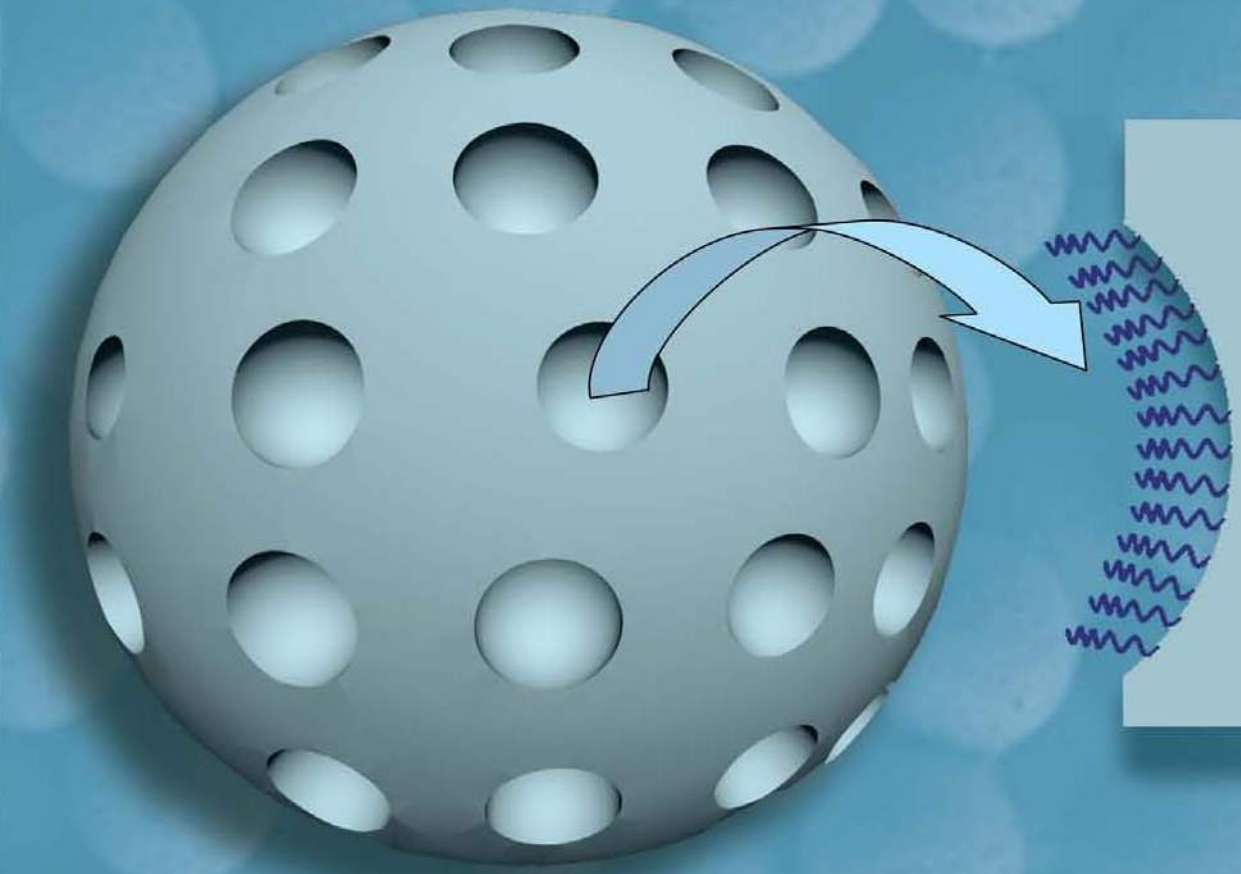
Size Exclusion Chromatography

Sepax Technologies

SRT®



Better Surface Chemistry for Better Separation

Sepax Technologies, Inc.

Sepax Technologies, Inc. develops and manufactures products in the area of chemical and biological separations, biosurfaces and proteomics. Sepax product portfolio includes 1) liquid chromatography columns and media, 2) SPE and Flash chromatography columns and tubes, 3) bulk resin for preparative separation and process chromatography, and 4) natural product and Chinese traditional medicine separation and purification.

A leader in Biological Separations

Sepax develops and manufactures wide range of biological separation products using both silica and polymeric resins as the support. The selection of particle size is from 1 µm to 100 µm and pore size from non-porous to 2000 Å. Unique and proprietary resin synthesis and surface technologies have been developed for solving the separation challenges in biological area.

Bioseparation Products

Size Exclusion
SRT®
SRT®-C
Nanofilm®
Zenix™
Zenix™-C

Ion-exchange
Proteomix®

Antibody Separation
Antibodix™

Carbohydrate Separation
Carbomix®

Analytical, Semi-prep and Preparative

SRT® SEC Phases

High Capacity and High Resolution Size Exclusion Separation

General Description

Utilizing proprietary surface technologies, SRT SEC phases are made of uniform, hydrophilic, and neutral nanometer thick films chemically bonded on high purity and mechanically stabilized silica. The well-controlled surface chemistry results in excellent lot-to-lot reproducibility. Our unique bonding chemistry, coupled with the maximized bonding density, allows SRT SEC to provide high stability and negligible non-specific interactions. SRT SEC packings have large pore volume, resulting in high separation resolution. The narrowly dispersed, spherical silica particles of the SRT packings for SEC-100, SEC-150, SEC-300, SEC-500, SEC-1000 and SEC-2000 have nominal pore sizes at 100, 150, 300, 500, 1,000, and 2,000 Å, respectively. Typical applications for SRT SEC columns include separation and detection of biological molecules and water soluble polymers in aqueous buffers.

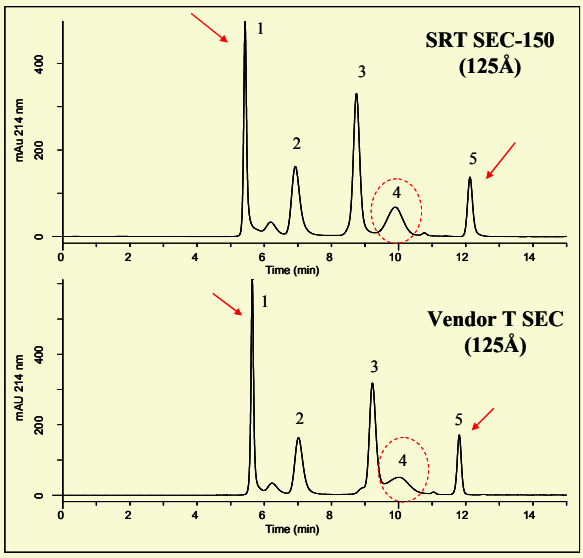
Featured Characteristics

- Highest pore volume, capacity and resolution
- Widest selection of pore size from 100 to 2000 Å
- Particle size selection of 5 µm (SRT) and 10 µm (SRT-10)
- High stability over low and high concentration salt
- Lot-to-lot reproducibility
- High protein recovery with intact biological activity
- Negligible non-specific interactions
- Ideal for separation and analysis of biological molecules: proteins, nucleic acids, oligonucleotides, peptides and virus
- Ideal for separation and analysis of natural polymers, e.g. polysaccharides, synthetic polymers, and nanomaterials, e.g. nanoparticles

High Capacity

As in size exclusion chromatography, peak capacity is primarily determined by the pore volume of the packing. The higher the pore volume, the higher peak capacity generated and better separation resolution. SRT packings are specially designed for achieving high pore volume, 1.3-1.5 mL/g for SRT SEC-150, 300 and 500 and 1.0-1.1 mL/g for SRT SEC-100, 1000 and 2000.

Figure 1. Comparison of SRT SEC-150 and a similar pore size SEC column from Vendor T.



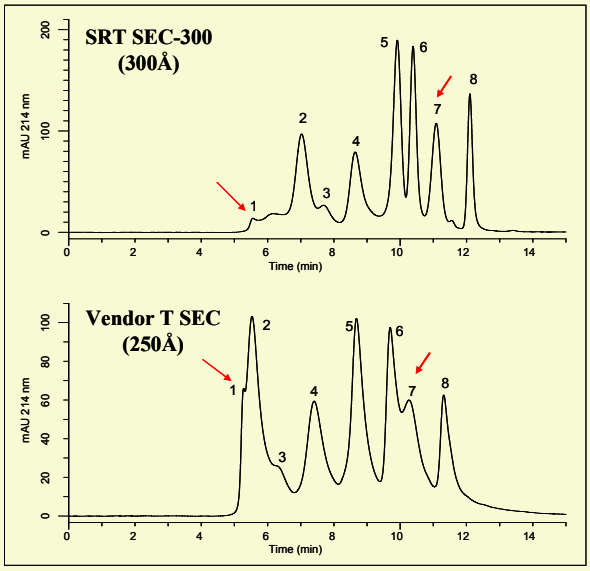
Column: 7.8x300 mm, 5 µm
Mobile phase: 150 mM sodium phosphate, pH 7
Flow rate: 1.0 mL/min
Temperature: ambient (~23° C)
Detection: UV 214nm
Injection: 10 µL
Sample: 1) Thyroglobulin, 670kD; 2) BSA monomer, 66kD; 3) Ribonuclease A, 13.7kD; 4) poly-DL-alanine, 1-5 kD; 5) Uracil, 120D.

All columns are new and equilibrated for >5 column volumes with mobile phase to achieve flat baseline runs. All samples were run on same day.

Compared to Vendor T SEC column, SRT SEC-150 demonstrates a number of benefits. First, SRT offers higher capacity, 6.7 mL for SRT vs. 6.17 mL for Vendor T, calculated from the total permeation peak (uracil) to total exclusion peak (thyroglobulin). Secondly SRT offers higher

resolution than Vendor T. Poly-DL-alanine (from Sigma) is a peptide with the MW of1-5 kD. For size exclusion chromatography, an empirical rule is that a baseline separation can be achieved for two compounds if their MWs difference is two fold (2x). SRT SEC-150 column well separated ribonuclease A (13.7kD) and poly-DL-alanine (1-5 kDa), while Vendor T column did not achieve a baseline separation. Thirdly SRT column shows a good separation profile of Poly-DL-alanine, indicating SRT packing does not have non-specific interactions with Poly-DL-alanine. In contrast, a broad and tailing peak of Poly-DL-alanine from Vendor T column indicates some non-specific bindings between its packing and the peptide.

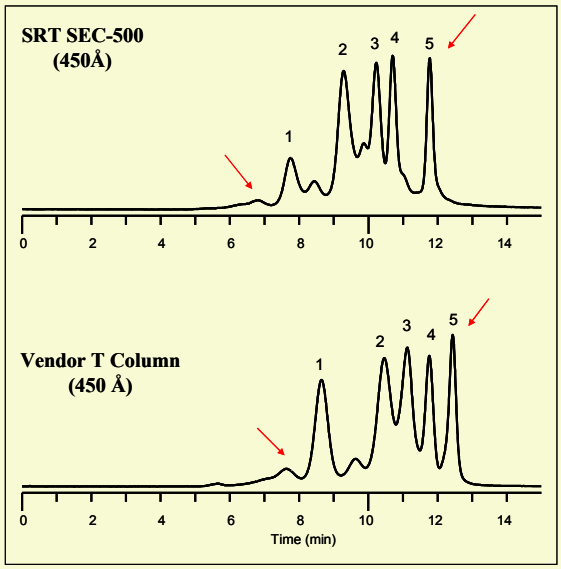
Figure 2. Comparison of SRT SEC-300 and a similar pore size SEC column from Vendor T.



Column: 7.8x300 mm, 5 µm (new and equilibrated)
Mobile phase: 150 mM sodium phosphate, pH 7
Flow rate: 1.0 mL/min
Temperature: Ambient (~23° C)
Detection: UV 214nm
Injection: 10 µL
Sample: 1) Thyroglobulin aggregate, 2) Thyroglobulin, 670kD; 3) γ-Globulin dimer; 4) γ-Globulin, 158 kD; 5) Ovalbumin, 44kD; 6) Myoglobin, 17.6 kD; 7) Poly-DL-alanine (1-5 kD), 8) Uracil, 120D. (All samples were run on same day.)

Figure 2 shows separations of 6 proteins and aggregates, 1 polypeptide, and a small molecule by SRT SEC-300 and Vendor T columns. Compared to Vendor T SEC column, SRT SEC-300 offers a number of advantages. First SRT offers higher capacity, calculating from the total permeation peak (uracil) to total exclusion peak (thyroglobulin aggregate). SRT has the capacity of 6.54 mL (thyroglobulin aggregate, 5.56 min; uracil, 12.10 min), while Vendor T column has the capacity of 6.08 mL (thyroglobulin aggregate, 5.23 min; uracil, 11.31 min). Secondly, in overall, SRT has higher resolution than Vendor T. Looking at the high molecular weight range, thyroglobulin and its aggregates were well separated by SRT SEC-300 column, but only partially separated by Vendor T column. Also in the low MW range, poly-DL-alanine (1-5 kD from Sigma) myoglobin (17.6 kD) were well separated by SRT SEC-300 column, but poorly separated by Vendor T column. Thirdly, SRT column shows a good separation profile of Poly-DL-alanine, indicating SRT packing does not have non-specific interactions with Poly-DL-alanine. In contrast, a broad and tailing peak profile from Vendor T column indicate some existence of non-specific bindings between its packing and the peptide.

Figure 3. Comparison of SRT SEC-500 and a similar pore size SEC column from Vendor T.

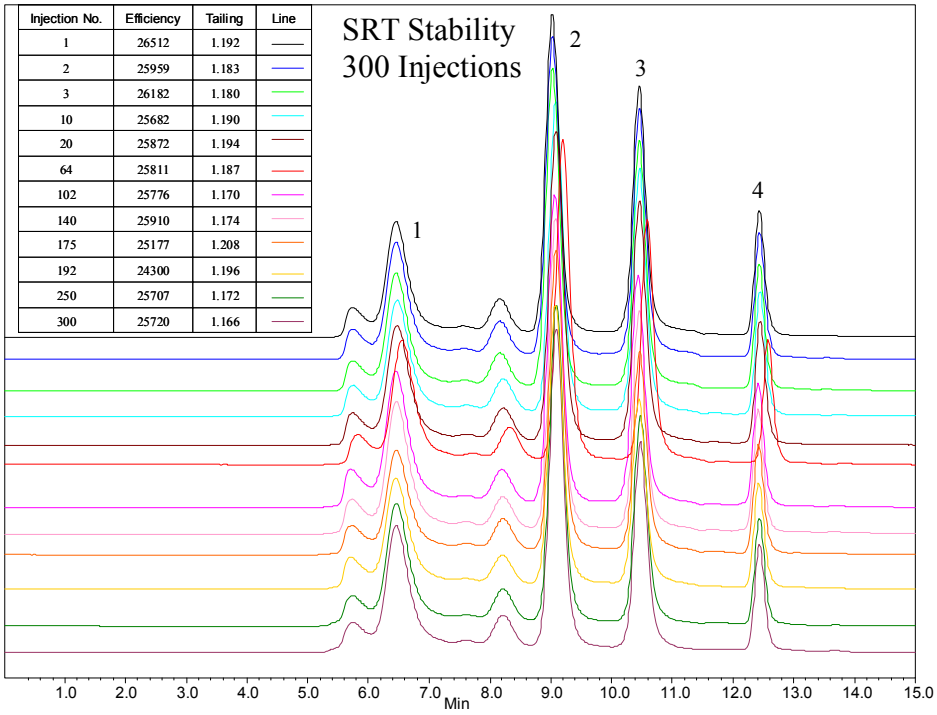


Column: 7.8x300 mm, 5 µm (new and equilibrated)
Mobile phase: 150 mM sodium phosphate, pH 7
Flow rate: 1.0 mL/min
Temperature: Ambient (~23° C)
Detection: UV 214nm
Injection: 10 µL
Sample: 1) Thyroglobulin, 670kD; 2) γ-Globulin, 158kD; 3) Ovalbumin, 44kD; 4) Myoglobulin, 16.9kD; 5) B12, 1,355D.

Figure 3 shows the separation profiles of four proteins (thyroglobulin, γ-globulin, ovalbumin and myoglobulin) and vitamin B12 with the molecular weight in the range of 660,000 – 1,355. The peak capacity is the elution volume from the total exclusive peak of thyroglobulin aggregate to the total permeation peak of vitamin B12. The capacity of SRT SEC-500 is slightly larger than that of Vendor T column (4.9 mL vs 4.7 mL). The resolution and efficiency of SRT SEC-500 is better than that of Vendor T column.

High Robustness

SRT SEC packings have specially designed stationary phases that are densely bonded on the silica surface which enhances the stability of the column, resulting in high number of injections per column life.



Injection No.	Efficiency	Tailing	Line
1	26512	1.192	
2	25959	1.183	
3	26182	1.180	
10	25682	1.190	
20	25872	1.194	
64	25811	1.187	
102	25776	1.170	
140	25910	1.174	
175	25177	1.208	
192	24300	1.196	
250	25707	1.172	
300	25720	1.166	

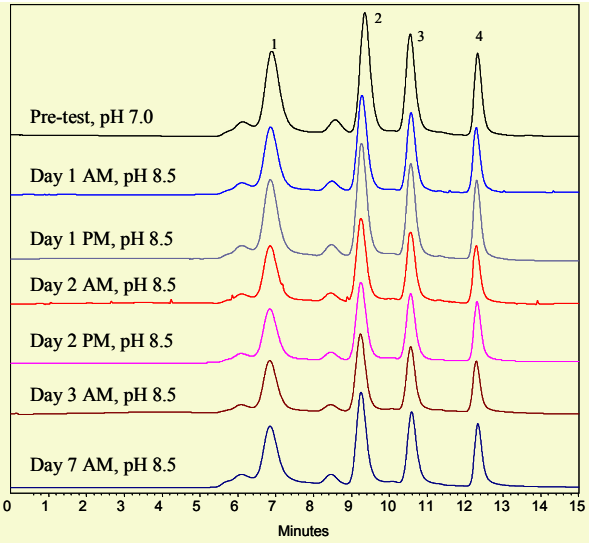
Figure 4. The performance of 300 injections of a SRT SEC-300 column (5 µm, 7.8x300 mm). Buffer: 150 mM sodium phosphate, pH 7.0. Flow rate: 1.0 mL/min. Sample: 1) thyroglobulin, 2) BSA, ribonuclease A, and 4) uracil. Injection: 10 µL. Detection: 214 nm UV.

High Stability at pH 8.5

The proprietary stationary phases of SRT SEC packings utilize densely bonded chemistry on the silica surface, which greatly hinders the diffusion of the molecules that would attack the bond of silica-stationary phase layer, thus enabling high stability over a wide range of pH from 2 to 8.5. Figure 5 shows that SRT SEC-300 phase demonstrates negligible change after running 700 column volume of phosphate buffer at pH 8.5.

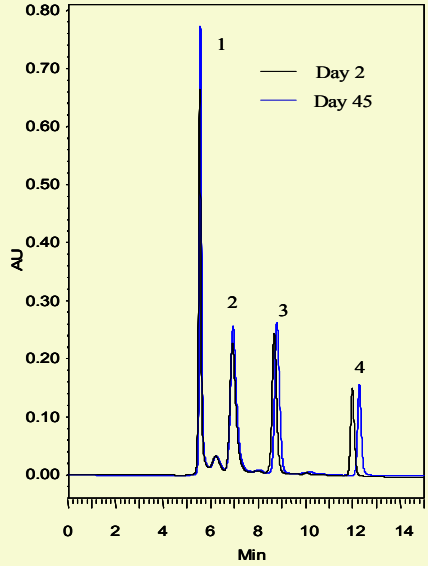
SRT SEC phases are compatible with most aqueous buffers, such as ammonium acetate, phosphate, trizma and so on. When 150 mM phosphate buffer at pH 7.0 was used as the mobile phase, the average retention time change was within 5% after 100 injections over a time span of 45 days, as shown in Figure 6. SRT SEC phases can tolerate high concentration of salts, such as 2.0 M. Furthermore, SRT SEC columns are stable in both organic solvents, such as methanol, ethanol, THF, DMF, DMSO, and so on; as well as the mixture of water and organic solvents.

Fig. 5. Stability test of SRT SEC-300 phase at pH 8.5.



Column: SRT-300 (5 µm, 4.6x300 mm)
Mobile phase: 150 mM sodium phosphate, pH 8.5
Flow rate: 0.35 mL/min
Detection: UV 214 nm
Injection: 3 µL
Sample: 1) Thyroglobulin, 2) BSA, 3) Ribonuclease A, 4) Uracil

Figure 6. Stability test for retention time of proteins and a small molecule after 100 injections.



Column: SRT SEC-150 (5 µm, 7.8x300 mm)
Mobile phase: 150 mM sodium phosphate, pH 7.0
Flow rate: 1.0 mL/min
Temperature: Ambient
Injection volume: 10 µL
Sample: 1. Thyroglobulin (1.0 mg/mL), 2. BSA (1.0 mg/mL), 3. Ribonuclease A (1.0 mg/mL), 4. Uracil (50 µg/mL)

High Lot-to-Lot Reproducibility

The controlled surface chemistry used to synthesize SRT SEC phases makes the surface coating highly reproducible, leading to consistent column manufacturing. Separation variation from batch to batch is controlled to be within 5% for retention time. Figure 7 is a separation of the Sepax standard protein mixture by SRT SEC-300 columns from three different lots. The largest variation retention time for ribonuclease A is less than 2%.

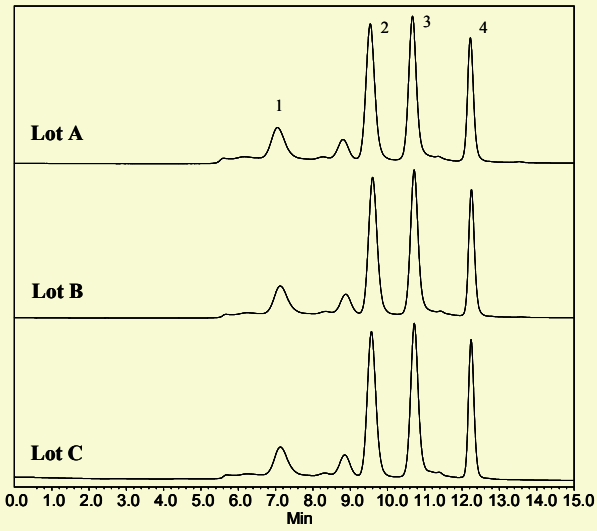
High Protein Recovery

SRT SEC phases are hydrophilic and neutral. Proteins and other biological molecules have negligible nonspecific interactions with SRT stationary phases. The protein adsorption to the silica surface is suppressed, leading to high recovery of intact proteins, maintaining the protein activity after separation. More than 95% recovery is achieved for BSA and lysozyme, the representatives for acidic and basic proteins, respectively.

High Loading Capacity

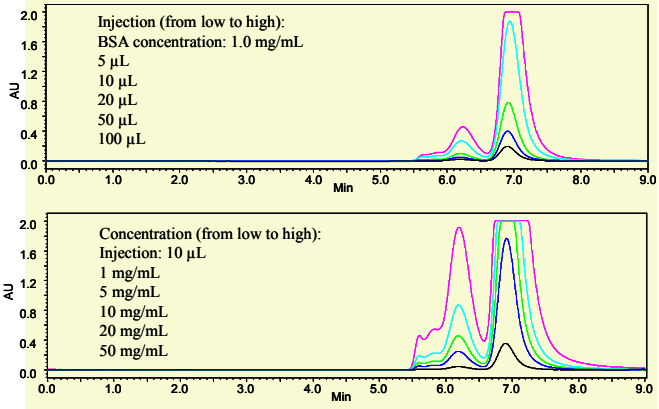
Loading capacity is critical for size exclusion separation and purification. Figure 8 shows high loading capacity for BSA as one example (>500 µg for an analytical column).

Figure 7. Variation of three different lots of SRT SEC-300 phases.



Column: SRT SEC-300 (5 µm, 7.8x300 mm)
Mobile phase: 150 mM sodium phosphate, pH 7.0
Flow rate: 1.0 mL/min
Detection: UV 214 nm
Temperature: Ambient (23 °C)
Injection volume: 10 µL
Sample: 1) Thyroglobulin (1.0 mg/mL), 2) BSA (1.0 mg/mL), 3) Ribonuclease A (1.0 mg/mL), 4) Uracil (2.5 µg/mL)

Figure 8. BSA loading test on a SRT SEC-150 column.



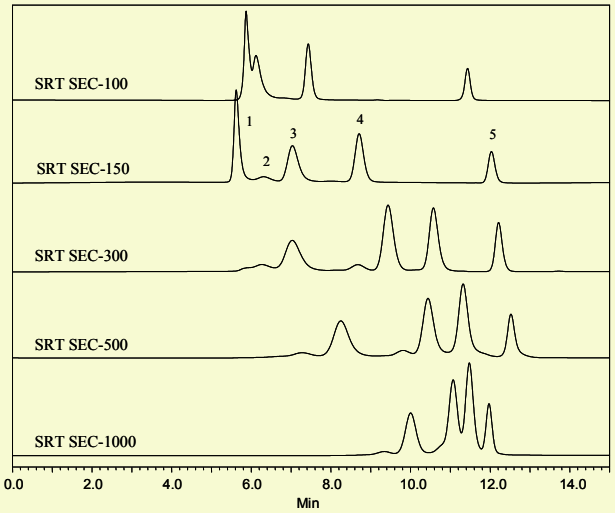
Column: 7.8x300 mm (5 µm)
Mobile phase: 150 mM sodium phosphate, pH 8.5
Flow Rate: 1.0 mL/min
Injection volume: 10 µL
Detection: UV214 nm

Wide Pore Size Selection

Combining innovative surface chemistry with the widest selection of pore size from 100 Å to 2,000 Å, SRT SEC phases were designed to ensure highest resolution and maximum recovery for a very broad range of separation applications. The applications cover large biological molecules (e.g. proteins and nucleic acids), small biological molecules (e.g. peptides and oligonucleotides), natural

polymers (e.g. polysaccharides), synthetic polymers, biological cells (e.g. bacteria and virus), and nanomaterials (e.g. nanoparticles).

Figure 9. Comparison of the separation profiles of a protein mixture by SRT SEC-100, 150, 300, 500 and 1000 columns.



Columns: 4.6x300 mm (5 µm)
Mobile phase: 150 mM sodium phosphate, pH 7.0
Flow rate: 0.35 mL/min
Detection: UV 214 nm
Temperature: Ambient (23 °C)
Injection volume: 3 µL
Sample: 1) Thyroglobulin (1.0 mg/mL), 670 kD; 2) BSA dimer, 132 kD; 3) BSA (1.0 mg/mL), 66 kD; 4) Ribonuclease A (1.0 mg/mL), 13.7 kD, and 5) Uracil (2.5 µg/mL), 120.

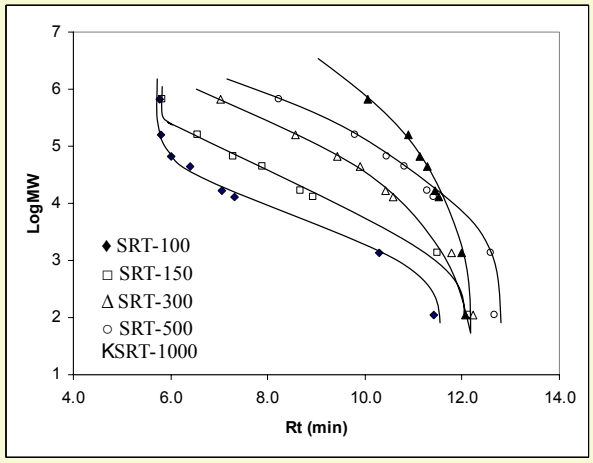
MW Calibration for Protein Separation

For size exclusion chromatography, individual pore size of packings determines the range of molecular weight for separation, while the pore volume controls the separation capacity and resolution. Six pore size SRT packings cover a wide range of separations of biological molecules. The protein calibration curves for SRT SEC-100, 150, 300, 500, and 1000 are shown in Figure 10.

Pore size vs. MW exclusion limit

Phases (5 µm)	Pore Size	Protein MW Exclusion Limit
SRT SEC-100	100 Å	100,000
SRT SEC-150	150 Å	150,000
SRT SEC-300	300 Å	1,250,000
SRT SEC-500	500 Å	5,000,000
SRT SEC-1000	1000 Å	7,500,000
SRT SEC-2000	2000 Å	>10,000,000

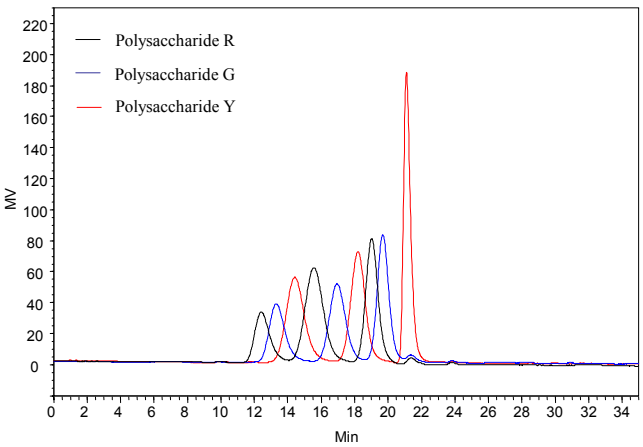
Figure 10. Protein MW calibration with retention time for SRT phases.



Columns: 7.8x300 mm, 5 µm
Mobile phase: 150 mM sodium phosphate, pH 7.0
Flow rate: 1.0 mL/min
Detection: UV 214 nm
Injection volume: 10 µL
Sample: 1. Thyroglobulin, 670 kD; 2. γ-Globulin, 158 kD; 3. BSA, 66 kD; 4. Ovalbumin, 44 kD; 5. Myoglobin, 17.6 kD; 6. Ribonuclease A, 13.7 kD; 7. B12, 1.35 kD; 8. Uracil, 120

Separation of Water Soluble Polymers

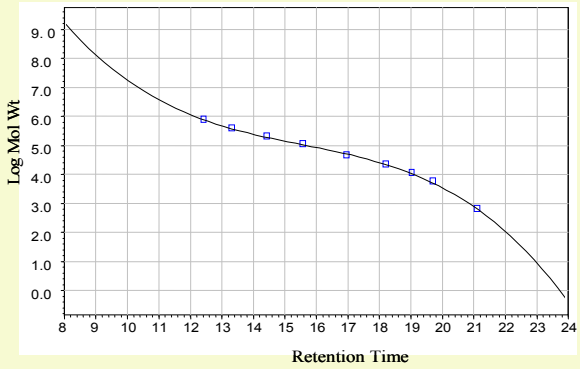
Figure 11. Separation of polysaccharide standards using a SRT SEC-1000 column and a SRT SEC-150 column consecutively. (Courtesy of Dr. Kihong Park, PolysisLab)



Column: 4.6x300 mm (5 µm)
Mobile phase: 0.2 M sodium phosphate, pH 7.0
Flow rate: 0.35 mL/min
Detection: Refractive index
Injection volume: 20 µL
Sample: Polysaccharides (1.0 mg/mL)
Polysaccharide R (Mp 788,000, 112,000, 11,800)
Polysaccharide G (Mp 404,000, 47,300, 5,900)
Polysaccharide Y (Mp 212,000, 22,800, 667)

Benefiting from unique surface chemistry and wide pore size selection (100 – 2,000 Å), SRT SEC phases are ideal for separation and characterization of water soluble polymers. Even though Individual SRT SEC column is suitable for separation and characterization of water soluble polymers, two columns connected in series are often recommended for achieving highest resolution, efficiency and accuracy. SRT SEC-150 and SRT SEC-1000 are recommended for measurement of water soluble polymers. Figure 11 is the chromatogram of polysaccharide standards with the MW from 667 to 788,000 by using SRT SEC-1000 and SRT SEC-150 columns. Figure 12 is the calibration curve of MW vs. retention time.

Figure 12. Calibration curve of polysaccharide MW vs. retention time by using SRT SEC-150 and 1000 phases consecutively. The separation conditions are the same as those in Figure 11. (Courtesy of Dr. Kihong Park, PolysisLab)



SRT SEC Technical Specifications

Phase	SRT SEC-100	SRT SEC-150	SRT SEC-300	SRT SEC-500	SRT SEC-1000	SRT SEC-2000
Material	Neutral, hydrophilic film bonded silica					
Particle size	5 μm	5 μm	5 μm	5 μm	5 μm	5 μm
Pore size	~ 100 Å	~ 150 Å	~ 300 Å	~ 500 Å	~ 1,000 Å	~ 2,000 Å
Protein MW range (native)	*100 - 100,000*	*500 - 150,000*	*5,000 – 1,250,000*	*15,000 - 5,000,000*	*50,000 - 7,500,000*	*> 10,000,000*
pH stability	2 – 8.5 (pH 8.5-9.5 can be tolerated temporarily)					
Back pressure (7.8x300 mm)	~ 700 psi	~ 700 psi	~ 700 psi	~700 psi	~700 psi	~700 psi
Maximum backpressure	~ 4,500 psi	~ 4,500 psi	~ 3,500 psi	~ 3,000 psi	~ 3,000 psi	~ 3,000 psi
Salt concentration range	20 mM - 2.0 M	20 mM - 2.0 M	20 mM - 2.0 M	20 mM - 2.0 M	20 mM - 2.0 M	20 mM - 2.0 M
Maximum temperature	~ 80 °C	~ 80 °C	~ 80 °C	~ 80 °C	~ 80 °C	~ 80 °C
Mobile phase compatibility	Aqueous and organic					

Sample Loading Recommendation

ID	2.1x300 mm	4.6x300 mm	7.8x300 mm	10x300mm	21.2x300mm	30x300mm	50x300mm
Type	Nano	Narrow-bore	Regular	Semi prep	Prep	Process	Process
V-injection	0.1-2μL	0.5-10μL	1-100μL	1-250 uL	0.01-1.0 mL	0.1-5ml	0.5-20ml
Mass (BSA)	0.1-10μg	0.5-50μg	1-500μg	1-750ug	0.1-5.0mg	0.1-10.0mg	0.1-25.0mg
Standard Flow rate (Maximum)	0.067mL/min	0.35mL/min	1.0mL/min	1.65 mL/min (2.0 mL/min)	7.5 mL/min (10mL/min)	15 ml/min (25 ml/min)	41 ml/min (60 ml/min)
Sensitivity	Highest	Higher	High	N/A	N/A	N/A	N/A
Back pressure	~300psi	~400psi	~700psi	700-900 psi	700-900 psi	700-900 psi	700-900psi
Instrument Type	Capillary	Regular	Regular	Prep	Prep	Process	Process

Column Dimension Availability

Available SRT SEC column dimensions are 0.75, 1.0, 2.1, 3.0, 4.6, 7.8, 10, 21.2 and 30 mm I.D., and 20, 30, 50, 100, 150, 250, 300 and 600 mm length. Sepax also offers custom-made columns. Both stainless steel and PEEK tubes are available.

Applications

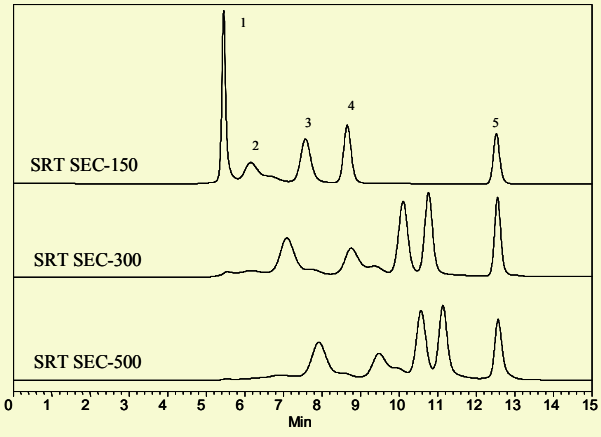
Separation and Analysis
Proteins
Monoclonal antibodies
Cell lysates
Nucleic acids
Nucleotides
Peptides
Water soluble polymers
Nanoparticles
Nanotubes

SRT phases have wide applications for separation, identification and purification of proteins, protein variants, peptide fragments, phosphorylated, sialylated, pegylated, and other derivatized proteins. They are well suited for studies such as molecular weight estimation, purification and analysis of biological molecules.

Separation of protein mixture

The protein elution profiles with different pore size provide general guidelines for selecting the precise SRT columns for a specific sample application with known molecular weights.

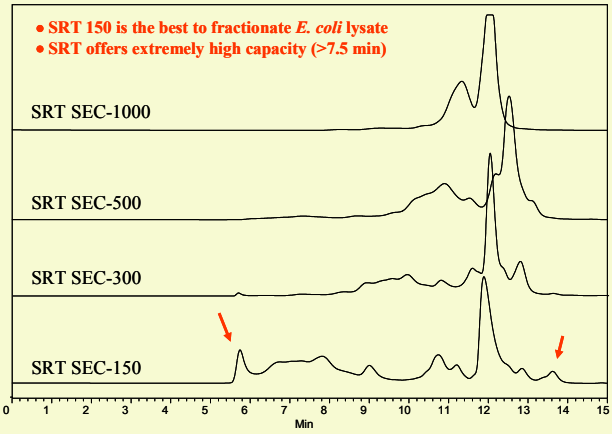
Figure 13. Separation of a protein mixture by SRT SEC-150, 300 and 500 columns.



Column:	7.8x300 mm (5 µm)
Mobile phase:	0.15 M sodium phosphate, pH 7.0
Flow rate:	1.0 mL/min
Detection:	UV214 nm
Injection:	10 µL
Sample:	1) Thyroglobulin, 670 kD; 2) γ-Globulin, 158 kD; 3) Ovalbumin, 44 kD; 4) Ribonuclease A, 13.7 kD; 5) p-Aminobenzoic acid, 137 D.

Separation of E. coli Lysate

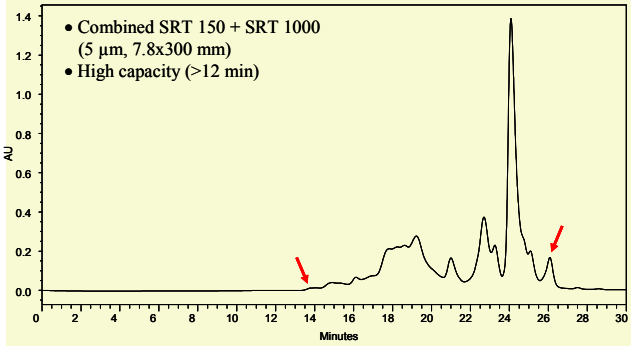
Figure 14. Separation of *E. coli* with various pore size SRT columns



Column:	7.8x300 mm (5 µm)
Mobile phase:	0.15 M sodium phosphate, pH 7.0
Flow rate:	1.0 mL/min
Detection:	UV 214 nm
Injection:	10 µL
Sample:	*E. coli* lysate (2.5 mg/mL)

Two consecutive SRT SEC columns with pore size of 150 and 1000 Å running in tandem achieved higher resolution separation of *E. coli* lysate with the elution of more than 12 mL.

Figure 15. Separation of *E. coli* with combined SRT SEC-150 and SRT SEC-1000 columns consecutively.

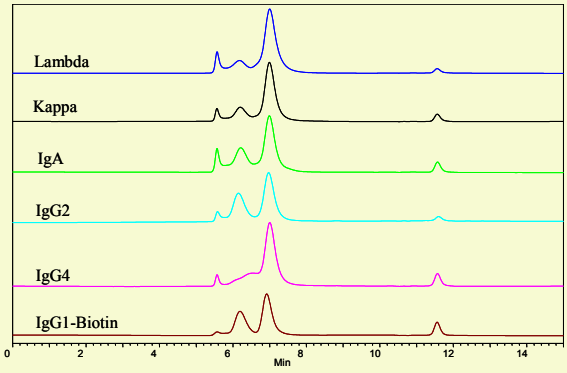


Column:	7.8x300 mm (5 µm)
Mobile phase:	0.15 M sodium phosphate, pH 7.0
Flow rate:	1.0 mL/min
Detection:	UV 214 nm
Injection:	10 µL
Sample:	*E. coli* lysate (2.5 mg/mL)

Separation of Antibodies

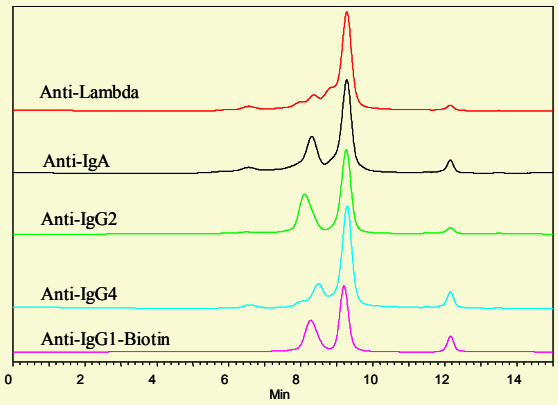
Monoclonal antibody proteins have the MW ~150 -160 kD. The most suitable phases are SRT SEC-150 and 300.

Figure 16. Elution profiles of commercial antibody samples separated by SRT SEC-150 phase.



Column:	SRT SEC-150 (5 µm, 7.8x300 mm)
Mobile phase:	150 mM sodium phosphate, pH 7.0
Flow rate:	1.0 mL/min
Detection:	UV 214 nm
Injection:	10 µL (1.0 mg/mL)

Figure 17. Elution profiles of commercial antibody samples separated by SRT SEC-300 phase.

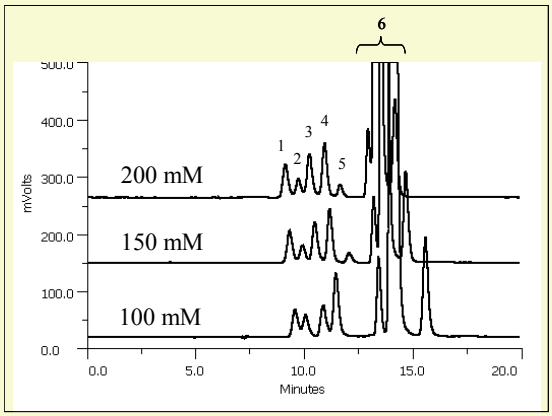


Column:	SRT SEC-300 (5 µm, 7.8x300 mm)
Mobile phase:	150 mM sodium phosphate, pH 7.0
Flow rate:	1.0 mL/min
Detection:	UV 214 nm
Injection:	10 µL (1.0 mg/mL)

Protein Separation in Organic Buffer

In order for size exclusion separation to be integrated with a mass spectrometer, inorganic salts need to be avoided in the mobile phase due to their likeliness to suppress the signal in mass spectrometer detection. Volatile organic buffers would be ideal for SEC-MS applications. However, non-specific interaction, most notably electrostatic interaction has been the major challenge for SEC packings to elute proteins in organic buffers. SRT packing was designed to have a highly protective coating on the silica surface that minimizes the electrostatic interaction and enables proper elution of proteins in organic buffers. Figure 18 shows the separation of five proteins (glutamate dehydrogenase, lactate dehydrogenase, enolase, adenylate kinase and cytochrome C) as well as sucrose and some small molecule impurities in ammonium acetate buffers with the concentration in the range of 100 – 200 mM at pH 6.3.

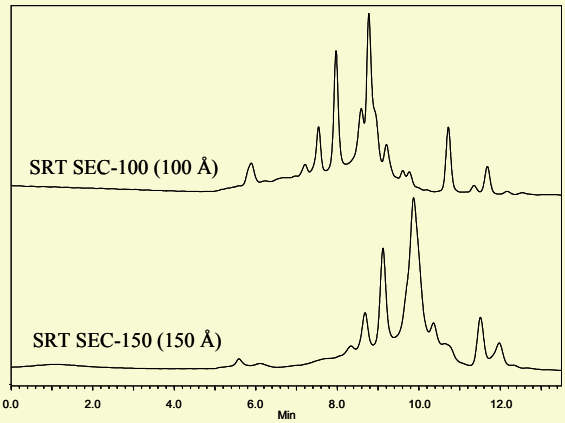
Figure 18. Separation of molecular weight marker proteins with organic mobile phases.



Column:	SRT SEC-150 (5 µm, 4.6x300 mm)
Mobile phase:	100 – 200 mM CH_3COONH_4/CH_3CN (pH 6.3)
Flow rate:	0.25 mL/min
Detection:	SofTA ELSD
Sample:	1. Glutamate dehydrogenase (290 kD); 2. Lactate dehydrogenase (142 kD); 3. Enolase (67 kD); 4. Adenylate kinase (6 kD); 5. Cytochrome C (12.4 kD); 6. Sucrose with some small molecule impurities

Low MW Polysaccharides

Figure 19. Separation of Achyranthes bidentata polysaccharides S from plant root extract. (ABPS) (MW<10,000).



Columns:	4.6x300 mm (5 µm)
Mobile phase:	0.15M sodium phosphate, pH 7
Flow rate:	0.35 mL/min
Injection:	10 µL
Detection:	UV214 nm

Ordering Information

SRT SEC-100 (5 µm, 100 Å)

ID x Length (mm)	P/N
21.2x300	SEP215100-21230
21.2x250	SEP215100-21225
21.2x150	SEP215100-21215
21.2x100	SEP215100-21210
21.2x50 (Guard)	SEP215100-21205
10x300	SEP215100-10030
10x250	SEP215100-10025
10x150	SEP215100-10015
10x100	SEP215100-10010
10x50 (Guard)	SEP215100-10005
7.8x300	SEP215100-7830
7.8x250	SEP215100-7825
7.8x150	SEP215100-7815
7.8x50 (Guard)	SEP215100-7805
4.6x300	SEP215100-4630
4.6x250	SEP215100-4625
4.6x150	SEP215100-4615
4.6x50 (Guard)	SEP215100-4605

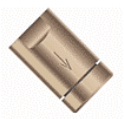
SRT SEC-150 (5 µm, 150 Å)

ID x Length (mm)	P/N
21.2x300	SEP215150-21230
21.2x250	SEP215150-21225
21.2x150	SEP215150-21215
21.2x100	SEP215150-21210
21.2x50 (Guard)	SEP215150-21205
10x300	SEP215150-10030
10x250	SEP215150-10025
10x150	SEP215150-10015
10x100	SEP215150-10010
10x50 (Guard)	SEP215150-10005
7.8x300	SEP215150-7830
7.8x250	SEP215150-7825
7.8x150	SEP215150-7815
7.8x50 (Guard)	SEP215150-7805
4.6x300	SEP215150-4630
4.6x250	SEP215150-4625
4.6x150	SEP215150-4615
4.6x50 (Guard)	SEP215150-4605

SRT SEC-300 (5 µm, 300 Å)

ID x Length (mm)	P/N
21.2x300	SEP215300-21230
21.2x250	SEP215300-21225
21.2x150	SEP215300-21215
21.2x100	SEP215300-21210
21.2x50 (Guard)	SEP215300-21205
10x300	SEP215300-10030
10x250	SEP215300-10025
10x150	SEP215300-10015
10x100	SEP215300-10010
10x50 (Guard)	SEP215300-10005
7.8x300	SEP215300-7830
7.8x250	SEP215300-7825
7.8x150	SEP215300-7815
7.8x50 (Guard)	SEP215300-7805
4.6x300	SEP215300-4630
4.6x250	SEP215300-4625
4.6x150	SEP215300-4615
4.6x50 (Guard)	SEP215300-4605

****Precolumn Filter 2.0 µm PEEK SEP102000-P355**



Precolumn Filter

SRT SEC-500 (5 µm, 500 Å)

ID x Length (mm)	P/N
21.2x300	SEP215500-21230
21.2x250	SEP215500-21225
21.2x150	SEP215500-21215
21.2x100	SEP215500-21210
21.2x50 (Guard)	SEP215500-21205
10x300	SEP215500-10030
10x250	SEP215500-10025
10x150	SEP215500-10015
10x100	SEP215500-10010
10x50 (Guard)	SEP215500-10005
7.8x300	SEP215500-7830
7.8x250	SEP215500-7825
7.8x150	SEP215500-7815
7.8x50 (Guard)	SEP215500-7805
4.6x300	SEP215500-4630
4.6x250	SEP215500-4625
4.6x150	SEP215500-4615
4.6x50 (Guard)	SEP215500-4605

SRT SEC-1000 (5 µm, 1000 Å)

ID x Length (mm)	P/N
21.2x300	SEP215950-21230
21.2x250	SEP215950-21225
21.2x150	SEP215950-21215
21.2x100	SEP215950-21210
21.2x50 (Guard)	SEP215950-21205
10x300	SEP215950-10030
10x250	SEP215950-10025
10x150	SEP215950-10015
10x100	SEP215950-10010
10x50 (Guard)	SEP215950-10005
7.8x300	SEP215950-7830
7.8x250	SEP215950-7825
7.8x150	SEP215950-7815
7.8x50 (Guard)	SEP215950-7805
4.6x300	SEP215950-4630
4.6x250	SEP215950-4625
4.6x150	SEP215950-4615
4.6x50 (Guard)	SEP215950-4605

SRT SEC-2000 (5 µm, 2000 Å)

ID x Length (mm)	P/N
21.2x300	SEP215980-21230
21.2x250	SEP215980-21225
21.2x150	SEP215980-21215
21.2x100	SEP215980-21210
21.2x50 (Guard)	SEP215980-21205
10x300	SEP215980-10030
10x250	SEP215980-10025
10x150	SEP215980-10015
10x100	SEP215980-10010
10x50 (Guard)	SEP215980-10005
7.8x300	SEP215980-7830
7.8x250	SEP215980-7825
7.8x150	SEP215980-7815
7.8x50 (Guard)	SEP215980-7805
4.6x300	SEP215980-4630
4.6x250	SEP215980-4625
4.6x150	SEP215980-4615
4.6x50 (Guard)	SEP215980-4605