



HALO[®]

BIOCLASS

INNOVATION YOU CAN TRUST – PERFORMANCE YOU CAN RELY ON

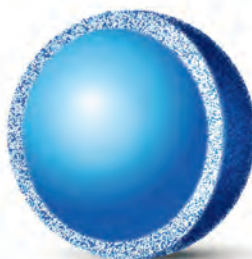
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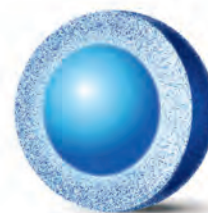
BIOCLASS



1000 Å 2.7 micron particle



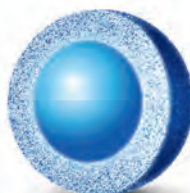
400 Å 3.4 micron particle



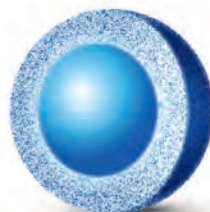
90 Å 2.7 micron particle

PROTEIN

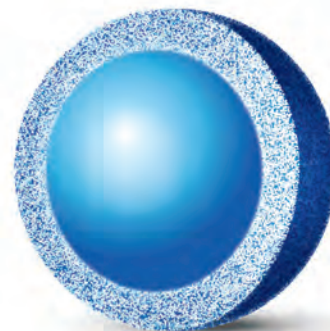
GLYCAN



160 Å 2 micron particle



160 Å 2.7 micron particle



160 Å 5 micron particle

PEPTIDE

HALO® PROTEIN, PEPTIDE AND GLYCAN

Advanced Materials Technology led the revolution in Fused-Core® particle technology with the development of the first commercially available sub-3 µm superficially porous particle (SPP) with the original HALO® 2.7 µm particle. Our manufacturing expertise has carried forward into being the wide pore particle leader. This innovative culture has been transferred to developing novel materials for the biotherapeutic market. HALO® particles are ready to solve the characterization challenges of these complex separations.

Today, researchers are keenly interested in both fast and high resolution separations of numerous biomolecules to support the development of novel therapeutic proteins and peptides in pharmaceutical drug development, advance academic understanding in modern University laboratories, characterize protein post-translation modifications, and to fully assess subtle differences

in biosimilars and other products of bioengineering and manufacturing. HALO® BioClass columns have been developed to simplify and promote a more comprehensive understanding - faster.

- Intact proteins, monoclonal antibodies (mAbs), biosimilars, and other large biomolecules such as pegylated proteins, antibody drug conjugates (ADCs), etc.
- Peptide mapping (analysis of enzyme digests) for characterization and monitoring of synthetic protein drugs
- Analysis of therapeutic peptides and peptide biomarkers (protein surrogates)
- High resolution separations of complex mixtures of glycans released from N- and O-linked glycoproteins

The HALO® BioClass column family is comprised of the following product lines.

PROTEIN

- Wide pore portfolio for unrestricted bonded phase access capable of characterizing very large proteins with good peak shape and recovery
- Compatible chemistries for UHPLC, HPLC, and mass spectrometry
- Variety of bonded phase options for a tailored solution

PEPTIDE

- SPP technology for fast, high resolution peptide separations
- High peak capacities delivering rugged, reliable performance for use with either UHPLC, HPLC, or LC-MS
- Extensive portfolio of particle sizes and chemistries

GLYCAN

- Improved retention of acidic and zwitterionic analytes
- Very low sensitivity to buffer concentration
- Able to separate isobaric oligosaccharides with different linkages

GUIDANCE FOR PORE SIZE SELECTION

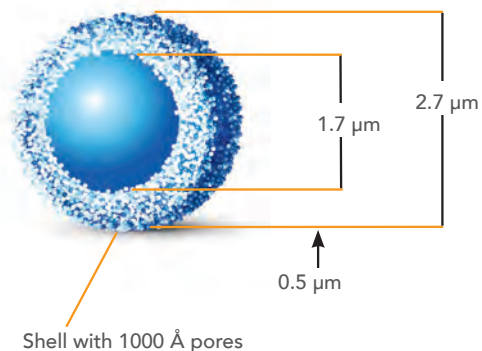
Molecule Size	Pore Size (Å)	Application	Particle Sizes (µm)
SMALL (< 20 kDa*)	90	Glycan	2.7
MEDIUM (100 Da < MW < 15 kDa)	160	Peptide	2, 2.7, 5
LARGE (2 kDa < MW < 500 kDa)	400	Protein	3.4
LARGE (> 50 kDa)	1000		2.7

* for glycans, glycopeptides and glycoproteins

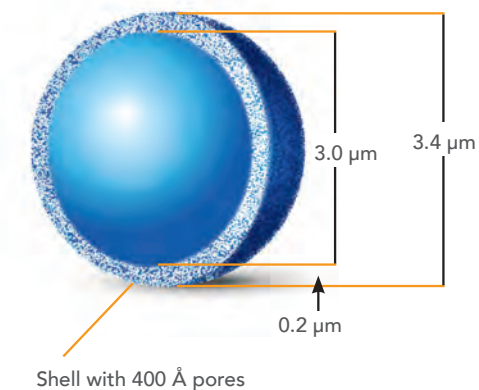
PROTEIN SOLUTIONS

- The advantages of using wide pore silica based superficially porous particles (SPP) for high resolution analysis of large proteins has been well established and as the innovator of the 1000 Å Fused-Core® particle, AMT recognizes the benefit of unrestricted pore access which combines the power of ultrafast and high resolution separations to the biologics workflow
- Fused-Core® particles provide narrower peak widths and improved resolution for characterization of biomolecules in comparison to fully porous particles (FPPs)
- As complex biotherapeutics development continues to grow, understanding structural modifications requires separation options. Often these minor variants consist of subtle differences in protein chains, glycosylation sites and free sulfhydryl groups
- HALO® delivers a comprehensive portfolio of both 400 Å and 1000 Å silica phase selectivities to choose from

HALO® PROTEIN 2.7 µm



HALO® PROTEIN 3.4 µm



APPLICATIONS

- mAbs
- ADCs
- Biosimilars
- H/D exchange
- Fragments

FEATURES

- Outstanding temperature stability up to 90 °C
- Compatible with UHPLC, HPLC and MS
- Elution of very large proteins with excellent peak shape and recovery
- Very low LC-MS bleed

ANTIBODY-DRUG CONJUGATES

BIOSIMILARS H/D EXCHANGE

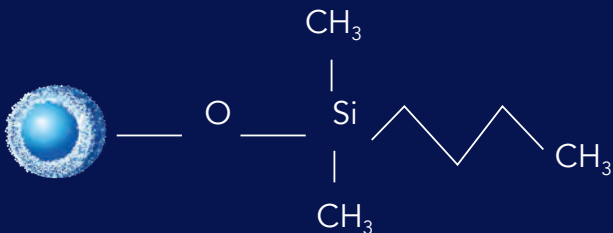
FRAGMENTS

mAb

PROTEIN

HALO 1000 Å PROTEIN BONDED PHASE PORTFOLIO

HALO 1000 Å C4



Ligand: DIMETHYLBUTYLSILANE

USP Designation: L26

Available Particle Sizes: 2.7 μm

Pore Size: 1000 Å

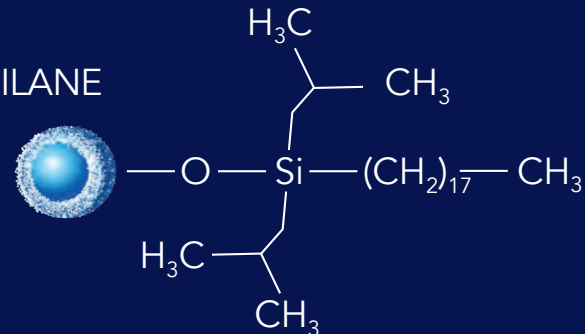
HALO 1000 Å ES-C18

Ligand: DIISOBUTYLOCTADECYLSILANE

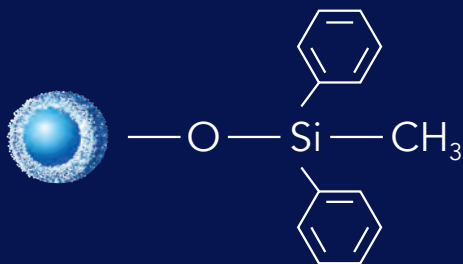
USP Designation: L1

Available Particle Sizes: 2.7 μm

Pore Size: 1000 Å



HALO 1000 Å DIPHENYL



Ligand: DIPHENYLMETHYL

USP Designation: L11

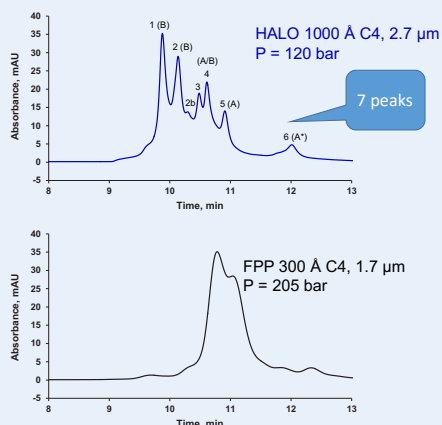
Available Particle Sizes: 2.7 μm

Pore Size: 1000 Å

INADAQUATE PORE SIZE RESULTS IN BROADER PEAKS AND LOWER RESOLUTION

The large pores of the HALO 1000 Å C4 column allow improved access to the stationary phase and increased resolution for IgG2 isoforms compared to the smaller 300 Å pores of the FPP C4 column.

Twice the peaks
Almost half the back pressure



TEST CONDITIONS:

Columns: HALO 1000 Å C4, 2.7 μm, 2.1 x 150 mm
Part Number: 92712-714
Mobile Phase A: 88/10/2 water/ACN/n-propanol/0.1% DFA
Mobile Phase B: 70/20/10 n-propanol/ACN/water/0.1% DFA
Gradient: 14-24% B in 20 min
Flow Rate: 0.2 mL/min
Temperature: 80 °C
Injection: 2 μL of 2 mg/mL denosumab in water/0.1% DFA
Detection: 280 nm, PDA
LC System: Shimadzu Nexera

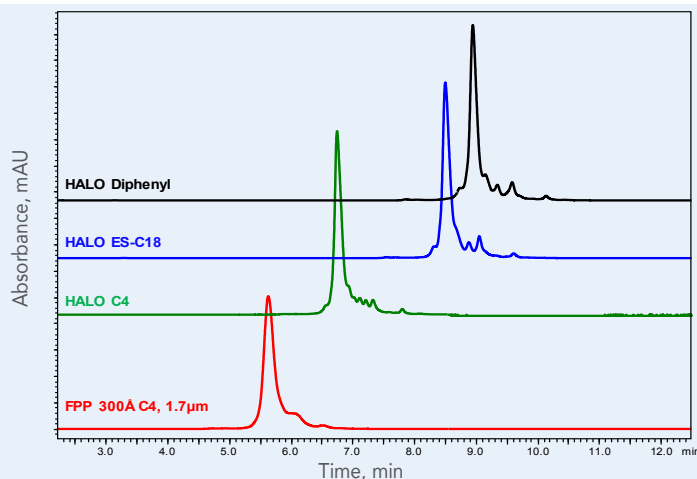
PEAK IDENTITIES

- | | |
|-------------|-------------|
| 1. IgG2-B | 4. IgG2-A/B |
| 2. IgG2-B | 5. IgG2-A |
| 2b. IgG2-B | 6. IgG2-A* |
| 3. IgG2-A/B | |

Comparative results presented here may not be representative for all applications.

WIDE PORE BONDED PHASE OPTIONS

AMT recognizes mAbs are unique and; therefore, developed three 1000 Å bonded phase options for tailored characterization screening.



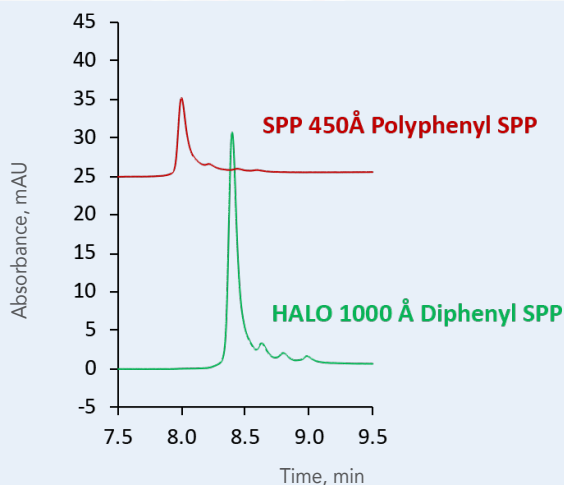
TEST CONDITIONS:

Columns: as indicated, 2.1 x 150 mm
Mobile phase A: water/0.1% TFA
Mobile phase B: ACN/0.1% TFA
Gradient: 32-40% B in 16 min
Flow rate: 0.4 mL/min
Temperature: 80 °C
Injection volume: 2 μL
Instrument: Shimadzu Nexera
Detection: 280 nm, PDA

Comparative results presented here may not be representative for all applications.

HALO® OUTPERFORMS THE COMPETITION

While many protein separations occur at higher temperatures, the desire to carry them out at lower temperature exists. In this example of the HALO® Diphenyl versus a competitor phenyl phase note the exemplary performance of the HALO® Diphenyl.



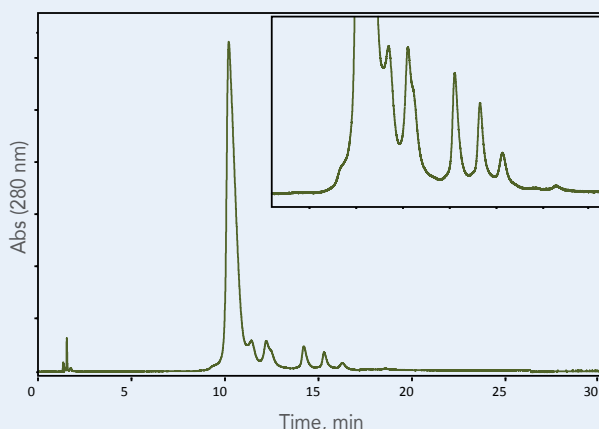
TEST CONDITIONS:

Columns: 2.1 x 150 mm
Mobile Phase A: water/0.1% TFA
Mobile Phase B: ACN/0.1% TFA
Gradient: 30-45% B in 15 min
Flow rate: 0.4 mL/min
Temperature: 40 °C
Injection volume: 2 μL of 2 mg/mL trastuzumab in water/0.1% TFA
Detection: 280 nm, PDA

Comparative results presented here may not be representative for all applications.

OPTIMIZED TRASTUZUMAB SEPARATION USING A HALO 1000 Å DIPHENYL COLUMN

The separation using this highly efficient HALO 1000 Å Protein Diphenyl column is completed in less than 30 minutes, while being compatible with both UV detection, as well as online high resolution MS detection.

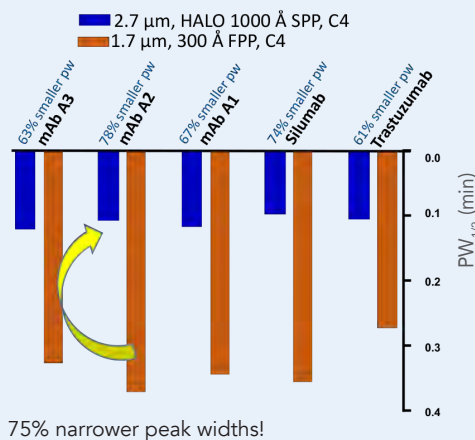


TEST CONDITIONS:

Mobile phase A: water (0.1% DFA)
 Mobile phase B: 50/50 ACN/n-propanol/0.1% DFA
 Gradient: 29–33% B in 29 min
 Flow rate: 0.25 mL/min
 Temperature: 60 °C
 Injection volume: 2 µL of 2mg/mL trastuzumab in water/0.1% TFA
 Instrument: Shimadzu Nexera
 Detection: 280 nm, PDA

IMPROVED PEAK WIDTH ACROSS VARIOUS MABS

The improved performance of ultra wide pores is not just realized with one mAb. Note the advantage to five various large proteins.

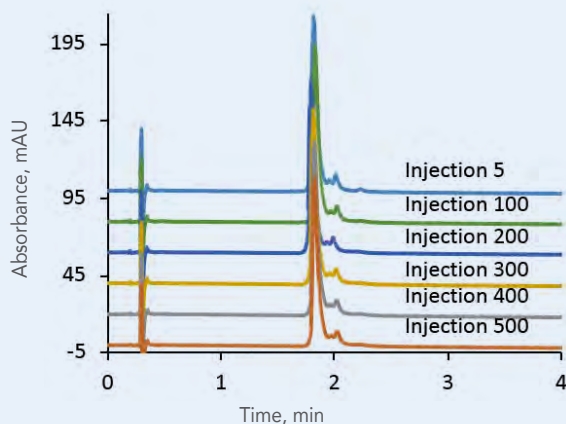


TEST CONDITIONS:

Columns: 2.1 x 150 mm
 Mobile Phase A: water/0.1% DFA
 Mobile Phase B: ACN/0.1% DFA
 Gradient: 27–37% B in 20 min
 Flow rate: 0.4 mL/min
 Temperature: 80 °C
 Injection Volume: 2 µL (1 µg)
 Instrument: Shimadzu Nexera
 Detection: 280 nm, PDA

RUGGEDNESS AND RELIABILITY

The HALO 1000 Å stationary phases offer rugged and reliable performance every time. In the example of HALO 1000 Å ES-C18, the retention times for trastuzumab show extreme phase stability for over 500 injections.

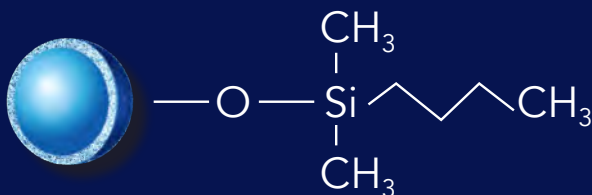


TEST CONDITIONS:

Columns: HALO 1000 Å ES-C18, 2.7 µm, 2.1 x 50 mm
 Mobile Phase A: water/ 0.1% TFA
 Mobile Phase B: ACN/ 0.1% TFA
 Gradient: 32–60% B in 6 min
 Flow Rate: 0.4 mL/min
 Injection Volume: 1.0 µL
 Temperature: 80 °C
 Detection: 280 nm, PDA
 Sample: trastuzumab

HALO 400 Å PROTEIN BONDED PHASE PORTFOLIO

HALO 400 Å C4



Ligand: DIMETHYLBUTYLSILANE

USP Designation: L26

Available Particle Sizes: 3.4 μm

Pore Size: 400 Å

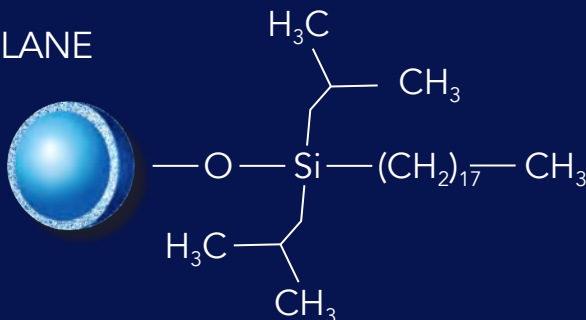
HALO 400 Å ES-C18

Ligand: DIISOBUTYLOCTADECYLSILANE

USP Designation: L1

Available Particle Sizes: 3.4 μm

Pore Size: 400 Å



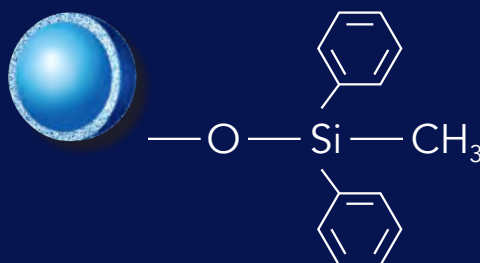
HALO 400 Å Diphenyl

Ligand: DIPHENYLMETHYL

USP Designation: L11

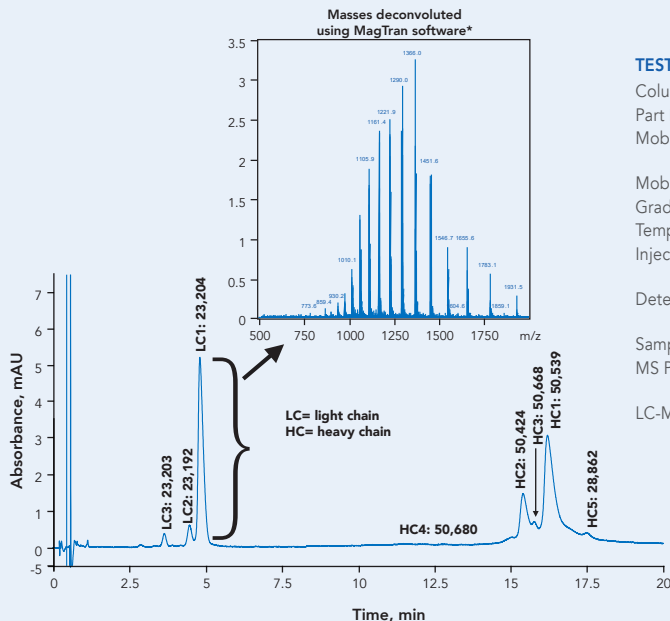
Available Particle Sizes: 3.4 μm

Pore Size: 400 Å



HIGH RESOLUTION OF LIGHT AND HEAVY CHAIN VARIANTS OF IgG1

Very high resolution is obtained between variants of light and heavy chains of a reduced and alkylated monoclonal antibody (IgG1) sample using a HALO 400 Å Protein C4 column.

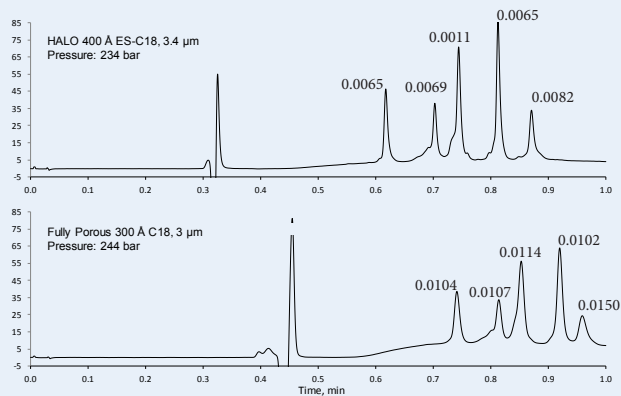


TEST CONDITIONS:

Columns: HALO 400 Å C4, 3.4 μm, 2.1 x 100 mm
 Part Number: 93412-614
 Mobile Phase A: 0.5% formic acid with 20 mM Ammonium Formate
 Mobile Phase B: 45% ACN/45% IPA/10% A solvent
 Gradient: 29–32% B in 20 min
 Temperature: 80 °C
 Injection Volume: 2 μL of 2 μg/μL reduced and alkylated IgG1
 Detection: 280 nm, UV and MS using 2pps scan rate from 500 to 2000 m/z
 Sample Solvent: 0.25% (v/v) formic acid in water
 MS Parameters: Positive ion mode, ESI at +4.5 kV, 400 °C heatblock, 225 °C capillary
 LC-MS System: Shimadzu Nexera and LCMS-2020 (single quadrupole MS)

PROTEIN SEPARATIONS: 3.4 μm FUSED-CORE VS. 3 μm FULLY POROUS PARTICLE

Improved peak widths are observed with the HALO 400 Å versus the competitor 300 Å fully porous column.



TEST CONDITIONS:

Columns: 4.6 x 100 mm
 Mobile Phase A: water/0.1% TFA
 Mobile Phase B: ACN/0.1% TFA
 Gradient: 23–85% B in 1 min
 3 + 6 μL heat exchangers
 Flow rate: 3 mL/min
 Temperature: 60 °C
 Injection Volume: 5 μL
 Instrument: Agilent 1200 SL
 Detection: 215 nm, PDA

PEAK IDENTITIES

- | | |
|-------------------|---|
| 1. Ribonuclease A | 13.7 kDa |
| 2. Cytochrome c | 12.4 kDa |
| 3. Lysozyme | 14.3 kDa |
| 4. α-Lactalbumin | 14.2 kDa |
| 5. Catalase | 250 kDa total; tetramer of ~60 kDa each |

Comparative results presented here may not be representative for all applications.

PEPTIDE SOLUTIONS

- HALO® BioClass Peptide solutions offer an extensive portfolio of particle sizes and phases to tailor a solution ideal for both ultrafast and ultrahigh resolution separations of peptides and polypeptides up to 20 kDa
- Fast, high resolution, high peak capacity peptide separations at 40-50% the back pressure compared to sub-2 μm particle columns
- Due to the lower back pressure of Fused-Core® design, columns can be used in series to maximize peak capacity for UHPLC and HPLC analyses of complex tryptic digest samples
- Compatible for UHPLC and LC-MS applications offering high efficiency and stability
- ~20% higher peak capacity than sub-2 μm non-core columns (2 μm)
- Available in PCS C18, a positively charged surface C18 designed for improving the peak shape of basic compounds while operating under low ionic strength (MS-friendly) mobile phase conditions

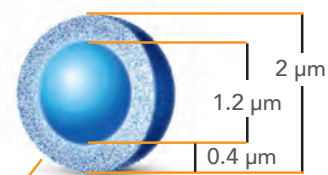
APPLICATIONS

- Tryptic digests
- Post-Translational Modifications (PTMs)
- Variants
- Polypeptides

FEATURES

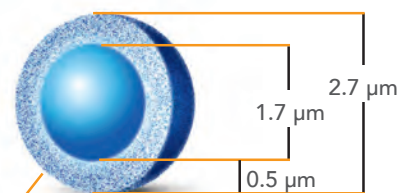
- Fast separations
- High peak capacity
- Rugged, reliable performance
- Alternative selectivity with ES-C18, ES-CN, Phenyl-Hexyl and PCS C18

HALO® 2 μm Peptide



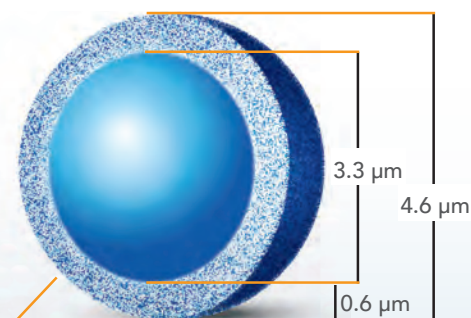
Shell with 160 Å pores

HALO® 2.7 μm Peptide



Shell with 160 Å pores

HALO® 5 μm Peptide



Shell with 160 Å pores

POLYPEPTIDE

2 μm

ES-C18

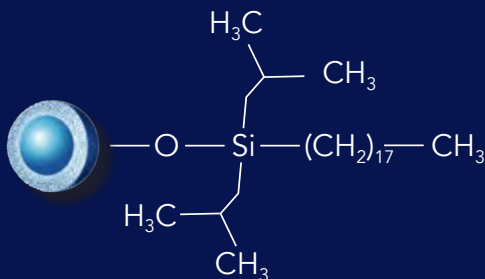
PTM

VARIANTS



HALO® PEPTIDE BONDED PHASE PORTFOLIO

HALO 160 Å ES-C18



Ligand: DIISOBUTYLOCTADECYLSILANE

USP Designation: L1

Available Particle Sizes: 2, 2.7, 5 μm

Pore Size: 160 Å

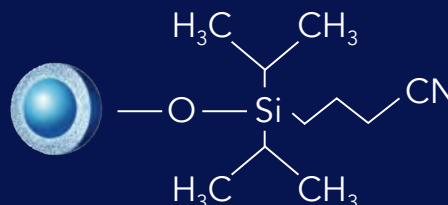
HALO 160 Å ES-CN

Ligand: DIISOPROPYLCYANOPROPYLSILANE

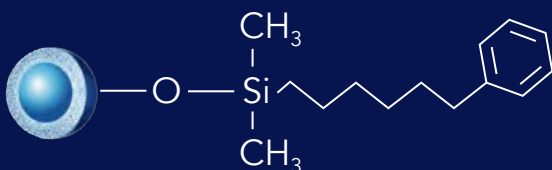
USP Designation: L10

Available Particle Sizes: 2.7, 5 μm

Pore Size: 160 Å



HALO 160 Å Phenyl-Hexyl



Ligand: DIMETHYLPHENYL-HEXYLSILANE

USP Designation: L11

Available Particle Sizes: 2.7 μm

Pore Size: 160 Å

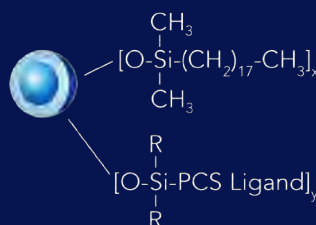
HALO 160 Å PCS C18

Ligand: DIMETHYLOCTADECYLSILANE

USP Designation: L1

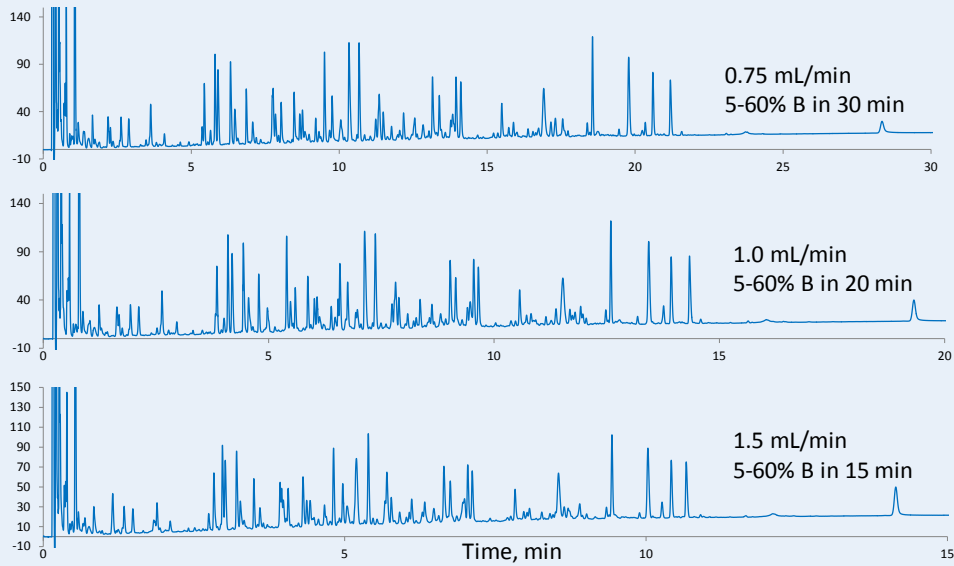
Available Particle Sizes: 2.7 μm

Pore Size: 160 Å



FAST TRYPTIC DIGEST SEPARATIONS WHILE MAINTAINING RESOLUTION

HALO® Peptide separations can be increased 2-fold while maintaining high resolution due to the Fused Core® particle design.

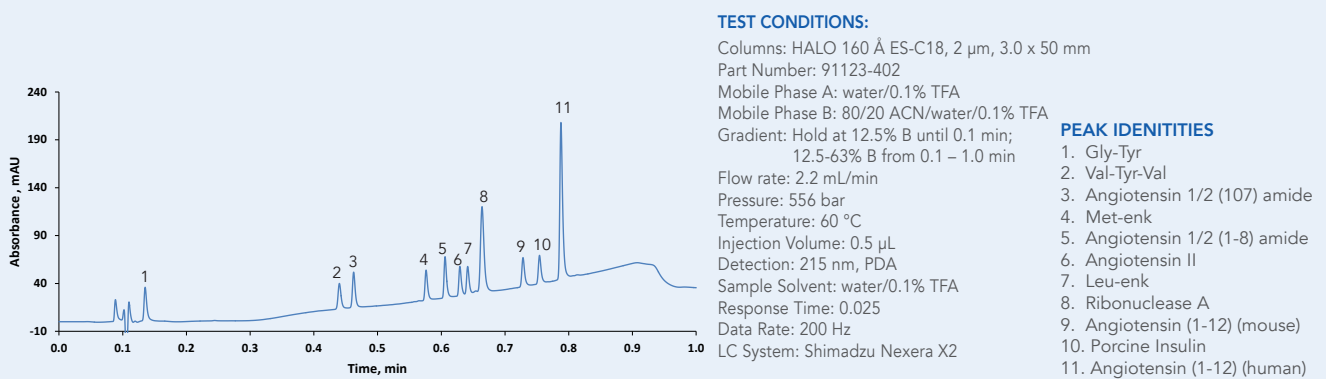


TEST CONDITIONS:

Columns: 2.1 x 100 mm HALO 160 Å ES-C18, 2.7 μm
 Mobile Phase A: water/0.1% TFA
 Mobile Phase B: 80% ACN/0.1% TFA
 Gradient: as indicated
 Temperature: 60 °C
 Injection volume: 15 μL
 Detection: 215 nm, PDA
 Sample: apotransferrin tryptic digest

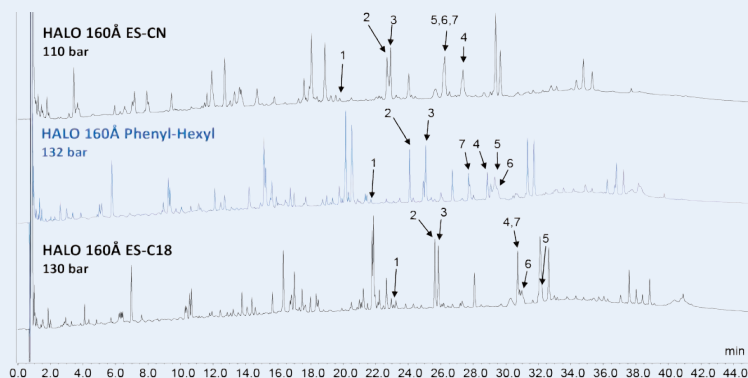
FAST, HIGH RESOLUTION SEPARATION WITH HALO®

Due to the Fused-Core® design and excellent mass transfer ability, ultra fast peptide separations are achievable with the HALO® Peptide



ENHANCE SELECTIVITY WITH HALO 160 Å PHENYL-HEXYL FOR A TRYPTIC DIGEST

The HALO 160 Å Phenyl-Hexyl column provides improved resolution between tryptic digest fragments 2 and 3 compared to the 160 Å ES-CN column and the 160 Å ES-C18 column. Peptide identification accomplished by using MS-MS fragmentation spectra.



PEAK IDENTITIES:

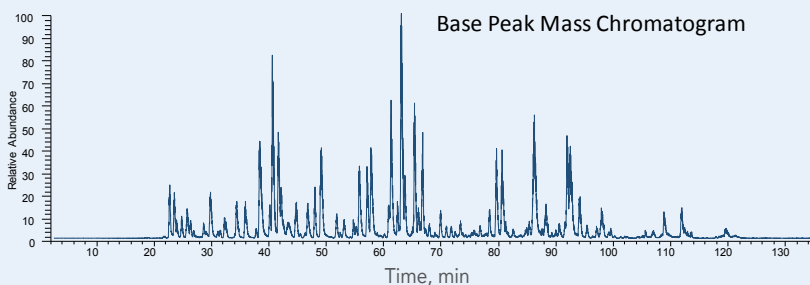
- | | |
|-------------------------------------|---|
| 1. FTISADTSKNTAYLQMNLSLR (754 m/z) | 4. LLIYSASFLYSGVPSR (592 m/z) |
| 2. LScAASGFNIKDTYIHWVR (747 m/z) | 5. SGTASVvcLLNNFYPR (899 m/z) |
| 3. GFYPSDIAVEWESNGQPENNYK (849 m/z) | 6. ScDKTHTePPcPAPELLGGPSVFLFPPKPK (834 m/z) |
| | 7. VVSVLTVLHQDWLNGKEYK (1115 m/z) |

TEST CONDITIONS:

Columns: HALO 160 Å ES-CN, 2.7 µm, 2.1 x 100 mm
 Part Number: 92122-604 HALO 160 Å Phenyl-Hexyl, 2.7 µm, 2.1 x 100 mm
 Part Number: 92112-606 HALO 160 Å ES-C18, 2.7 µm, 2.1 x 100 mm
 Part Number: 92122-602
 Mobile Phase A: water + 10 mM difluoroacetic acid (DFA)
 Mobile Phase B: ACN + 10 mM difluoroacetic acid
 Gradient: 2-50% B in 60 min
 Flow Rate: 0.3 mL/min
 Temperature: 60 °C
 Injection Volume: 5 µL of 0.2 mg/mL digest
 Detection: 220 nm, PDA
 Sample Solvent: 50 mM Tris-HCl/1.5 M Guanidine-HCl with 0.25% formic acid
 LC System: Shimadzu Nexera
 Flow Cell: 2.5 µL semi-micro

NANOSCALE HIGH RESOLUTION LC-MS ANALYSIS OF TRASTUZUMAB TRYPTIC DIGEST

In this example, two 0.2 x 250 mm HALO 160 Å ES-C18, 5 µm nanoscale columns were connected in series to provide additional resolving power for LC analysis of the tryptic digest of reduced and alkylated trastuzumab.



TEST CONDITIONS:

Columns: HALO 160 Å ES-C18, 5 µm two 0.2 mm x 250 mm columns in series
 Mobile Phase A: 0.1% difluoroacetic acid in water
 Mobile Phase B: 0.1% difluoroacetic acid in ACN
 Flow Rate: 3 µL/min
 Gradient:

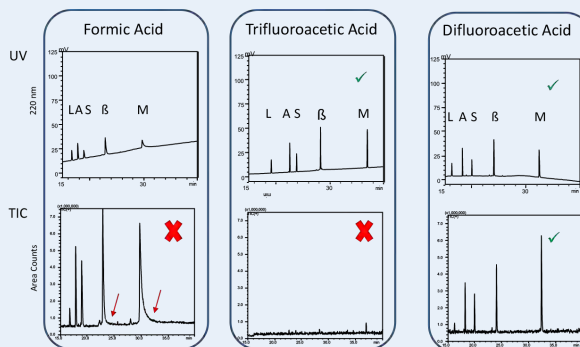
Time (min)	% B
0	5
2	5
137	42.5

Temperature: 60 °C
 Injection Volume: 5 µL
 Sample: 10 µg/µL trastuzumab tryptic peptides (Sample loaded at 2% B at 10 µL/min)
 HPLC: Dionex Ultimate 3000
 Mass Spectrometer: Thermo Orbitrap Velos Pro™ Hybrid Ion Trap-Orbitrap

HALO 160 Å columns are also available in capillary and nano dimensions for proteomics experiments and other sample-limited situations.

BENEFITS OF DFA

Switching to Difluoroacetic Acid (DFA), a less fluorinated ion pairing acid mobile phase modifier provides MS sensitivity improvement relative to TFA, particularly with small to mid size molecules. DFA has the practical advantage of similar chromatographic benefits of TFA, (including excellent peak shape and recovery), along with easier removal from instrument components. DFA can be easily removed in 10-15 minutes with 50:50 ACN/water.



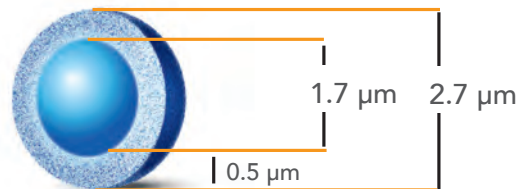
L = leucine enkephalin, A = angiotensin I, S = substance P, β = β-endorphin, M = melittin

GLYCAN SOLUTIONS

The HALO® Glycan incorporates a highly polar ligand that contains 5 hydroxyl groups tethered to 2.7 µm Fused-Core® silica particles via novel, proprietary linkage chemistry resulting in a high-resolution separation of complex glycan mixtures.

- Improved retention of acidic and zwitterionic analytes
- Ideal for hydrophilic interaction liquid chromatography (HILIC) separations of oligosaccharides, and particularly, of released and labeled glycans from glycoproteins and proteoglycans
- Each lot of HALO® Glycan material is tested for quality assurance by separation of a procainamide-reducing-end-labeled glycan ladder of oligosaccharides having 2–25 glucose units (GU)
 - Peaks for oligosaccharides composed of 5 and 10 GU must meet tight specifications for retention and peak width before lot is approved for glycan analysis

HALO® Glycan



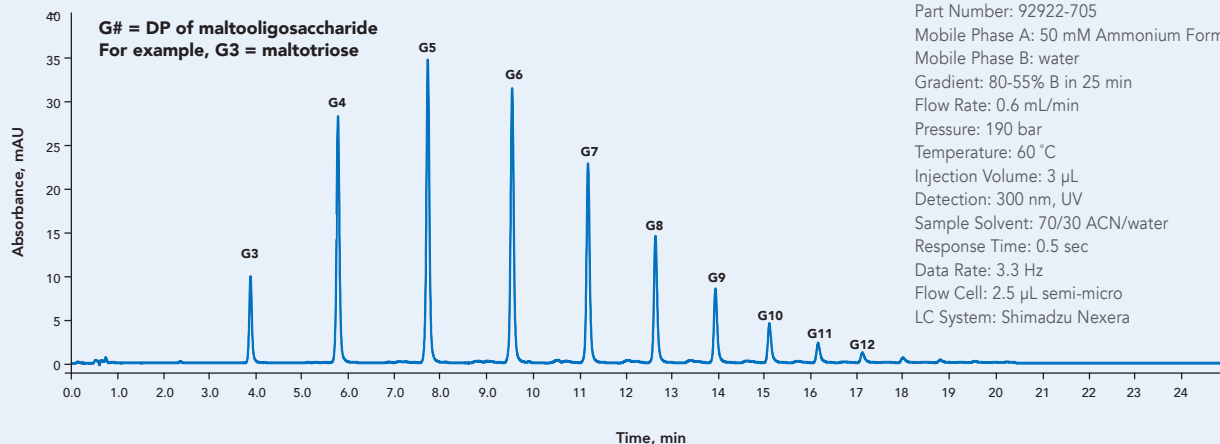
Shell with 90 Å pores

HALO 90 Å GLYCAN

Ligand: PROPRIETARY POLY-HYDROXY
USP Designation: L95
Available Particle Sizes: 2.7 µm
Pore Size: 90 Å

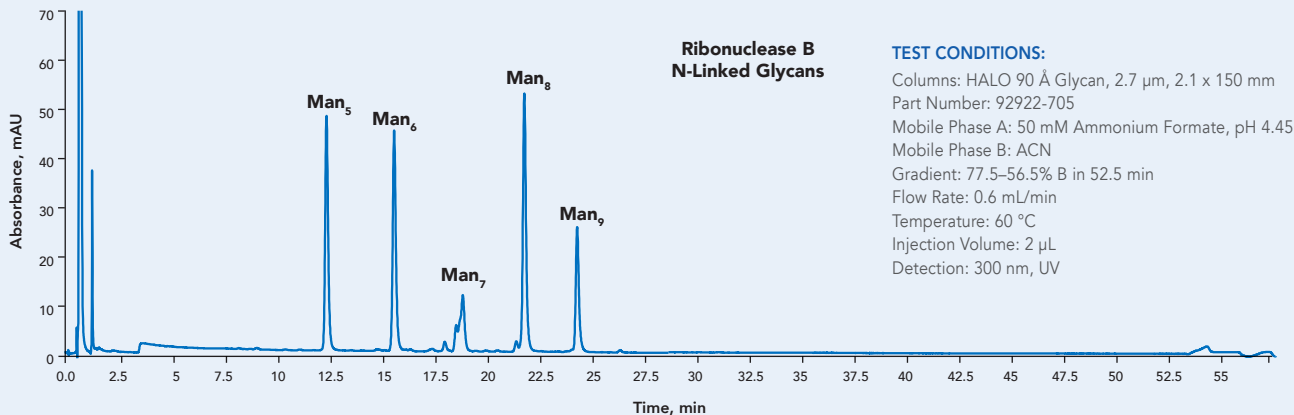
QA ANALYSIS OF HALO® GLYCAN

Example QA Chromatogram for HALO® Glycan column. Each HALO® Glycan packing lot is tested using this glycan ladder mixture to assess and ensure lot-to-lot reproducibility.



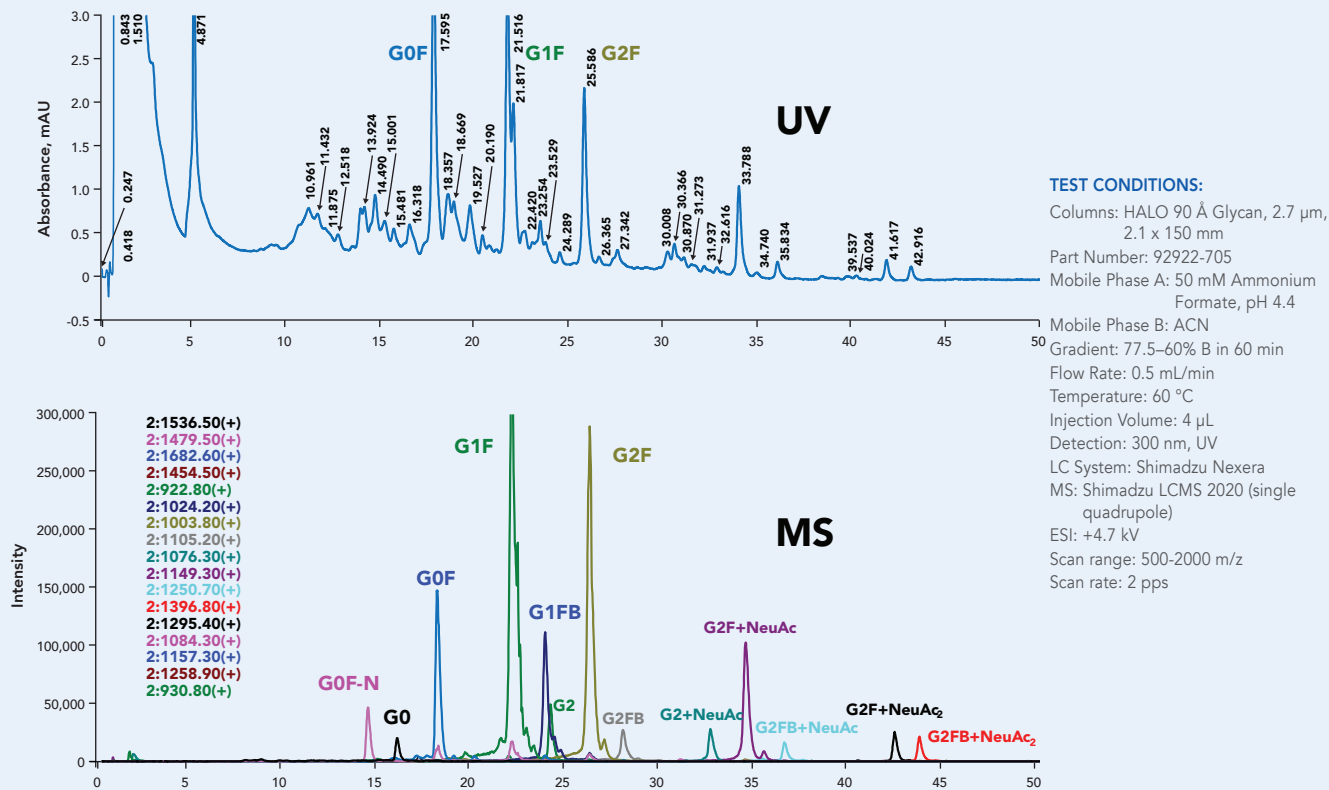
SEPARATION OF N-LINKED GLYCANS FROM RIBONUCLEASE B

Gradient HILIC-MS separation of N-linked glycans, which had been released using PNGase from ribonuclease B, using the HALO® Glycan column.



SEPARATION OF N-LINKED GLYCANS FROM HUMAN IgG

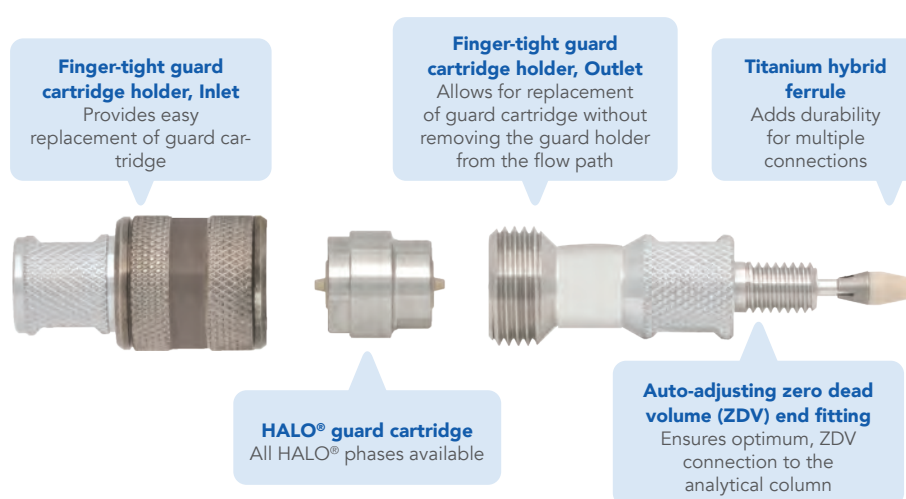
Released- and procainamide-labeled glycans from human IgG were separated using a 2.1 x 150 mm HALO® Glycan column and detected using UV and selected-ion-monitoring MS detection.



HALO® UHPLC AND HPLC GUARD COLUMNS

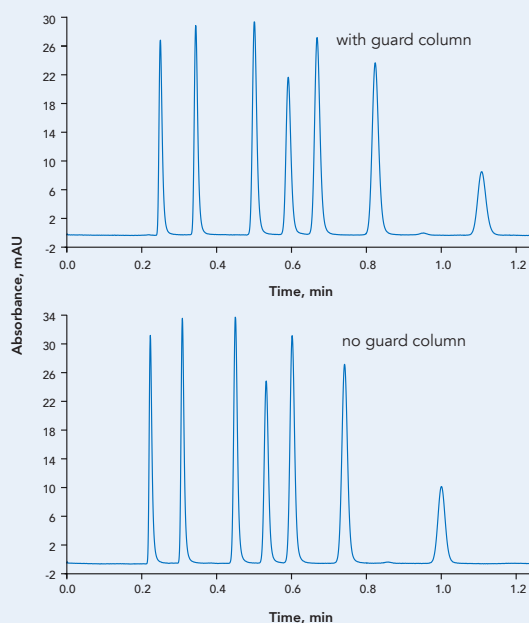
- Collect strongly retained compounds from the sample and minimizes column fouling
- Ultra-low dispersion, easy to use, operate at pressures up to 1000 bar
- Finger-tight, direct-connect units that auto-adjust to any column with a 10–32 inlet port
- Easily replace guard cartridge without removing guard holder from the flow path
- Available for all HALO® analytical geometries (2.1, 3.0 and 4.6 mm ID) and phases

See below for an exploded view of the HALO® guard cartridge and guard holder. Please see pages 18-19 for ordering information.



HALO® GUARD COLUMNS: PROTECTION + PERFORMANCE

HALO® guard columns provide optimum protection for your HALO® HPLC and UHPLC column without sacrificing column efficiency.



TEST CONDITIONS:

Columns: HALO 90 Å C18, 2.7 μ m, 4.6 x 50 mm
 Mobile Phase: 60/40 ACN/water
 Flow Rate: 1.8 mL/min
 Temperature: 30 °C
 Injection Volume: 1 μ L
 Detection: 254 nm, UV
 Pressure: 158 bar with guard column
 146 bar without guard column
 Instrument: Optimized Agilent 1100
 bypassed semi-micro flow cell
 0.05" ID tubing
 14 Hz data rate

HALO® BIOCLASS SPECIFICATIONS TABLES

PROTEIN SPECIFICATIONS

Bonded Phase	Pore Size (Å)	Particle Sizes (s) (µm)	USP #	Carbon Load (%)	Surface Area (m ² /g)	Low pH/T Limit	High pH/T Limit	End-capped
C4	1000	2.7	L26	0.6	22	2/90 °C	9/40 °C	Yes
	400	3.4		0.4	15			
ES-C18	1000	2.7	L1	1.4	22	1/90 °C	8/40 °C	Yes
	400	3.4		1.0	15			
Diphenyl	1000	2.7	L11	1.0	22	2/90 °C	9/40 °C	Yes
	400	3.4		0.7	15			

PEPTIDE SPECIFICATIONS

Bonded Phase	Pore Size (Å)	Particle Sizes (s) (µm)	USP #	Carbon Load (%)	Surface Area (m ² /g)	Low pH/T Limit	High pH/T Limit	Endcapped
ES-C18	160	2	L1	4.0	65	1/90 °C	8/40 °C	No
		2.7		4.6	90			
		5		4.0	60			
ES-CN	160	2.7	L10	2.2	90	1/90 °C	8/40 °C	Yes
		5		1.5	60			
Phenyl-Hexyl	160	2.7	L11	4.7	90	2/90 °C	9/40 °C	Yes
PCS C18	160	2.7	L1	5.09	90	2/60 °C	8/40 °C	Yes

GLYCAN SPECIFICATIONS

Bonded Phase	Pore Size (Å)	Particle Sizes (s) (µm)	USP #	Carbon Load (%)	Surface Area (m ² /g)	Low pH/T Limit	High pH/T Limit	Endcapped
Proprietary Poly-Hydroxy	90	2.7	L95	3.2	135	2/65 °C	9/40 °C	No

HALO 1000 Å & 400 Å PROTEIN COLUMNS

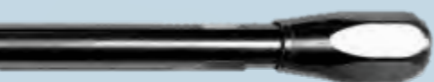
Part numbers for nano, capillary, analytical and semi-preparative HALO 1000 and 400 Å in 2.7 and 3.4 µm phases are provided below. Guard columns are available in 2.1, 3.0 and 4.6 mm IDs for UHPLC and HPLC applications to provide additional column protection when desired.

Dimensions ID x Length (in mm)	400 Å, 3.4 µm			1000 Å, 2.7 µm		
	C4	ES-C18	Diphenyl	C4	ES-C18	Diphenyl
0.3 x 50	94316-414	94316-402	94316-426	97216-414	97216-402	97216-426
0.3 x 100	94316-614	94316-602	94316-626	97216-614	97216-602	97216-626
0.3 x 150	94316-714	94316-702	94316-726	97216-714	97216-702	97216-726
0.5 x 50	94315-414	94315-402	94315-426	97215-414	97215-402	97215-426
0.5 x 100	94315-614	94315-602	94315-626	97215-614	97215-602	97215-626
0.5 x 150	94315-714	94315-702	94315-726	97215-714	97215-702	97215-726
1.0 x 50	93411-414	93411-402	93411-426	92711-414	92711-402	92711-426
1.0 x 100	93411-614	93411-602	93411-626	92711-614	92711-602	92711-626
1.0 x 150	93411-714	93411-702	93411-726	92711-714	92711-702	92711-726
1.5 x 50				9271X-414		9271X-426
1.5 x 100				9271X-614		9271X-626
1.5 x 150				9271X-714		9271X-726
2.1 x 20	93412-214	93412-202	93412-226	92712-214	92712-202	92712-226
2.1 x 30	93412-314	93412-302	93412-326	92712-314	92712-302	92712-326
2.1 x 50	93412-414	93412-402	93412-426	92712-414	92712-402	92712-426
2.1 x 75	93412-514	93412-502	93412-526	92712-514	92712-502	92712-526
2.1 x 100	93412-614	93412-602	93412-626	92712-614	92712-602	92712-626
2.1 x 150	93412-714	93412-702	93412-726	92712-714	92712-702	92712-726
2.1 x 250	93412-914	93412-902	93412-926	92712-914	92712-902	92712-926
3.0 x 20	93413-214	93413-202	93413-226	92713-214	92713-202	92713-226
3.0 x 30	93413-314	93413-302	93413-326	92713-314	92713-302	92713-326
3.0 x 50	93413-414	93413-402	93413-426	92713-414	92713-402	92713-426
3.0 x 75	93413-514	93413-502	93413-526	92713-514	92713-502	92713-526
3.0 x 100	93413-614	93413-602	93413-626	92713-614	92713-602	92713-626
3.0 x 150	93413-714	93413-702	93413-726	92713-714	92713-702	92713-726
3.0 x 250	93413-914	93413-902	93413-926	92713-914	92713-902	92713-926
4.6 x 20	93414-214	93414-202	93414-226	92714-214	92714-202	92714-226
4.6 x 30	93414-314	93414-302	93414-326	92714-314	92714-302	92714-326
4.6 x 50	93414-414	93414-402	93414-426	92714-414	92714-402	92714-426
4.6 x 75	93414-514	93414-502	93414-526	92714-514	92714-502	92714-526
4.6 x 100	93414-614	93414-602	93414-626	92714-614	92714-602	92714-626
4.6 x 150	93414-714	93414-702	93414-726	92714-714	92714-702	92714-726
4.6 x 250	93414-914	93414-902	93414-926	92714-914	92714-902	92714-926
10.0 x 50	93410-414	93410-402	93410-426	92710-414	92710-402	92710-426
10.0 x 100	93410-614	93410-602	93410-626	92710-614	92710-602	92710-626
10.0 x 150	93410-714	93410-702	93410-726	92710-714	92710-702	92710-726
Guard Columns, 3-Pack						
Dimensions ID x Length (in mm)	C4	ES-C18	Diphenyl	C4	ES-C18	Diphenyl
2.1 x 5	93412-114	93412-102	93412-126	92712-114	92712-102	92712-126
3.0 x 5	93413-114	93413-102	93413-126	92713-114	92713-102	92713-126
4.6 x 5	93414-114	93414-102	93414-126	92714-114	92714-102	92714-126
Guard Column Holder 94900-001						

HALO 90 Å GLYCAN COLUMNS

HALO® Glycan columns are available in 2.1 and 4.6 mm diameters in the following lengths as a 2.7 µm particle size. Guard columns are available for UHPLC and HPLC applications if additional protection is desired.

Dimensions ID x Length (in mm)	HALO® Glycan
0.3 x 150	99226-705
2.1 x 50	92922-405
2.1 x 100	92922-605
2.1 x 150	92922-705
4.6 x 50	92924-405
4.6 x 100	92924-605
4.6 x 150	92924-705
Guard Columns, 3-Pack	
Dimensions ID x Length (in mm)	HALO® Glycan
2.1 x 5	92922-105
4.6 x 5	92924-105
Guard Column Holder 94900-001	



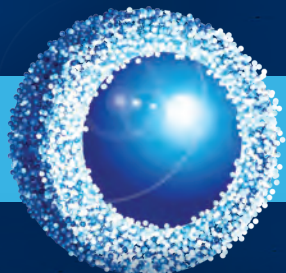
HALO 160 Å PEPTIDE COLUMNS

The part numbers are provided below for the nano, capillary, analytical and semi-preparative HALO 160 Å 2, 2.7 and 5 µm phases. Guard columns are available for 2.1, 3.0 and 4.6 mm internal diameters for UHPLC and HPLC applications, if additional protection is desired.

	160 Å, 2 µm	160 Å, 2.7 µm				160 Å, 5 µm	
Dimensions ID x Length (in mm)	ES-C18	ES-C18	ES-CN	Phenyl-Hexyl	PCS C18	ES-C18	ES-CN
0.3 x 50		91226-402	91226-404	91216-406			
0.3 x 100		91226-602	91226-604	91216-606			
0.3 x 150		91226-702	91226-704	91216-706			
0.5 x 50		91225-402	91225-404	91215-406			
0.5 x 100		91225-602	91225-604	91215-606			
0.5 x 150		91225-702	91225-704	91215-706			
1.0 x 50		92121-402	92121-404	92111-406			
1.0 x 100		92121-602	92121-604	92111-606			
1.0 x 150		92121-702	92121-704	92111-706			
1.0 x 250							
1.5 x 50	9112X-402	9212X-402			9211X-417		
1.5 x 100	9112X-602	9212X-602			9211X-617		
1.5 x 150	9112X-702	9212X-702			9211X-717		
2.1 x 20	91122-202	92122-202	92122-204	92112-106		95122-202	95122-204
2.1 x 30	91122-302	92122-302	92122-304	92112-206		95122-302	95122-304
2.1 x 50	91122-402	92122-402	92122-404	92112-306	92112-417	95122-402	95122-404
2.1 x 75	91122-502	92122-502	92122-504	92112-406		95122-502	95122-504
2.1 x 100	91122-602	92122-602	92122-604	92112-506	92112-617	95122-602	95122-604
2.1 x 150	91122-702	92122-702	92122-704	92112-606	92112-717	95122-702	95122-704
2.1 x 250	91122-902	92122-902	92122-904	92112-706		95122-902	95122-904
3.0 x 20	91123-202	92123-202	92123-204	92113-106		95123-202	95123-204
3.0 x 30	91123-302	92123-302	92123-304	92113-206		95123-302	95123-304
3.0 x 50	91123-402	92123-402	92123-404	92113-306	92113-417	95123-402	95123-404
3.0 x 75	91123-502	92123-502	92123-504	92113-406		95123-502	95123-504
3.0 x 100	91123-602	92123-602	92123-604	92113-506	92113-617	95123-602	95123-604
3.0 x 150	91123-702	92123-702	92123-704	92113-606	92113-717	95123-702	95123-704
3.0 x 250	91123-902	92123-902	92123-904	92113-706		95123-902	95123-904
4.6 x 20		92124-202	92124-204	92114-106		95124-202	95124-204
4.6 x 30		92124-302	92124-304	92114-206		95124-302	95124-304
4.6 x 50		92124-402	92124-404	92114-306	92114-417	95124-402	95124-404
4.6 x 75		92124-502	92124-504	92114-406		95124-502	95124-504
4.6 x 100		92124-602	92124-604	92114-506	92114-617	95124-602	95124-604
4.6 x 150		92124-702	92124-704	92114-606	92114-717	95124-702	95124-704
4.6 x 250		92124-902	92124-904	92114-706		95124-902	95124-904
10.0 x 50		92120-402	92120-404	92110-406		95120-402	95120-404
10.0 x 100		92120-602	92120-604	92110-606		95120-602	95120-604
10.0 x 150		92120-702	92120-704	92110-706		95120-702	95120-704
10.0 x 250						95120-902	95120-904
Guard Columns, 3-pack							
Dimensions ID x Length (in mm)	ES-C18	ES-C18	ES-CN	Phenyl-Hexyl	PCS C18	ES-C18	ES-CN
2.1 x 5	91122-102	92122-102	92122-104	92122-106	92112-117	95122-102	95122-104
3.0 x 5	91123-102	92123-102	92123-104	92123-106	92113-117	95123-102	95123-104
4.6 x 5	-	92124-102	92124-104	92124-106	92114-117	95124-102	95124-104
Guard Column Holder 94900-001							



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