

# 13

## Packing Materials

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## Packing materials

## Packing materials for preparative separation

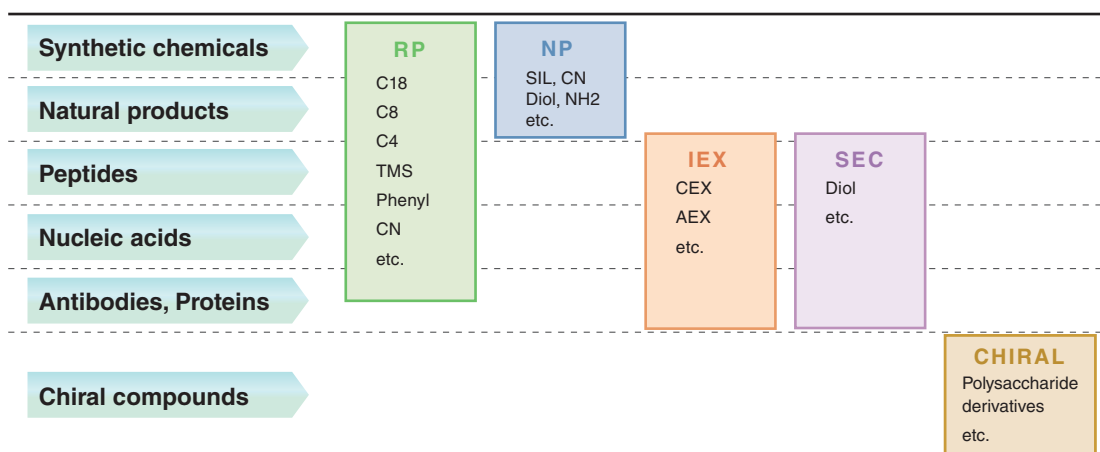
YMC offers packing materials for various purposes: HPLC, flash/open chromatography, chiral separation, and bioprocess chromatography.

Our packing materials with high durability and high loading capacity are effective for not only HPLC but supercritical fluid chromatography (SFC) and simulated moving bed (SMB) chromatography, and enable highly efficient and cost effective in various fields such as pharmaceuticals and foods.

## Abundant product lineup for wide separation range

## ~ Enabling selection of optimum packing materials for the target substances ~

YMC offers various products, such as HPLC packing including organic/inorganic hybrid silica based materials, ion exchange media for bioseparation, and chiral separation packing materials. Selecting the suitable separation mode and phase of the material can achieve effective purification of small molecules, biologics (including oligonucleotides, peptides, and proteins), and chiral compounds.

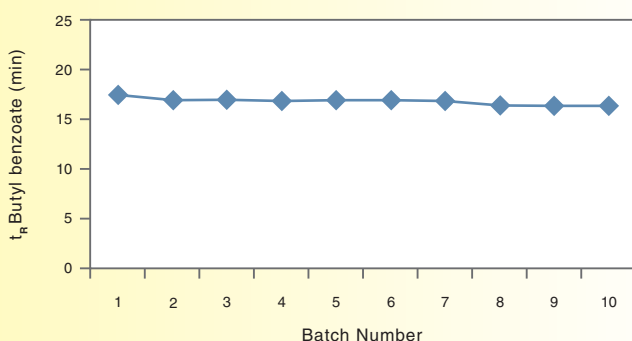


## Production capacity/quality control

YMC can offer packing materials on the scale of 100 tons/year. YMC packing materials achieve excellent batch-to-batch reproducibility by thorough quality control, so those are highly valued in various fields, including pharmaceuticals, foods, and chemicals, all over the world. DMF (Drug Master File) registration indicates the high level of reliability of YMC products.

## Excellent batch-to-batch reproducibility

The reproducibility of retention time among 10 batches of packing materials



Column : YMC\*GEL ODS-A-HG (10 μm, 120 Å)  
250 X 6.0 mm I.D.  
Eluent : acetonitrile/water (60/40)  
Flow rate : 1.7 mL/min  
Temperature : 40°C  
Detection : UV at 270 nm  
Sample : *n*-butyl benzoate

### for HPLC and flash/open chromatography

YMC offers packing materials based on organic/inorganic hybrid silica (YMC-Triart) and silica gel. YMC packing materials with various phases and particle sizes meet any purpose and requirement. It is effective also in semi-preparative separation as well as industrial separation using axial compression column.

YMC offers dynamic axial compression columns DAD of automatic self-packing type and preparative HPLC system K-Prep adequate for the packing materials.



DAD

K-Prep

### for Chiral separation

CHIRAL ART are HPLC packing materials immobilized/coated with polysaccharide derivatives as chiral selectors, and are suitable for the separation of a wide range of chiral compounds. CHIRAL ART packing materials have excellent mechanical strength and chemical stability that can provide excellent peak shape without tailing. It enables to smooth and easy scale up from analytical to preparative purification. CHIRAL ART are effective for supercritical fluid chromatography (SFC) and simulated moving bed (SMB) as well as HPLC, and achieve high efficiency and low-cost purification.

### for Bioprocess chromatography

BioPro IEX media are adequate for the biopharmaceuticals and protein purification. BioPro IEX media, which are based on hydrophilic polymer with low nonspecific adsorption, are designed for the capture step to polishing step of proteins and nucleotides. High dynamic binding capacity (DBC) and high recovery allow fast purification process at a large scale. They offer high productivity on industrial purification of peptides, proteins, and nucleotides including biopharmaceuticals such as antibodies.

Various types of screening kits offer significant advantage and efficiency in media screening and purification method development.

YMC offers biochromatography systems and columns.

\* See chapter 15 (pp.151-) for details of preparative systems



YMC Pilot

BioStream

## Packing materials

## Packing materials for HPLC and flash/open chromatography

## Specifications

Product	Characteristics	Particle size (μm)	Pore size (Å)	Usable pH range	Page
Triart C18	Suitable as a first choice ODS packing with excellent durability	3, 5	120	1-12	49-51, 127
Triart Prep C18-S	Preparative ODS packing allows the effective cleaning of the gel with alkaline solution	10, 15, 20	120	2-10	127, 129-131
Triart C8	Effective for fast separation of compounds with low polarity or for separation of isomers	3, 5	120	1-12	53, 127
Triart Prep C8-S	Preparative C8 packing allows the effective cleaning of the gel with alkaline solution	10, 15, 20	200	2-10	127, 129-131
Triart SIL Triart Prep SIL	Organic/inorganic hybrid silica based packing material	3, 5, 10, 15, 20	120, 200	—	127, 129-131
ODS-A ODS-A-HG	Currently in use worldwide ODS with wide pore size available, useful for separation of proteins and peptides	3, 5, 75, 150 10, 15, 20, 50	120, 200, 300	2-7.5	82, 127 127, 132
ODS-AM	Outstanding batch-to-batch reproducibility	3, 5	120	2-7.5	82, 127
ODS-AQ ODS-AQ-HG	Superior separation of hydrophilic compounds	3, 5 10, 15, 20, 50	120, 200, 300	2-7.5	83, 127 127, 132
C <sub>8</sub> C <sub>8</sub> -HG	Useful for separation of relatively highly hydrophobic compounds, useful for separation of proteins and peptides	3, 5 10, 15, 20, 50	120, 200, 300	2-7.5	84, 127 132
C <sub>4</sub> C <sub>4</sub> -HG	C4 with wide pore size available, useful for separation of proteins and peptides	3, 5 10, 15, 20, 50	120, 200, 300	2-7.5	84, 127 132
TMS TMS-HG	Allowing rapid elution compared to other packing materials for retention based on hydrophobic interaction	3, 5 10, 15, 20, 50	120, 200, 300	2-7.5	85, 127 132
Ph (Phenyl) Ph-HG	The π electron interaction gives a separation selectivity different from ODS	3, 5 10, 15, 20, 50	120, 200, 300	2-7.5	85, 127 132
CN CN-HG	The medium polarity of the bonded phase allows selectable normal-phase and reversed-phase separation modes	3, 5 10, 15, 20, 50	120, 200, 300	2-7.5	86, 127 132
YMCbasic	Superior separation of basic compounds and peptides	3, 5, 10	200	2-7.5	87
Omega	Superior separation of omega-fatty acids	10, 20, 50	—	2-7.5	—
SIL SIL-HG	Fully porous silica gel packing material, popular among normal-phase products	3, 5, 75, 150 10, 15, 20, 50	60, 120, 200, 300	2-7.5	96, 127 127, 132
Diol Diol-HG	Useful for gel filtration or normal-phase applications	3, 5 10, 15, 20, 50	60, 120, 200, 300	2-7.5	34-35 132
NH <sub>2</sub> NH <sub>2</sub> -HG	Chemically bonded with aminopropyl groups	5 10, 15, 20, 50	120, 200, 300	2-7.5	100, 127 132
CHIRAL ART	Packing material with polysaccharide derivatives chiral selector	3, 5, 10, 20	—	2-9	62-66, 133

## Ordering Information –Packing materials–

### High resolution packing materials

Packing material	Particle size (µm)	Pore size (Å)	Product number
Triart C18	3	120	TA12S03
	5		TA12S05
Triart C8	3	120	TO12S03
	5		TO12S05
Triart SIL	3	120	TS12S03
	5		TS12S05
ODS-A	3	120	AA12S03
	5		AA12S05
	5	300	AA30S05
ODS-AM	3	120	AM12S03
	5		AM12S05
ODS-AQ	3	120	AQ12S03
	5		AQ12S05
C <sub>8</sub>	5	120	OC12S05
	5	300	OC30S05
C <sub>4</sub>	5	120	BU12S05
	5	300	BU30S05
TMS	5	120	TM12S05
Ph	5	120	PH12S05
CN	5	120	CN12S05
	5	300	CN30S05
SIL	5	60	SL06S05
	5	120	SL12S05
NH <sub>2</sub>	5	120	NH12S05

### Bulk packing materials

Packing material	Particle size (µm)	Pore size (Å)	Product number
Triart Prep C18-S	10	120	TAS12S11
	15		TAS12S16
	20		TAS12S21
Triart Prep C8-S	10	200	TOS20S11
	15		TOS20S16
	20		TOS20S21
Triart Prep SIL	10	120	TSS12S11
	15		TSS12S16
	20		TSS12S21
ODS-A-HG	10	120	AAG12S11
	15		AAG12S16
	20		AAG12S21
	50		AAG12S50
ODS-AQ-HG	10	120	AQG12S11
	15		AQG12S16
	20		AQG12S21
	50		AQG12S50
SIL-HG	10	120	SLG12S11
	15		SLG12S16
	20		SLG12S21
	50		SLG12S50

### Packing materials for open column chromatography

Packing material	Particle size (µm)	Pore size (Å)	Product number
ODS-A	75	120	AA12S75
	150		AA12SA5
SIL	75	120	SL12S75
	150		SL12SA5

## Packing materials

## Scale up to preparative separation

To establish a preparative-scale separation and purification method, separation conditions are first developed in analytical scale, then shifted to preparative scale. For this scale-up, particle size, column inner diameter and length are selected based on sample load and specifications of a purification system to be used. Then, further studies are conducted to optimize the separation conditions and load for the selected particle size. (See pp.108-109 for details of optimization method for isolation/purification)

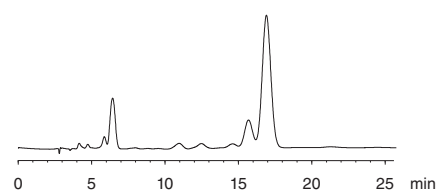
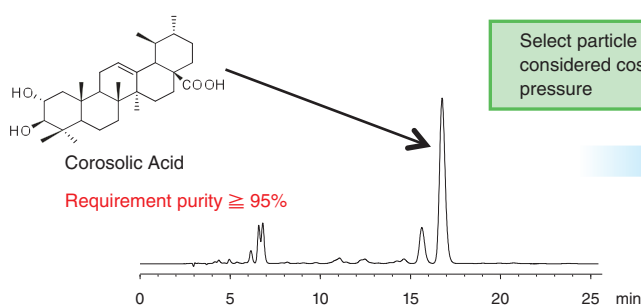
YMC offers packing materials for a wide range of applications from laboratory scale to plants scale. Furthermore, YMC's solid foundation of knowledge and resources help it purpose the most suitable preparative columns such as dynamic axial compression columns, and preparative systems as well as contract services for method development/optimization and/or execution of preparative purification.

## Purification of corosolic acid from plant extract

## Analysis

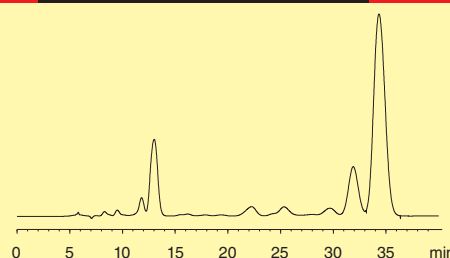
5  $\mu\text{m}$ , 120 Å, 250 X 4.6 mm I.D., 1.0 mL/min

10  $\mu\text{m}$ , 120 Å, 250 X 4.6 mm I.D., 1.0 mL/min



Separation improvement to lower flow rate

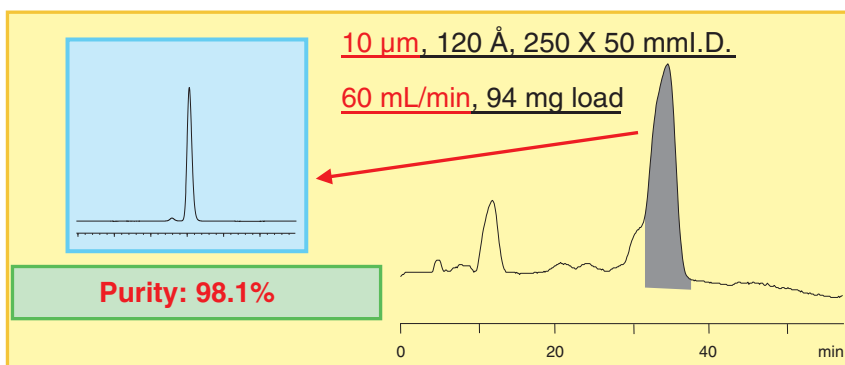
10  $\mu\text{m}$ , 120 Å, 250 X 4.6 mm I.D., 0.5 mL/min



Optimization sample loading

Perform the preparative separation in the maximum load

## Purification



Column : ODS-AQ  
Eluent : methanol/water/TFA  
(85/15/0.05)  
Temperature : ambient  
Detection : UV at 210 nm

## YMC-Triart

- Excellent mechanical stability
- Excellent chemical durability and compatible with alkaline solution
- Outstanding cost-effectiveness

■ Particle size: 3, 5, 10, 15, 20  $\mu\text{m}$

### Applicable from laboratory scale purification to industrial scale

Triart, YMC-Triart and YMC-Triart Prep, are organic/inorganic hybrid silica packing materials for preparative separation.

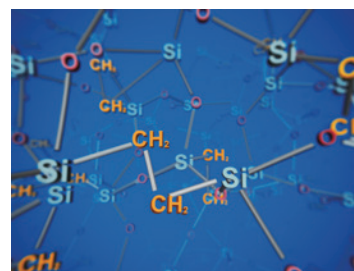
Triart's excellent durability allows the effective cleaning of the gel with alkaline solution. It provides excellent mechanical stability, and can be packed into a column repeatedly. Longer lifetime of Triart greatly contributes to reduction of production cost.

### Specifications

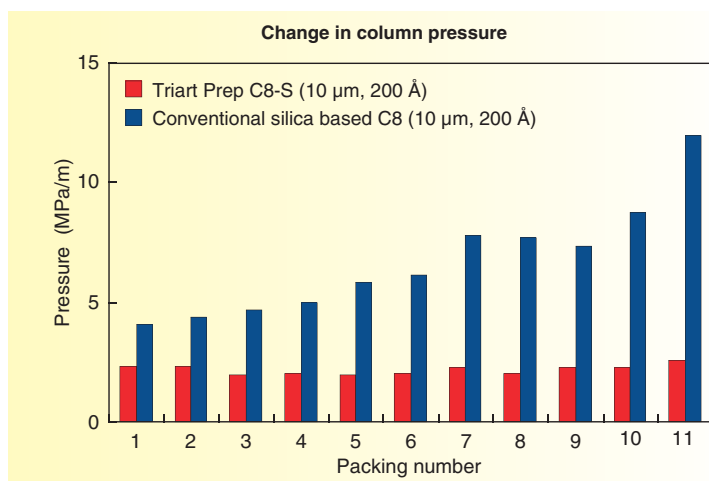
	Triart SIL	Triart C18	Triart C8	Triart Prep SIL	Triart Prep C18-S	Triart Prep C8-S
Particle size ( $\mu\text{m}$ )	3, 5			10, 15, 20		
Pore size ( $\text{\AA}$ )	120			120, 200	120	200
Carbon content (%)	—	20	17	—	20	13
Usable pH range	—	1-12		—	2-10 for regular use (-12 for alkaline CIP)	

### Versatile hybrid based material

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.

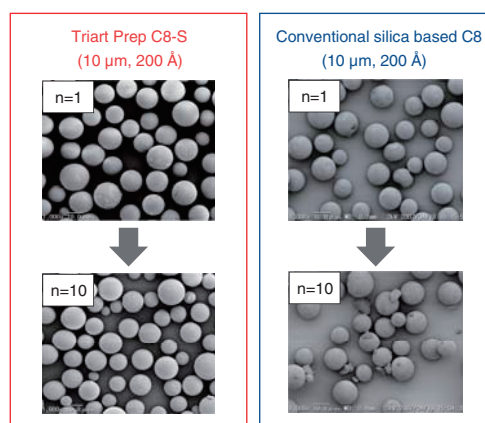


### Excellent mechanical stability



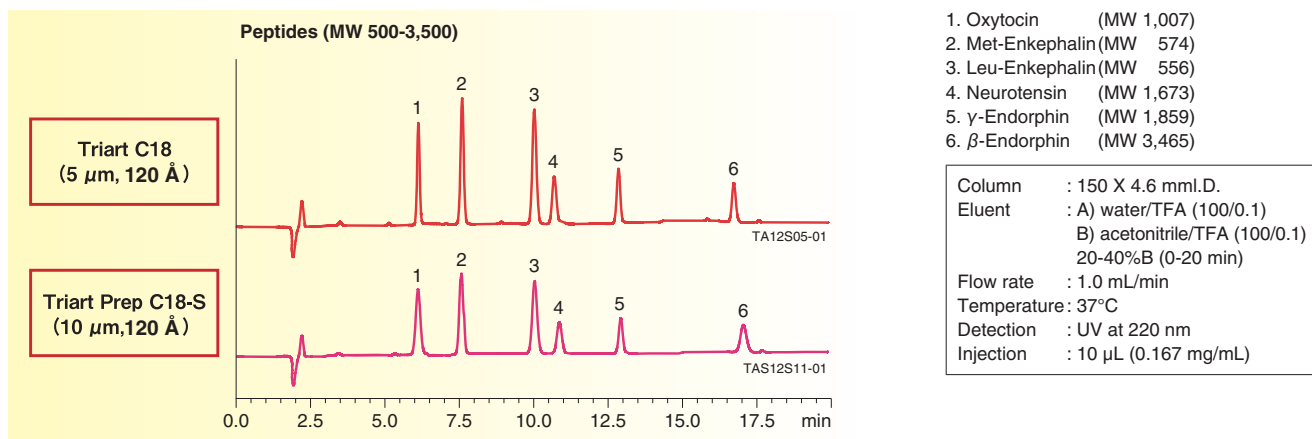
Conditions of column packing  
Column size : 100 X 50 mm I.D., Packing pressure : 6.5 MPa  
Conditions of pressure measurement  
Eluent : methanol/water (85/15), Flow rate : 50 mL/min

### SEM images



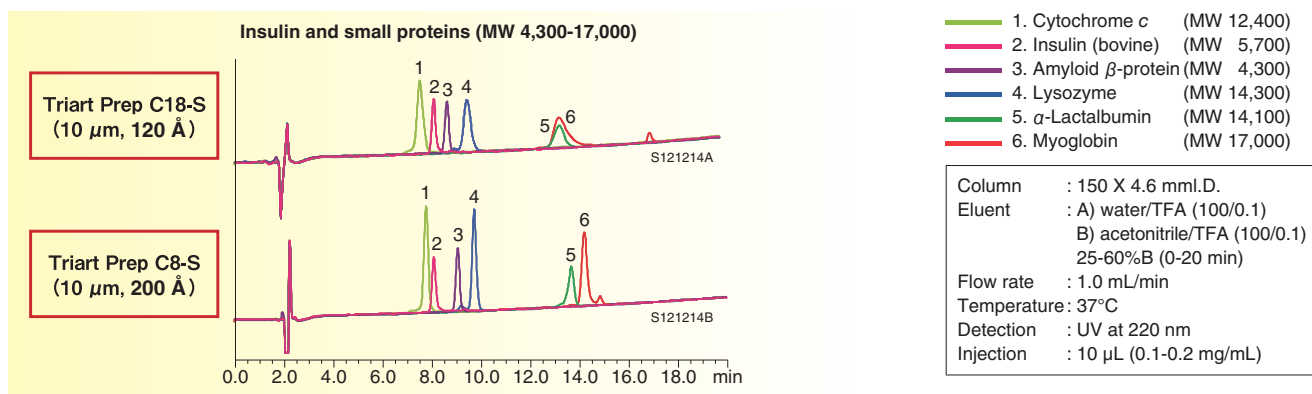
Triart Prep material still remained initial state after more than 10 times of repacking. On the other hand, conventional silica showed pressure increase or crush of particles. Triart Prep with its high mechanical stability enables longer column lifetime, and this feature provides reduction of purification cost.

## Easy scale up from analytical to preparative



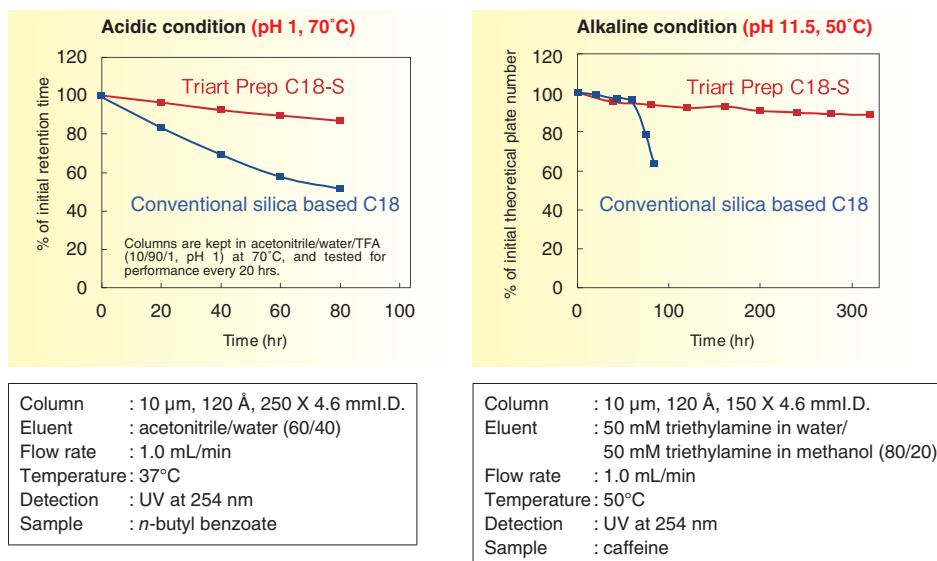
Triart Prep C18-S has identical selectivity to analytical Triart C18. A method established with analytical Triart C18 can be directly transferred to preparative scale with Triart Prep C18-S material.

## Selection of optimal stationary phase



Proteins with molecular weight (MW) of 10,000 or larger are effectively separated with Triart Prep C8-S while there is little difference in separation of proteins with MW of less than 10,000 between Triart Prep C18-S and Triart Prep C8-S. It is useful to select optimal phase for establishing effective preparative method.

## Excellent chemical durability



Triart Prep materials provide strong acidity-proof in the lower pH condition and alkaline-proof in the higher pH. These features enables purification with a mobile phase containing TFA and cleaning with alkaline solution, which are often used on peptides and proteins purification.



## Regeneration with alkaline solution

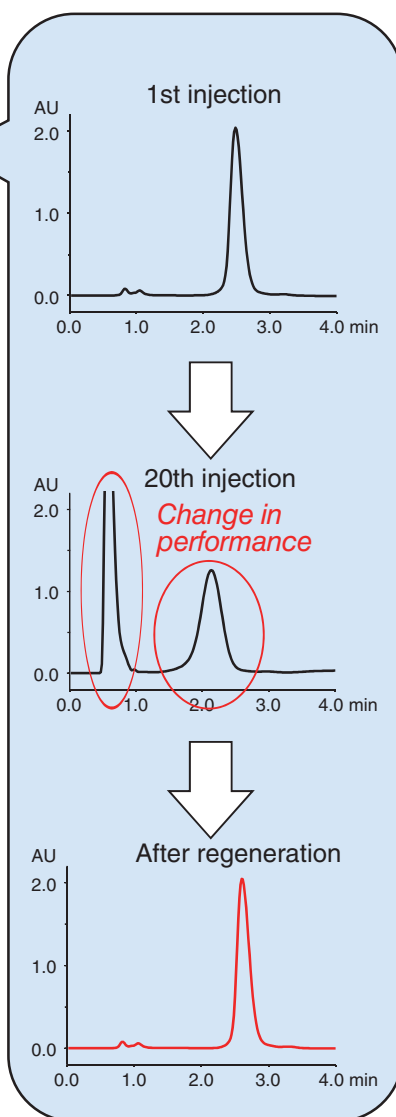
### Test procedure

**Sample injection**  
(insulin in human serum)  
Repeated 20 times

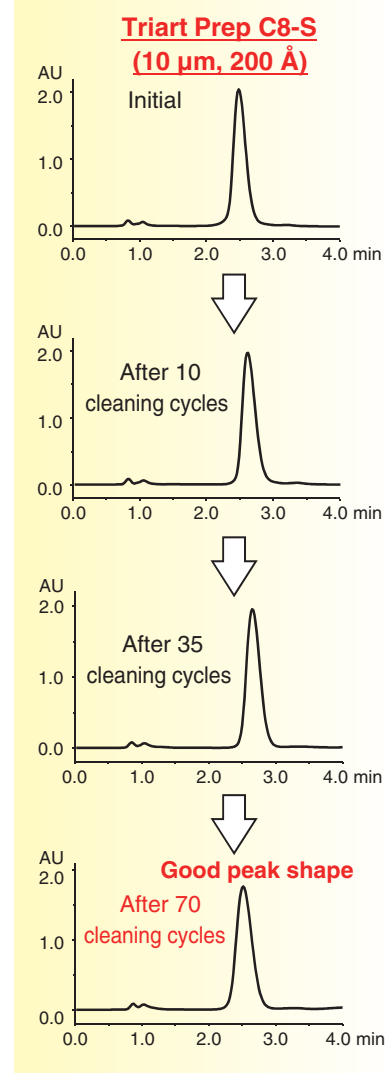
**Cleaning with alkaline solution**  
**0.1 M NaOH/acetonitrile (50/50)**  
**10 column volumes**

**Neutralization and cleaning with organic solvent**  
1. acetonitrile/water (20/80)  
2. acetonitrile/water (90/10)

Column : 50 X 4.6 mm I.D.  
Eluent : A) water/TFA (100/0.1)  
          B) acetonitrile  
              29-36%B (0-2 min), 36%B (2-3 min),  
              29%B (3-6 min)  
Flow rate : 1.0 mL/min  
Temperature : 25°C  
Detection : UV at 220 nm  
Sample : 10 mg/mL bovine insulin/human serum (2/1)  
Injection : 6 µL



### Result



After repeated injection of crude serum sample, absorption of protein and/or other impurities on the surface of the packing material sometimes results in poor peak shape or degradation of retention capacity. In such case, alkaline washing procedure is generally adopted for regeneration and removing impurities on the packing materials. Hybrid silica based Triart Prep which shows strong resistance at high pH allows the effective cleaning of the gel with alkaline solution. This feature provides highly cost-effective purification of target compounds.

## Packing materials

## YMC\*GEL HG

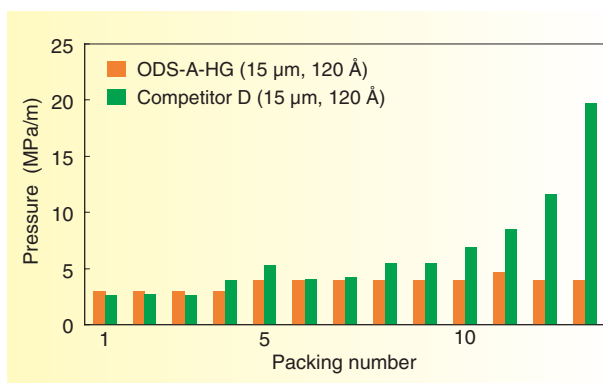
- High density and high strength silica gel
- Excellent mechanical suitability
- Narrow distribution of particle size and pore size

■ Particle size: 10, 15, 20, 50  $\mu\text{m}$

## High strength packing material

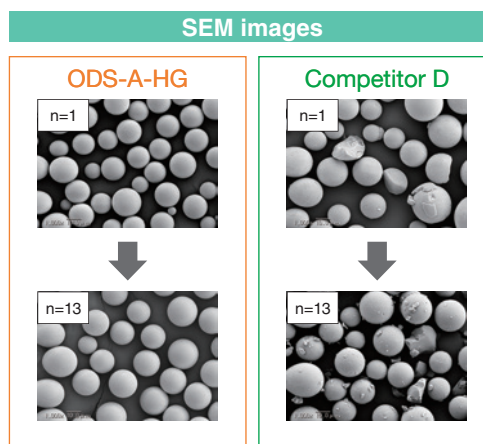
YMC\*GEL HG is packing material based on high density and high strength silica gel. Excellent mechanical stability allows them to be used for a long term repacking into the dynamic axial compression column. YMC\*GEL HG packing materials have same chemical modifications as YMC-Pack columns. This feature offers smooth and easy scale up from analytical to preparative conditions with high sample loading.

## Excellent mechanical stability



Conditions of column packing  
Column size : 100 X 50 mmI.D., Packing pressure : 6.5 MPa

Conditions of pressure measurement  
Eluent : methanol/water (85/15), Flow rate : 50 mL/min



High packing mechanical stability of YMC\*GEL HG is demonstrated by means of repeated of a dynamic axial compression column (DAC). Even after more than 10 repacking cycles for the same material the pressure does not increase. The absence of fines is proven by a constant backpressure.

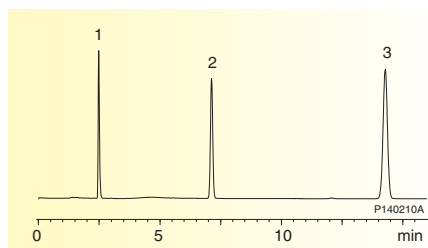
## Easy scale up from analytical to preparative

## Analysis

Particle size : 5  $\mu\text{m}$

Column : YMC-Pack ODS-AQ (120 Å)  
250 X 4.6 mmI.D.

Flow rate : 1.0 mL/min



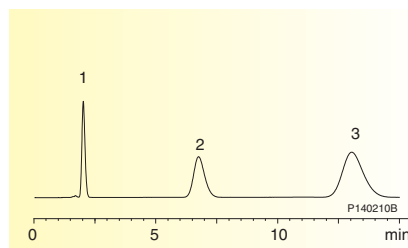
Identical selectivity

## Purification

Particle size : 50  $\mu\text{m}$

Column : ODS-AQ-HG (120 Å)  
250 X 10 mmI.D.

Flow rate : 4.7 mL/min



Eluent : acetonitrile/water (60/40)  
Temperature: ambient  
Detection : UV at 270 nm  
Sample : 1. Uracil  
2. Methyl benzoate  
3. Naphthalene

YMC\*GEL HG packing materials have same chemical modifications as YMC-Pack columns. This feature offers smooth and easy scale up from analytical to preparative conditions with high sample loading.

# CHIRAL ART

- Applicable to various chiral compounds
- Excellent peak shape under high loading
- Extremely low initial cost on analysis and purification

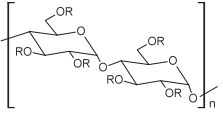
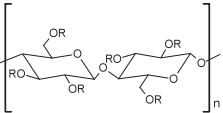
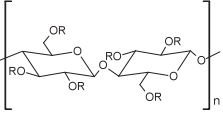
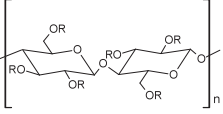
■ Particl size: 3, 5, 10, 20 μm

## Packing materials with polysaccharide derivatives as chiral selector

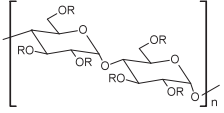
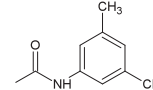
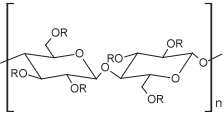
CHIRAL ART are packing materials immobilized/coated with polysaccharide derivatives as chiral selector. CHIRAL ART immobilized type can be used either in normal- or reversed-phase modes. CHRAL ART are suitable for separations of wide range of chiral compounds, *cis-trans* isomers and geometric isomers. Packing materials are available in large quantities (multi kg).

## Specifications

### Immobilized type

Packing material	Particle size (μm)	Chiral selector	USP Classification
CHIRAL ART Amylose-SA	3 5 10 20	 Amylose tris(3,5-dimethylphenylcarbamate)	L99
CHIRAL ART Cellulose-SB		 Cellulose tris(3,5-dimethylphenylcarbamate)	—
CHIRAL ART Cellulose-SC		 Cellulose tris(3,5-dichlorophenylcarbamate)	L119
CHIRAL ART Cellulose-SJ		 Cellulose tris(4-methylbenzoate)	—
Usable mobile phase	Normal-phase	<i>n</i> -hexane, <i>n</i> -heptane, methanol, ethanol, 2-propanol, acetonitrile, ethyl acetate, tetrahydrofuran, chloroform, <i>t</i> -butyl methyl ether, etc.	
	Reversed-phase	acetonitrile, methanol, ethanol, 2-propanol, tetrahydrofuran, water, aqueous buffer, etc.	

### Coated type

Packing material	Particle size (μm)	Chiral selector		USP Classification
CHIRAL ART Amylose-C Neo	3 5 10 20	 Amylose tris(3,5-dimethylphenylcarbamate)	 R: 3,5-Dimethylphenylcarbamate	L51
CHIRAL ART Cellulose-C		 Cellulose tris(3,5-dimethylphenylcarbamate)		L40
Usable mobile phase	<i>n</i> -hexane, <i>n</i> -heptane, ethanol, 2-propanol, acetonitrile, etc.			

\* Inquire us for the Amylose-C

\* See pp.62-66 for details of CHIRAL ART.

## Packing materials

# BioPro IEX SmartSep Q/S BioPro IEX Q/S

- High productivity on purification
- Hydrophilic polymer beads with low nonspecific adsorption
- High binding capacity and high resolution over a wide range of flow rate
- Suitable for purification of antibodies, proteins and nucleic acids

■ Usable pH range : 2-12

### Ion exchange media for purification of biopharmaceuticals

BioPro IEX media are available in strong ion exchangers of hydrophilic porous polymer beads with low nonspecific adsorption and high binding capacity.

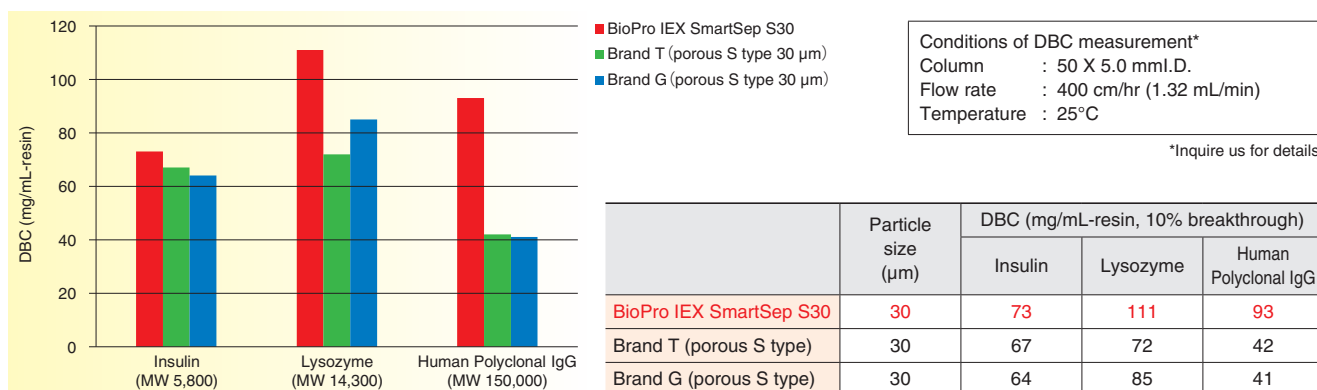
BioPro IEX SmartSep Q/S are suitable for intermediate purification step and polishing step of biopharmaceuticals. BioPro IEX SmartSep Q/S show high resolution and recovery even at a high flow rate and high loading condition.

BioPro IEX Q/S are designed for capture and intermediate purification of proteins and nucleotides. High dynamic binding capacity and high recovery allow fast purification process at large scale. It offers high productivity on industrial purification.

## Specifications

	BioPro IEX SmartSep Q	BioPro IEX SmartSep S	BioPro IEX Q	BioPro IEX S
Matrix	Hydrophilic porous polymer			
Particle size (μm)	10, 20, 30		75	
Charged group	-R-N <sup>+</sup> (CH <sub>3</sub> ) <sub>3</sub>	-R-SO <sub>3</sub> <sup>-</sup>	-R-N <sup>+</sup> (CH <sub>3</sub> ) <sub>3</sub>	-R-SO <sub>3</sub> <sup>-</sup>
Ion exchange capacity (meq/mL-resin)	> 0.08		> 0.10	
Dynamic binding capacity (mg/mL-resin)	> 100 (BSA)	> 100 (lysozyme)	> 160 (BSA)	> 160 (lysozyme)
Usable pH range	2-12			

### High dynamic binding capacity (DBC) for various samples



BioPro IEX media have higher DBC compared to conventional ion exchange media. Especially for IgG, BioPro IEX media have more than twice as high DBC as competitors' media. This feature of BioPro IEX media make purification productivity of IgG per unit time double or more.

\* See pp.27-29 for details of BioPro IEX media.