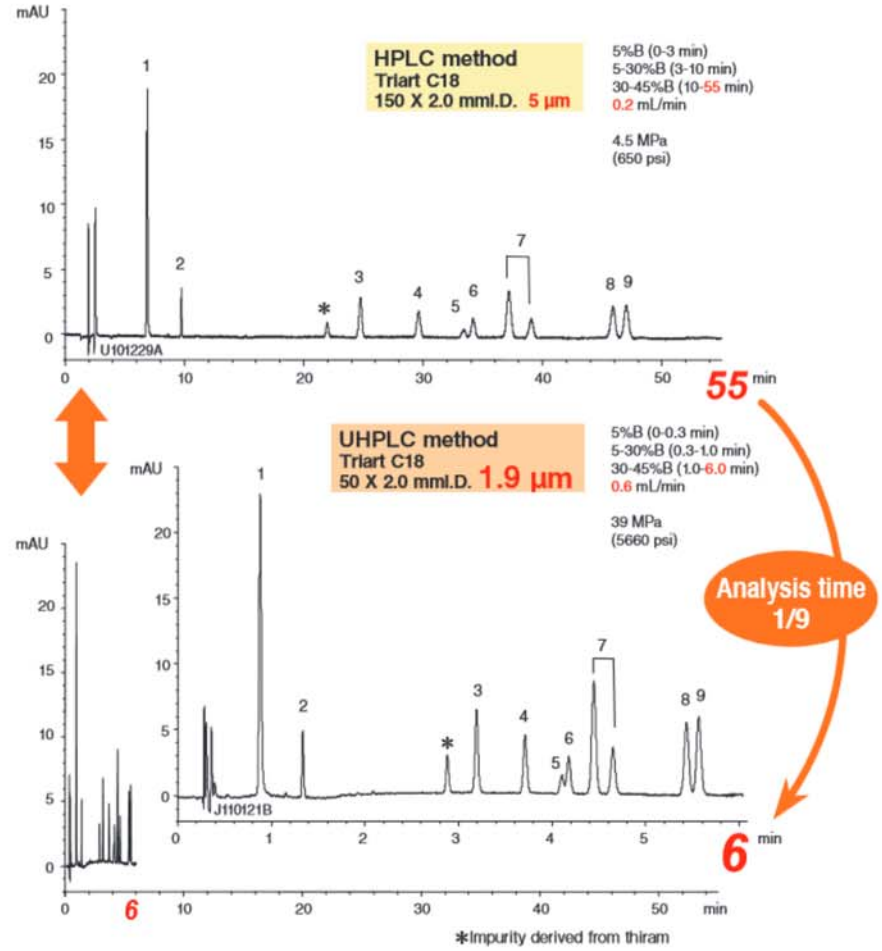
Basic drugs

1. Chlorpheniramine 2. Dextromethorphan 3. Propyl paraben (I.S.)

Column	: 50 X 2.0 mmI.D. or 2.1 mmI.D.
Eluent	: 20 mM KH_2PO_4-KH_2PO_4 (pH 6.9)/acetonitrile (65/35)
Flow rate	: 0.2 mL/min
Temperature	: 40℃
Detection	: UV at 235 nm

Triart columns show the identical selectivity and the excellent peak shapes of basic (ionic) compounds across all of the particle sizes including 1.9 µm. It allows predictable scale up from UHPLC to conventional HPLC and even to semi-preparative LC, and vice versa. In contrast, commercially available C18 columns often show some differences in selectivity, retention, and peak shape between different particle sizes.

【Method transfer between HPLC and UHPLC】



Agrichemicals

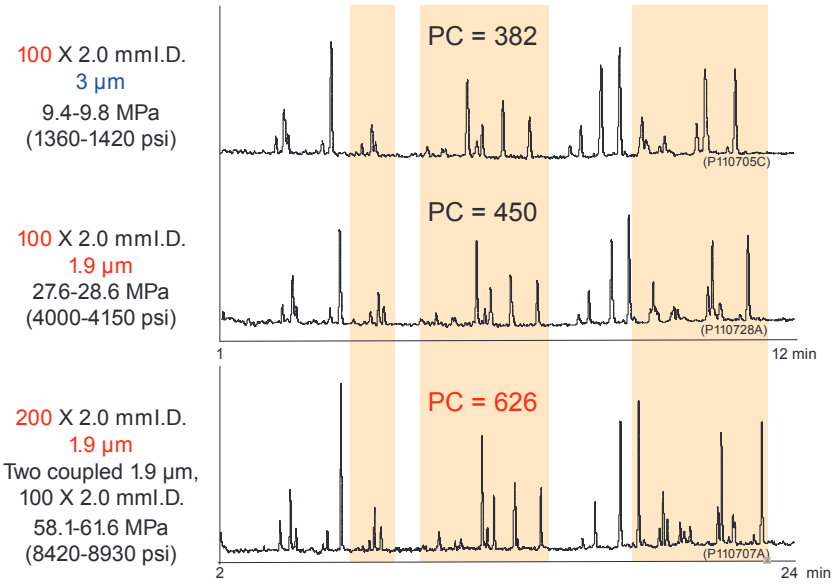
1. Oxine-copper (Copper 8-quinolinolate)
2. Asulam
3. Thiram
4. Triclopyr
5. Mecoprop
6. Flazasulfuron
7. Siduron
8. Halosulfuron-methyl
9. Azoxystrobin

Eluent	: A) water/formic acid (100/0.1) B) acetonitrile/formic acid (100/0.1)
Temperature	: 40℃
Detection	: UV at 240 nm
Injection	: 1 µL (5 µg/mL)
System	: Agilent 1200SL

A 90% decrease of analysis time is achieved by transferring analysis method from conventional HPLC using 5 µm particle to UHPLC using 1.9 µm particle at three times faster linear velocity. Also, a method developed with UHPLC can easily be transferred to HPLC.

Effective as a high resolution column

[Peptide mapping]



PC (peak capacity)
=1+(gradient time/peak width*)
*peak width = $2W_{0.5h}$ average

Co-elution peaks on 3 µm

↓ Changing particle size to 1.9 µm

Improvement of resolution and peak capacity on 1.9 µm

↓ Changing column length to 200 mm

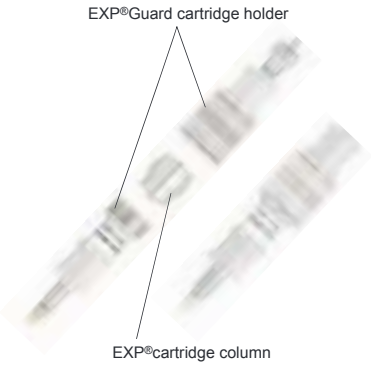
Higher resolution is achieved

Column	: YMC-Triart C18	Temperature	: 70℃
Eluent	: A) water/TFA (100/0.1)	Detection	: UV at 220 nm
	B) acetonitrile/TFA (100/0.08)	Injection	: 10 µL for a single column
	5-40%B (0-15 min) for a single column		20 µL for two coupled columns
	5-40%B (0-30 min) for two coupled columns	Sample	: Triptic digest of Bovine Hemoglobin
Flow rate	: 0.4 mL/min	System	: Agilent 1290

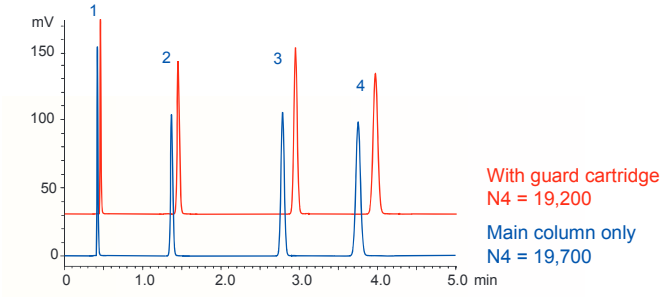
Triart 1.9 µm has superior column efficiency, and a coupling of two 100 mm length of Triart 1.9 µm columns offers outstanding separation ability. This allows the precise separation in an analysis of complicated samples, such as peptide mapping.

Guard cartridge column for UHPLC

- High Pressure resistance up to 100 MPa (15000 psi)
- Low-volume, low-dispersion cartridges minimize the impact on separation
- Zero-dead-volume direct connection to column
- Hand-tight guard replacement (No tools required)



Low-volume, low-dispersion cartridges minimize the impact on separation



Column	: YMC-Triart C18 1.9 µm 100 X 2.0 mmI.D.
Eluent	: acetonitrile/water (60/40)
Flow rate	: 0.4 mL/min
Temperature	: 25°C
Detection	: UV at 270 nm
Injection	: 1 µL
Sample	: 1. Uracil 2. Methyl benzoate 3. Naphthalene 4. Butyl benzoate

EXP® guard cartridge column with low-volume and low-dispersion column minimize the impact on separation. EXP® guard cartridge column provides less than 3% decrease in theoretical plate count.

Hand-tight EXP® fitting

□ Fitting for connecting system and main column/guard cartridge is also available.

EXP is a registered trademark of Optimize Technologies, Inc.

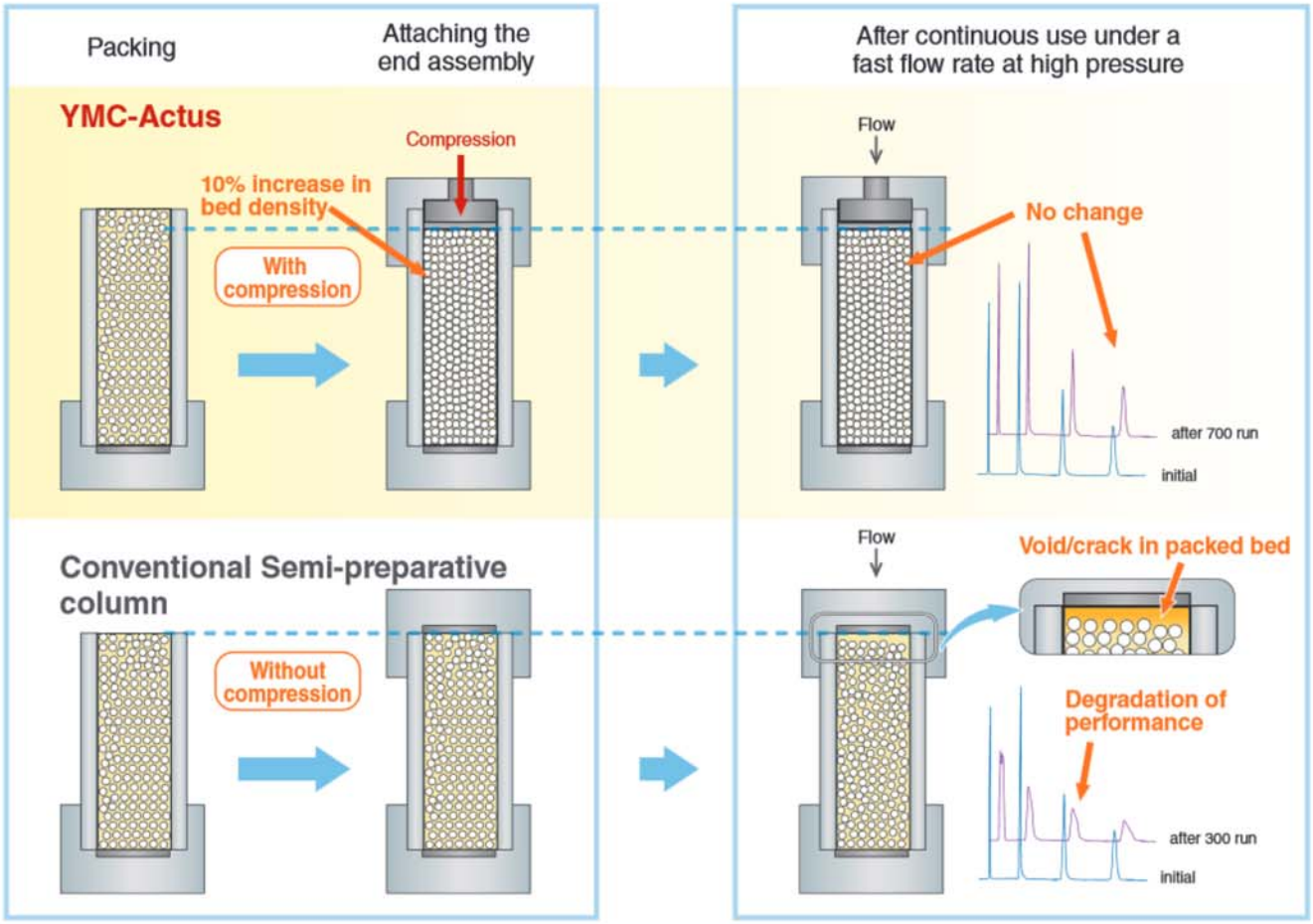
Semi-preparative HPLC columns with outstanding column durability

YMC-Actus Triart

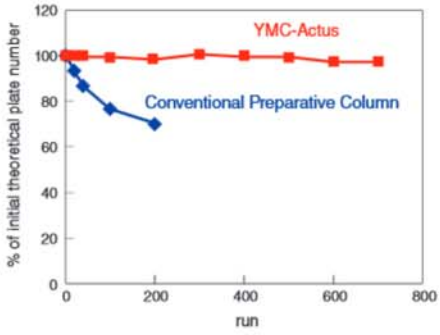
- Improved durability by applying axial compression technology
- Prepacked column for milligram scale preparative HPLC
- Excellent resolution

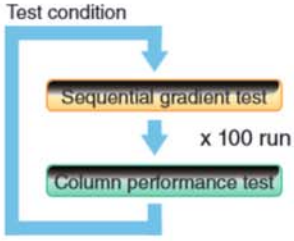
Great durability achieved by applying axial compression technology

【Excellent durability provided by improved bed density】



Column durability study





Sequential gradient test
(high-speed and high-pressure)
Column size : 5 µm, 50 X 20 mmI.D. or 50 X 19 mmI.D.
Eluent : A) water B) methanol
Gradient : 5%B (0-0.5 min),
5-95%B (0.5-3.1 min),
95%B (3.1-3.6 min),
5%B (3.6-4.0 min)
Flow rate : 50 mL/min
Pressure : ~17 MPa

Column performance test
Column size : 5 µm, 50 X 20 mmI.D. or 50 X 19 mmI.D.
Eluent : methanol/water (60/40)
Flow rate : 10 mL/min
Sample : naphthalene

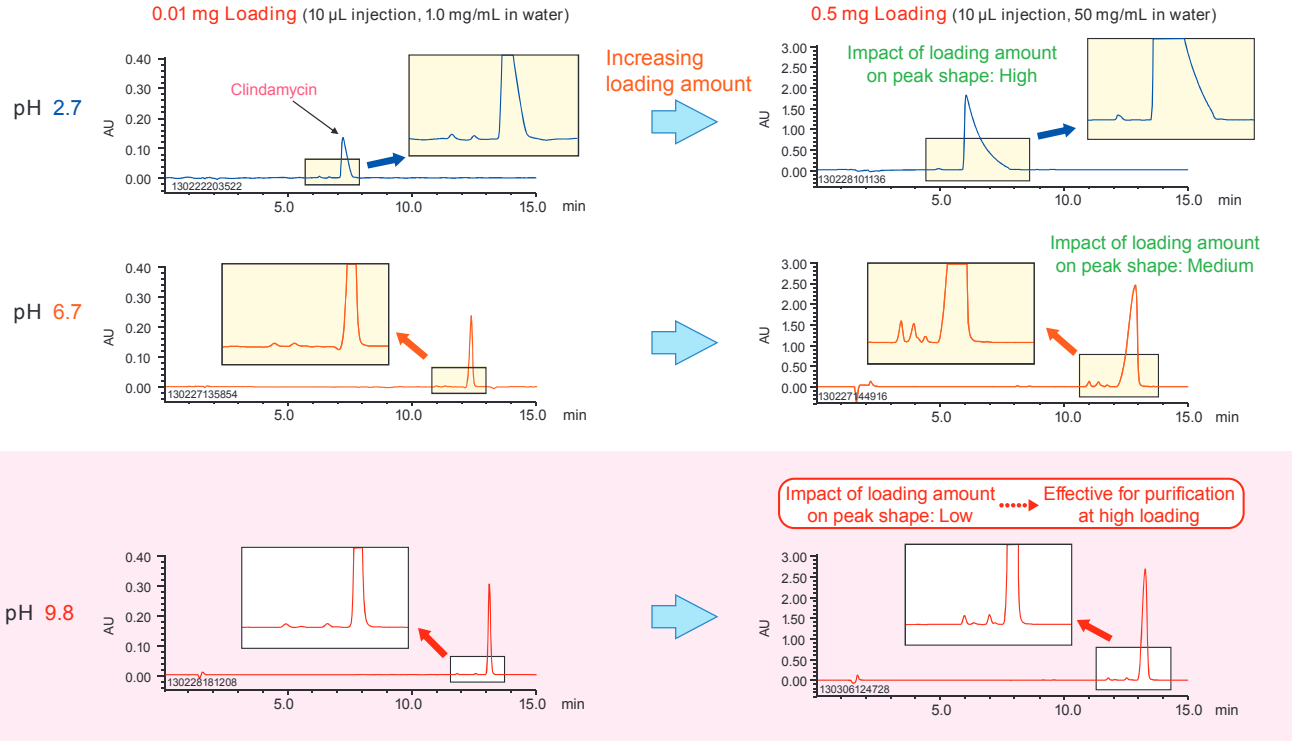
Uniformly high density packing is necessary for high performance HPLC column. DAC (Dynamic Axial Compression) column is widely used for preparative separation in pilot or production scale. It allows uniformly high density packing and prevents formation of voids during use by applying continuous compression. YMC-Actus series have been developed by applying this Axial Compression Technology to semi-prep column. This column bed is compressed adequately by attaching the end assembly newly designed for YMC-Actus. It provides proper bed density (10% higher than conventional columns) and results in higher efficiency and durability.

Separation at high loading

[Purification of basic pharmaceutical: Clindamycin]

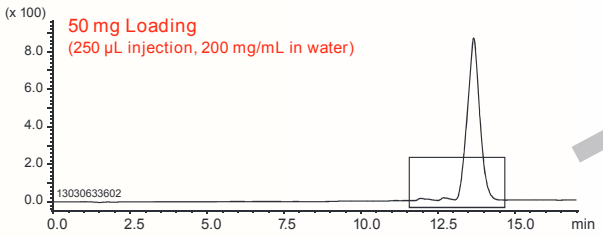
Purification method development

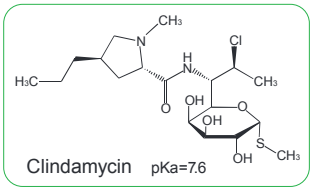
YMC-Triart C18 5 µm, 150 X 4.6 mmI.D.



Purification at pH 9.8

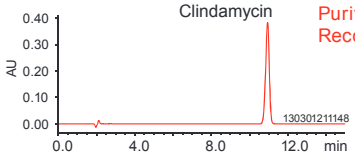
YMC-Actus Triart C18 5 µm, 150 X 20 mmI.D.





Eluent	: A) 20 mM HCOOH for pH 2.7 20 mM $HCOONH_4$ for pH 6.7 20 mM $HCOONH_4$-NH_3 for pH 9.8 B) acetonitrile 10-75%B (0-15 min)
Flow rate	: 1.0 mL/min for 150 X 4.6 mmI.D. 18.9 mL/min for 150 X 20 mmI.D.
Temperature	: 25°C for 150 X 4.6 mmI.D. ambient for 150 X 20 mmI.D.
Detection	: UV at 210 nm
Pressure	: 7.0 MPa for 150 X 4.6 mmI.D. 8.4 MPa for 150 X 20 mmI.D.

Fraction analysis



Column	: YMC-Triart C18 5 µm 150 X 4.6 mmI.D.
Eluent	: 50 mM KH_2PO_4 (pH 7.5 adjusted by 8 M KOH)/ acetonitrile (55/45)
Flow rate	: 1.0 mL/min
Temperature	: 25°C
Detection	: UV at 210 nm
Injection	: 20 µL

Clindamycin and its impurities (related compounds) are more hydrophobic in their un-ionized form and are retained stronger at pH 9.8. At higher pH condition, the resolution between main peak and impurities is improved and the peak shape is less affected by increase of mass loading.
Excellent chemical durability of YMC-Triart offers an option of purification at a high pH that is effective for basic compounds by increasing retention and mass loading. Moreover, highly efficient YMC-Actus Triart has identical performance to YMC-Triart analytical column. This enables direct scale up from analytical condition to preparative condition. The combination of YMC-Triart and YMC-Actus offers highly efficient purification of various compounds.

Ordering Information

Please choose the following gel code, and fill in the square in each product number.
Triart C18 → TA12 Triart C18 ExRS → TAR08 Triart C8 → TO12
Triart Phenyl → TPH12 Triart PFP → TPF12 Triart Diol-HILIC → TDH12
Example) Triart C18 5 µm, 4.6 X 150 mmI.D.
Product number : TA12S05-1546WT

YMC-Triart 1.9 µm

Maximum pressure: 100 MPa; Style of endfitting: Parker style (UPLC compatible)

Particle size (µm)	Column size inner diameter X length (mm)	Product number
1.9	2.0 X 20	SP9-0202PT
	2.0 X 30	SP9-0302PT
	2.0 X 50	SP9-0502PT
	2.0 X 75	SP9-L502PT
	2.0 X 100	SP9-1002PT
	2.0 X 150	SP9-1502PT
	2.1 X 20	SP9-02Q1PT
	2.1 X 30	SP9-03Q1PT
	2.1 X 50	SP9-05Q1PT
	2.1 X 75	SP9-L5Q1PT
	2.1 X 100	SP9-10Q1PT
	2.1 X 150	SP9-15Q1PT
	3.0 X 50	SP9-0503PT
	3.0 X 75	SP9-L503PT
	3.0 X 100	SP9-1003PT
	3.0 X 150	SP9-1503PT

YMC-Triart

Maximum pressure: 45 MPa
Style of endfitting: Parker style

Particle size (µm)	Column size inner diameter X length (mm)	Product number
3	2.1 X 20	S03-02Q1PTH
	2.1 X 33	S03-H3Q1PTH
	2.1 X 50	S03-05Q1PTH
	2.1 X 75	S03-L5Q1PTH
	2.1 X 100	S03-10Q1PTH
	2.1 X 150	S03-15Q1PTH
	3.0 X 50	S03-0503PTH
	3.0 X 75	S03-L503PTH
	3.0 X 100	S03-1003PTH
	3.0 X 150	S03-1503PTH
	4.6 X 33	S03-H346PTH
	4.6 X 50	S03-0546PTH
	4.6 X 75	S03-L546PTH
	4.6 X 100	S03-1046PTH
	4.6 X 150	S03-1546PTH
	4.6 X 250	S03-2546PTH
5	2.1 X 20	S05-02Q1PTH
	2.1 X 33	S05-H3Q1PTH
	2.1 X 50	S05-05Q1PTH
	2.1 X 75	S05-L5Q1PTH
	2.1 X 100	S05-10Q1PTH
	2.1 X 150	S05-15Q1PTH
	3.0 X 50	S05-0503PTH
	3.0 X 75	S05-L503PTH
	3.0 X 100	S05-1003PTH
	3.0 X 150	S05-1503PTH
	4.0 X 150	S05-1504PTH
	4.0 X 250	S05-2504PTH
	4.6 X 33	S05-H346PTH
	4.6 X 50	S05-0546PTH
	4.6 X 75	S05-L546PTH
	4.6 X 100	S05-1046PTH
	4.6 X 150	S05-1546PTH
	4.6 X 250	S05-2546PTH

Maximum pressure: 10-25 MPa, depending on dimensions
Style of endfitting: Waters style

Particle size (µm)	Column size inner diameter X length (mm)	Product number
3	2.0 X 20	S03-0202WT
	2.0 X 30	S03-0302WT
	2.0 X 50	S03-0502WT
	2.0 X 75	S03-L502WT
	2.0 X 100	S03-1002WT
	2.0 X 150	S03-1502WT
	3.0 X 50	S03-0503WT
	3.0 X 75	S03-L503WT
	3.0 X 100	S03-1003WT
	3.0 X 150	S03-1503WT
	4.6 X 35	S03-H546WT
	4.6 X 50	S03-0546WT
	4.6 X 75	S03-L546WT
	4.6 X 100	S03-1046WT
	4.6 X 150	S03-1546WT
	4.6 X 250	S03-2546WT
5	2.0 X 20	S05-0202WT
	2.0 X 30	S05-0302WT
	2.0 X 50	S05-0502WT
	2.0 X 75	S05-L502WT
	2.0 X 100	S05-1002WT
	2.0 X 150	S05-1502WT
	3.0 X 50	S05-0503WT
	3.0 X 75	S05-L503WT
	3.0 X 100	S05-1003WT
	3.0 X 125	S05-R503WT
	3.0 X 150	S05-1503WT
	4.0 X 125	S05-R504WT
	4.0 X 150	S05-1504WT
	4.0 X 250	S05-2504WT
	4.6 X 35	S05-H546WT
	4.6 X 50	S05-0546WT
	4.6 X 75	S05-L546WT
	4.6 X 100	S05-1046WT
	4.6 X 150	S05-1546WT
	4.6 X 250	S05-2546WT
	6.0 X 150	S05-1506WT
	6.0 X 250	S05-2506WT
	10 X 150	S05-1510WT
	10 X 250	S05-2510WT

Ordering Information

Please choose the following gel code, and fill in the square in each product number.
Triart C18 → TA12 Triart C18 ExRS → TAR08 Triart C8 → TO12
Triart Phenyl → TPH12 Triart PFP → TPF12 Triart Diol-HILIC → TDH12
Example) Triart C18 5 µm, 4.6 X 150 mmI.D.
Product number : TA12S05-1546WT

YMC-Actus Triart

Maximum pressure: 30 MPa; Style of endfitting: Waters style

Particle size (µm)	Column size inner diameter X length (mm)	Product number
5	20 X 50	□S05-0520WX
	20 X 100	□S05-1020WX
	20 X 150	□S05-1520WX
	20 X 250	□S05-2520WX
	30 X 50	□S05-0530WX
	30 X 75	□S05-L530WX
	30 X 100	□S05-1030WX
	30 X 150	□S05-1530WX
	30 X 250	□S05-2530WX

EXP®Guard Cartridge Column/Cartridge Column

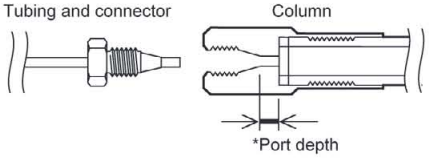
Particle size (µm)	Column size inner diameter X length (mm)	Quantity	Product number
1.9	2.1 X 5	3-pack	□SP9-E5Q1CC*
	3.0 X 5		□SP9-E503CC*
3	2.1 X 10	5-pack	□S03-01Q1GC
	3.0 X 10		□S03-0103GC
	4.0 X 10		□S03-0104GC
5	2.1 X 10	5-pack	□S05-01Q1GC
	3.0 X 10		□S05-0103GC
	4.0 X 10		□S05-0104GC
	10 X 10	2-pack	□S05-0110CC
	20 X 10		□S05-0120CC
	30 X 10		□S05-0130CC

∗ Excluding Triart Diol-HILIC.

EXP®Guard Cartridge Holder/Cartridge Holder Set/Cartridge Holder

EXP®direct connect holder (inner diameter : 2.1 and 3.0 mm 2 titanium hybrid ferrule and 1 nut included)	XPCHUHP
Cartridge holder set (10 mm length) (a cartridge holder (1 set), and a column coupler included)	XPGCH-Q1
Cartridge holder (inner diameter : 10 mm)	XPCHSPW1
Cartridge holder (inner diameter : 20 mm)	XPCHSPW2
Cartridge holder (inner diameter : 30 mm)	XPCHSPW3

Consideration of connector and column fittings



The end of the product number	*Port depth	Style of endfitting
PT / PTH	2 mm	Parker style (UPLC compatible)
WT / WX	3 mm	Waters style

EXP is a registered trademark of Optimize Technologies, Inc.
UPLC is a registered trademark of Waters Corporation

16021KⓎ