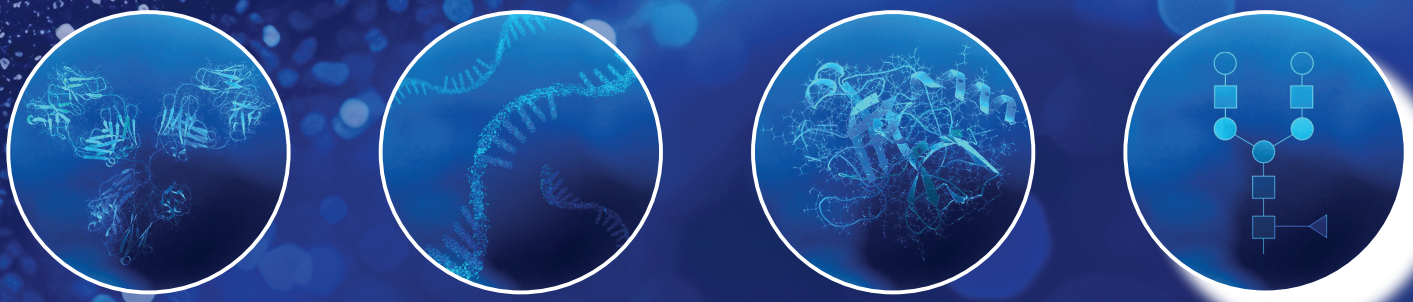
HALO®

BIOPHARMACEUTICAL SOLUTIONS



HALO® BIOCLASS

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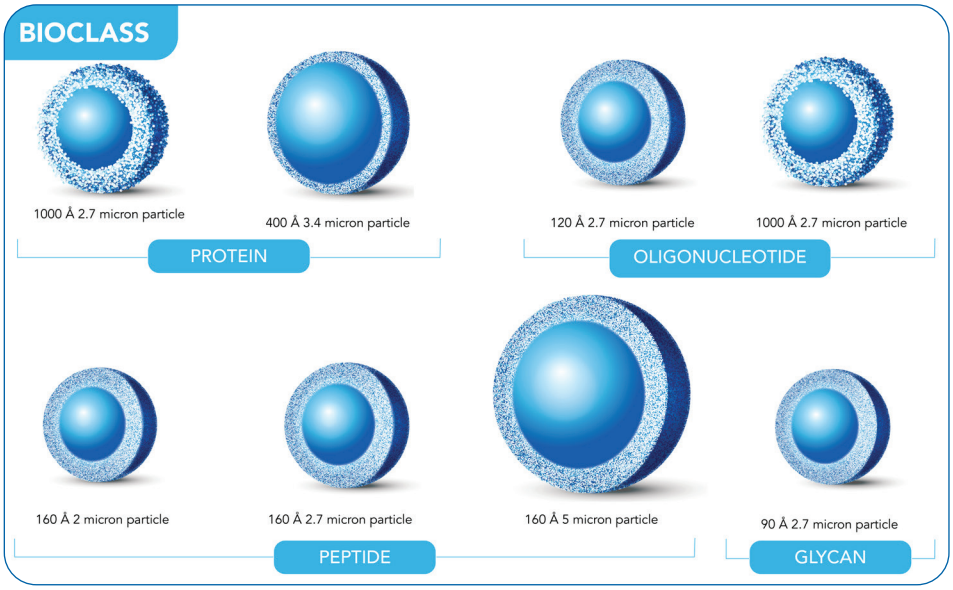


PROTEIN

- 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

OLIGONUCLEOTIDE

- 120 Å pore size for oligomers up to 60 bases in length and 1000 Å pore size for oligomers up to 100+ bases in length
- High pH and temperature stability
- Surface passivated hardware to reduce adsorption of oligonucleotides

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

GLYCAN

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

HALO® BIOCLASS OVERVIEW

Advanced Materials Technology pioneered Fused-Core® particle technology with the introduction of the first commercially available sub-3 µm superficially porous particle (SPP) - the original HALO® 2.7 µm particle. This expertise in precision particle engineering and manufacturing has since established AMT as a leader in wide-pore SPP technology, enabling efficient separations of large and complex biomolecules. That same innovation-driven approach has been applied to the development of advanced stationary phases tailored for biotherapeutic analysis. HALO® particles are engineered to meet the rigorous performance demands associated with high-efficiency characterization of complex biological samples.

Modern researchers require rapid, high-resolution separations of diverse biomolecules to support pharmaceutical development of therapeutic proteins, peptides, and oligonucleotides; advance fundamental research in academic laboratories; characterize protein post-translational modifications; and differentiate subtle structural and compositional variations in biosimilars and other bioengineered products. HALO® BioClass columns are specifically designed to address these challenges, combining optimized pore structures, surface chemistries, and SPP efficiency to simplify method development and enable faster, more comprehensive biomolecular characterization.

- Intact proteins, monoclonal antibodies (mAbs), biosimilars, and other large biomolecules such as pegylated proteins, antibody drug conjugates (ADCs), etc.
- 120 Å and 1000 Å OLIGO solutions that span the full range of separation challenges (up to 100 + bases in length)
- 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

GUIDANCE FOR PORE SIZE SELECTION

Application	Differentiation	Pore Size (Å)
Glycan	SMALL (< 20 kDa*)	90
Peptides	MEDIUM (100 Da < MW < 15 kDa)	160
Proteins mAbs	LARGE (2 kDa < MW < 500 kDa)	400
Proteins (mAbs, ADCs, DARs)	LARGE (> 50 kDa)	1000
Oligonucleotides (DNA, Primers, ASOs, SiRNAs, Aptamers	Best up to ~60 Base Pairs	120
Oligonucleotides (siRNAs, Aptamers, sgRNAs, mRNAs)	Covers the lower range as well as above 100+ base pairs	1000

* for glycans, glycopeptides and glycoproteins

PROTEIN SOLUTIONS

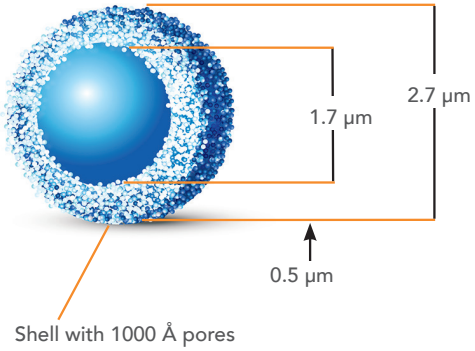
- The advantages of using wide pore silica based superficially porous particles (SPP) for high resolution analysis of large proteins has been well established and as the innovator of the 1000 Å Fused-Core® particle, AMT recognizes the benefit of unrestricted pore access which combines the power of ultrafast 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)

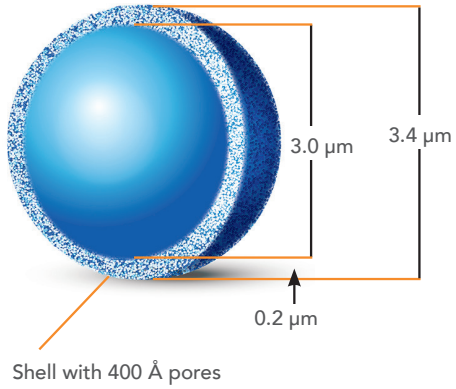
- As complex biotherapeutics development continues to grow, understanding structural modifications requires separation options. Often these minor variants consist of subtle differences in protein chains, glycosylation sites and free sulfhydryl groups

- 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

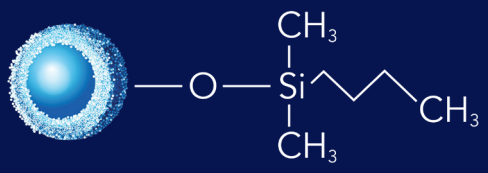
- mAbs
- ADCs
- Biosimilars
- H/D exchange
- Fragments

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

HALO 1000 Å PROTEIN BONDED PHASE PORTFOLIO

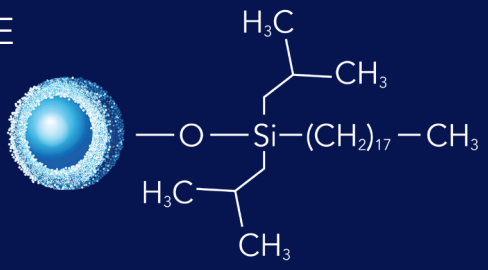
HALO 1000 Å C4



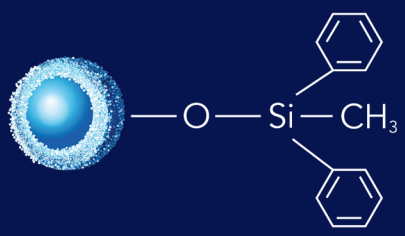
Ligand: DIMETHYLBUTYLSILANE
USP Designation: L26
Available Particle Sizes: 2.7 µm
Pore Size: 1000 Å

HALO 1000 Å ES-C18

Ligand: DIISOBUTYLOCTADECYLSILANE
USP Designation: L1
Available Particle Sizes: 2.7 µm
Pore Size: 1000 Å



HALO 1000 Å DIPHENYL



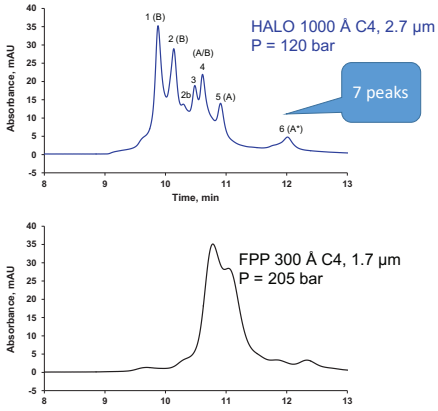
Ligand: DIPHENYLMETHYL
USP Designation: L11
Available Particle Sizes: 2.7 µm
Pore Size: 1000 Å

WIDE PORE SIZE RESULTS IN SHARPER PEAKS AND HIGHER 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
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

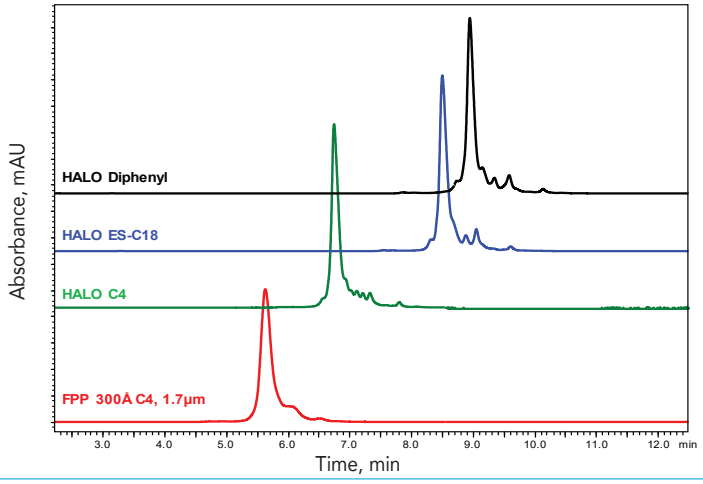
PEAK IDENTITIES:

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

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 charaterization screening.



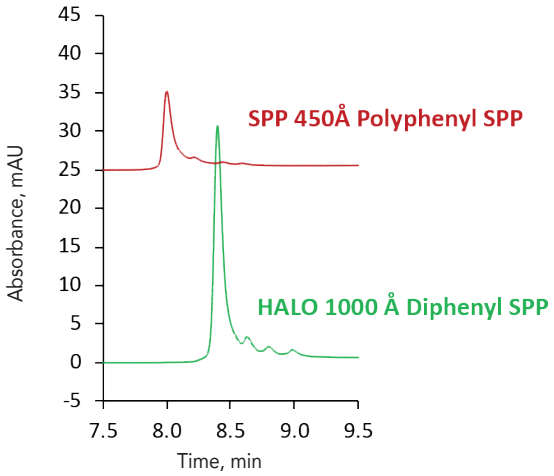
TEST CONDITIONS:

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.



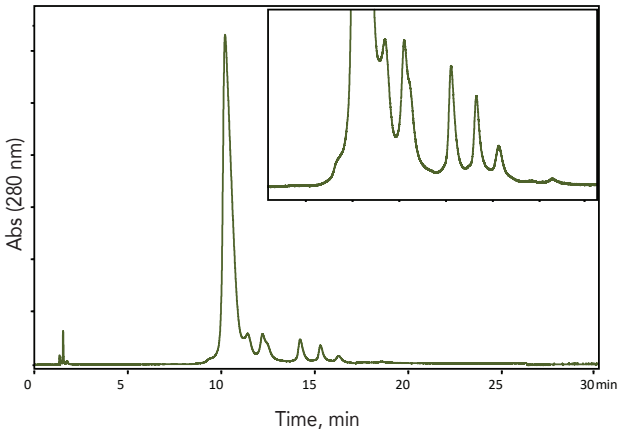
TEST CONDITIONS:

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.

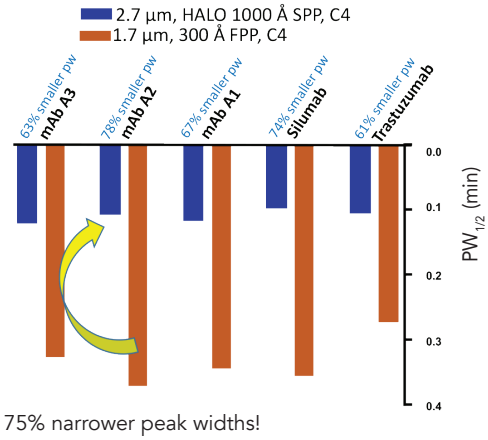


TEST CONDITIONS:

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.



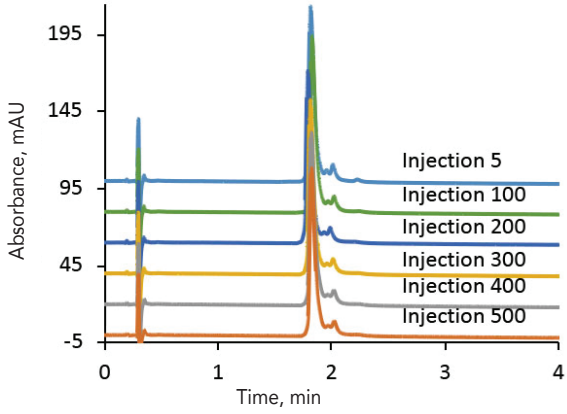
75% narrower peak widths!

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.



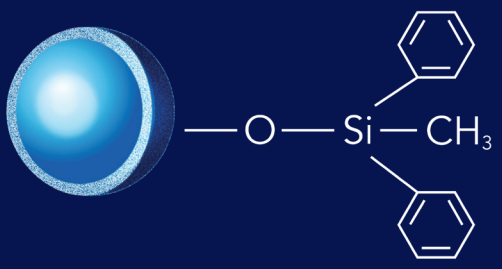
TEST CONDITIONS:

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

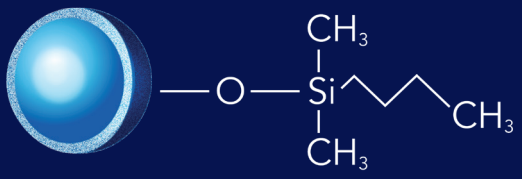
HALO 400 Å PROTEIN BONDED PHASE PORTFOLIO

HALO 400 Å Diphenyl

Ligand: DIPHENYLMETHYL
USP Designation: L11
Available Particle Sizes: 3.4 µm
Pore Size: 400 Å



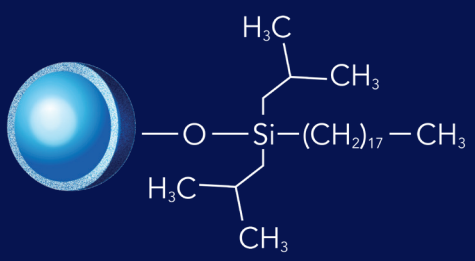
HALO 400 Å C4



Ligand: DIMETHYLBUTYLSILANE
USP Designation: L26
Available Particle Sizes: 3.4 µm
Pore Size: 400 Å

HALO 400 Å ES-C18

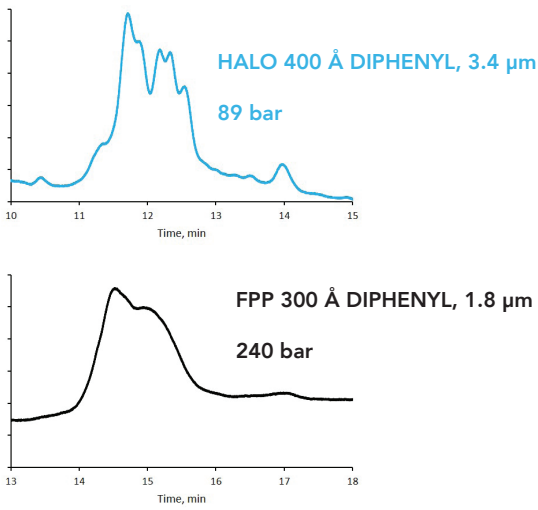
Ligand: DIISOBUTYLOCTADECYLSILANE
USP Designation: L1
Available Particle Sizes: 3.4 µm
Pore Size: 400 Å



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

IMPROVED RESOLUTION WITH HALO® DIPHENYL FUSED-CORE® TECHNOLOGY VS. FULLY POROUS PARTICLE

Denosumab, a human IgG2 monoclonal antibody that is used to treat cancer in the bones was analyzed on two different types of HPLC columns. The HALO 400 Å column outperformed the 300 Å fully porous diphenyl column by providing much better resolution at 2.5-
fold lower back pressure along with a quicker run time.

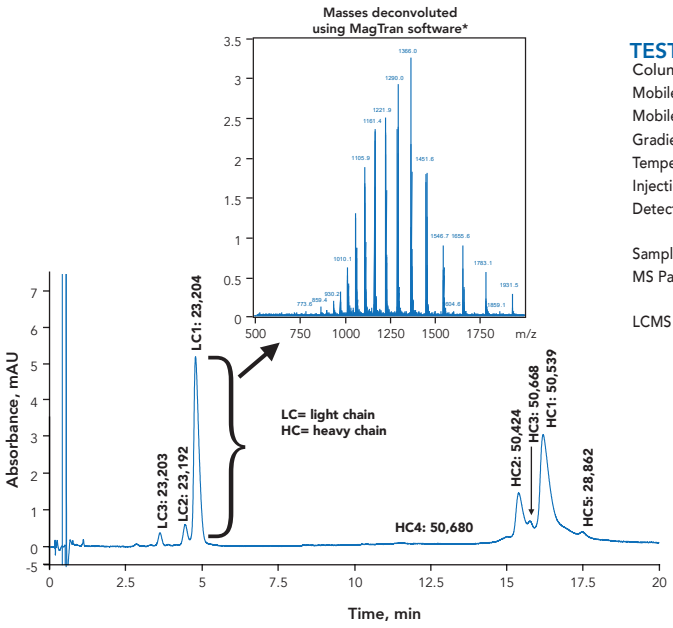


TEST CONDITIONS:

Columns:
HALO 400 Å Diphenyl, 3.4 µm, 2.1x150 mm
FPP 300 Å Diphenyl, 1.8 µm, 2.1x150 mm
Mobile Phase A: 88/10/2: Water/Acetonitrile/**n-Prop/
0.1% *DFA
Mobile Phase B: 70/20/10: **nProp/Acetonitrile/Water/
0.1% *DFA
Gradient: Time (min.) %B
0.0 18
20.0 28
Flow Rate: 0.2 mL/min.
Temperature: 60 °C
Detection: 220 nm, PDA
Injection Volume: 2 µL
Sample Solvent: Water/ 0.1% DFA
Data Rate: 100 Hz
Response Time: 0.025 sec.
Flow Cell: 1 µL
LC System: Shimadzu Nexera X2
*DFA = difluoroacetic acid
**nProp = n- propanol

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.

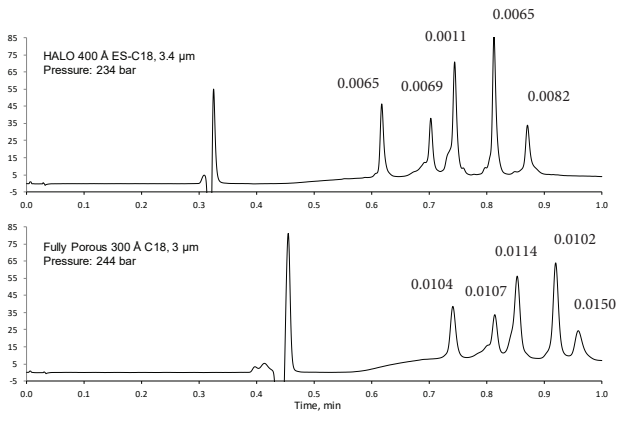


TEST CONDITIONS:

Columns: HALO 400 Å C4, 3.4 µm, 2.1 x 100 mm
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
LCMS System: Shimadzu Nexera and LCMS-2020 (single quadrupole MS)

IMPROVED PEAK WIDTH WITH HALO® ES-C18 FUSED-CORE® TECHNOLOGY VS. FULLY POROUS PARTICLE

An average of 49% reduced peak width is measured with the HALO® 400 Å ES-C18 versus the competitor 300Å fully porous column.



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

TEST CONDITIONS:

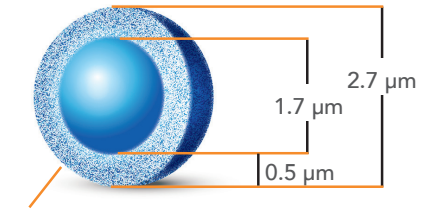
Columns: HALO 400 Å ES-C18, 3.4 µm, 4.6 x 100 mm
Competitor: FPP 300 Å C18, 3 µm, 4.6 x 100 mm
Mobile Phase A: water/0.1% TFA
Mobile Phase B: ACN/0.1% TFA
Gradient: 23-85% B in 1 min; 3 + 6 µL heat exchangers
Flow rate: 3 mL/min.
Temperature: 60 °C
Injection Volume: 5 µL
Instrument: Agilent 1200 SL
Detection: 215 nm, PDA

OLIGONUCLEOTIDE SOLUTIONS

- HALO® OLIGO columns are built on the foundational advantages of Fused-Core® technology, delivering high-efficiency, high-speed separations tailored specifically for oligonucleotide analysis. With the introduction of a new 1000 Å pore-size option designed to enhance performance for larger and more complex oligos HALO® now offers OLIGO solutions that span the full range of separation challenges. Closely related impurities and failure sequences can be clearly resolved, enabling confident characterization even for demanding oligonucleotide workflows.

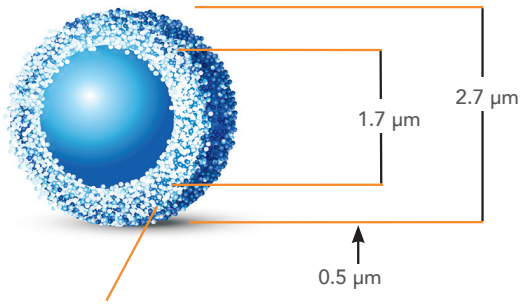
- The HALO® OLIGO C18 features surface-modified organo-silane chemistry that provides enhanced alkaline resistance, resulting in excellent stability under the elevated pH conditions commonly used in oligonucleotide separations. In addition, inert column hardware minimizes analyte adsorption, ensuring maximum recovery and reliable, reproducible results.

HALO® OLIGO 2.7 µm



Shell with 120 Å pores

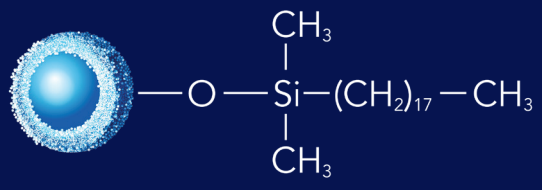
HALO® OLIGO 2.7 µm



Shell with 1000 Å pores

HALO 120 Å OLIGO BONDED PHASE

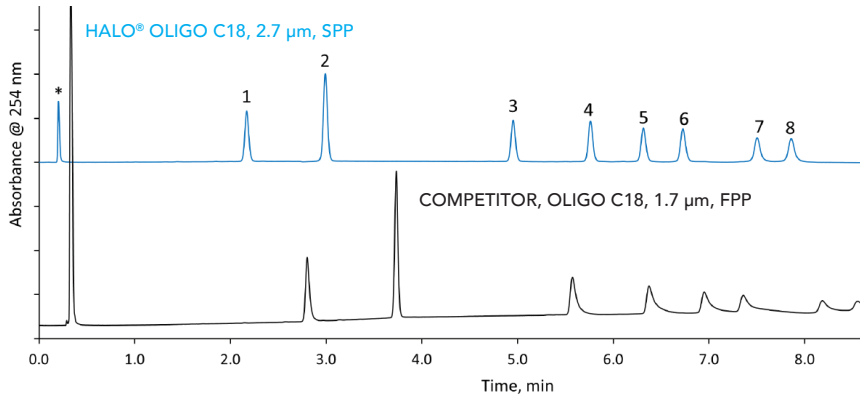
HALO 120 Å C18



Ligand: DIMETHYLOCTADECYLSILANE
Designation: L1
Available Particle Sizes: 2.7 µm
Pore Size: 120 Å

HALO® FUSED-CORE® PARTICLE TECHNOLOGY SHOWING COMPETITIVE ADVANTAGE OVER FPP

An oligonucleotide ladder of mixed sequence and length is separated on the HALO® OLIGO C18 and a competitor oligonucleotide column under high pH conditions. The oligomers of 20 base length AND higher begin to tail significantly on the competitor column. The same oligomers show no tailing on the HALO® column demonstrating the chromatographic efficiency and speed of Fused-Core®. Note: Tailing of the competitor column could represent poor column loading, however, both the HALO® and competitor columns were QC tested and passed prior to analysis.



PEAK IDENTITIES:

1.	10 mer	5.	30 mer	*Tris HCl/
2.	15 mer	6.	40 mer	EDTA
3.	20 mer	7.	50 mer	
4.	25 mer	8.	60 mer	

TEST CONDITIONS:

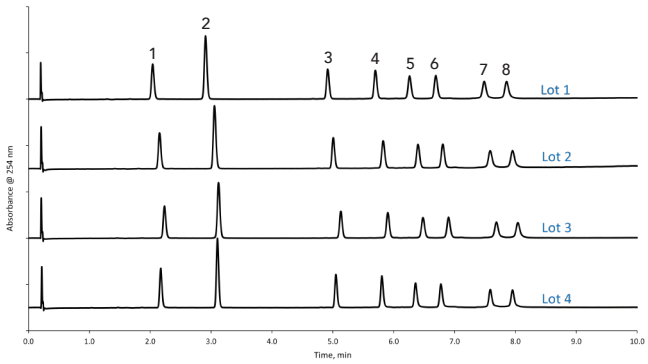
Column: HALO 120 Å OLIGO C18, 2.7 µm, 2.1 x 50 mm
Competitor: Oligo 130 Å C18, 1.7 µm, 2.1 x 50 mm
Mobile Phase A: 100mM TEAA, Adjusted to pH = 8.5
Mobile Phase B: ACN
Gradient:

Time	%B
0.0	5
10.0	11
11.0	11
11.5	0
16.5	0

Flow Rate: 0.5 mL/min.
Back Pressure: HALO® - 140 bar
Competitor - 255 bar
Temperature: 60 °C
Injection: 1.0 µL, 10µg on column
Sample Solvent: 10mM Tris HCl/1mM EDTA pH=8.0
Wavelength: PDA, 254 nm
Flow Cell: 1 µL
Data Rate: 100 Hz
Response Time: 0.025 sec.
LC System: Shimadzu Nexera X2

EXCELLENT LOT-TO-LOT REPRODUCIBILITY

Four different lots of HALO® OLIGO C18 were tested using a ladder of single stranded DNA ranging in base length from 10 mer to 60 mer.



PEAK IDENTITIES:

1. 10 mer
2. 15 mer
3. 20 mer
4. 25 mer
5. 30 mer
6. 40 mer
7. 50 mer
8. 60 mer

TEST CONDITIONS:

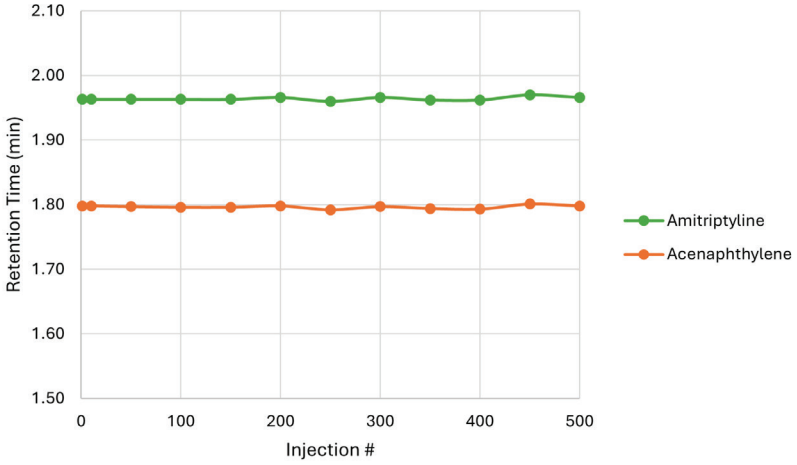
Columns: HALO 120 Å OLIGO C18, 2.7 µm, 2.1 x 50 mm
Mobile Phase A: 10mM TEAA, pH 8.5
Mobile Phase B: Acetonitrile
Gradient:

Time	%B
0.0	5
10.0	11
11.0	11
11.5	5

Flow Rate: 0.5 mL/min.
Back Pressure: 125 bar
Temperature: 60 °C
Injection Volume: 1.0 µL
Sample Solvent: 10mM Tris HCl/1mM EDTA
Detection: UV/PDA, 254 nm
Flow Cell: 1 µL
Data Rate: 100 Hz
Response Time: 0.025 sec.
LC System: Shimadzu Nexera X2

PERFORMANCE YOU CAN RELY ON!

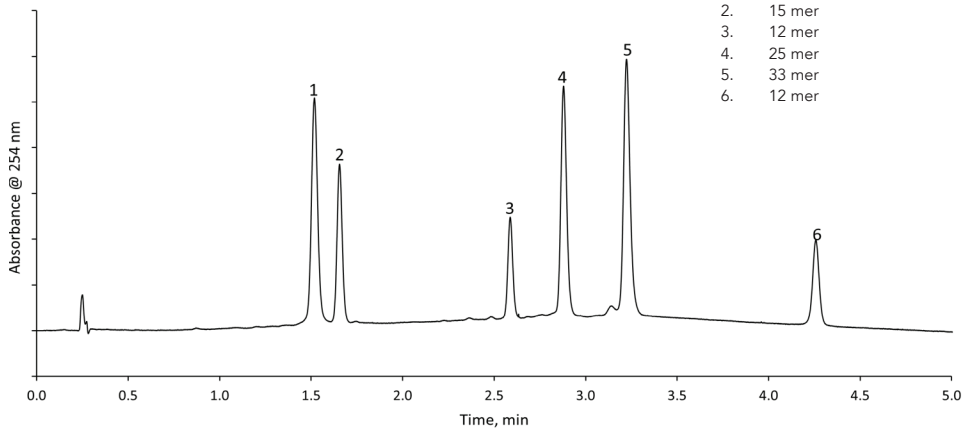
Testing the packing material stability that is used in the HALO® OLIGO C18 column, a less than 1% change in retention is achieved over 20,000 column volumes. This stability run was performed at both high pH (10) and high T (60 °C).



RSD < 1% FOR BOTH ANALYTES

OLIGONUCLEOTIDE PERFORMANCE MIX

By using the HALO® OLIGO C18 column under high pH conditions a sample of 6 different oligonucleotides can be separated in under 4.5 minutes. Using the SigmaAldrich Oligonucleotide Performance Standard Mix, the HALO® OLIGO C18 demonstrates utility as part of system suitability testing. The standard, with a range of 12 to 33 oligomers in base length, and having two 12 base length oligos, serves as an ideal performance mix.



PEAK IDENTITIES:

1. 20 mer
2. 15 mer
3. 12 mer
4. 25 mer
5. 33 mer
6. 12 mer

TEST CONDITIONS:

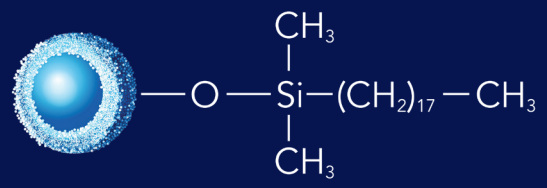
Column: HALO 120 Å OLIGO C18, 2.7µm, 2.1 x 50 mm
Mobile Phase A: 100mM TEAA @ pH 8.5
Mobile Phase B: Acetonitrile
Gradient:

Time	%B
0.0	7.5
5.0	15
5.3	60
5.6	60
8.0	7.5

Flow Rate: 0.4 mL/min
Back Pressure: 142 bar
Temperature: 50 °C
Injection: 1 µL of Oligonucleotide Performance Standard Mix, 12-33 NT
P/N: PHR8667-1EA
Sample Solvent: 10mM Tris HCl/ 1mM EDTA
Wavelength: PDA, 254 nm
Flow Cell: 1 µL
Data Rate: 100 Hz
Response Time: 0.05 sec.
LC System: Shimadzu Nexera X2

HALO 1000 Å OLIGO BONDED PHASE

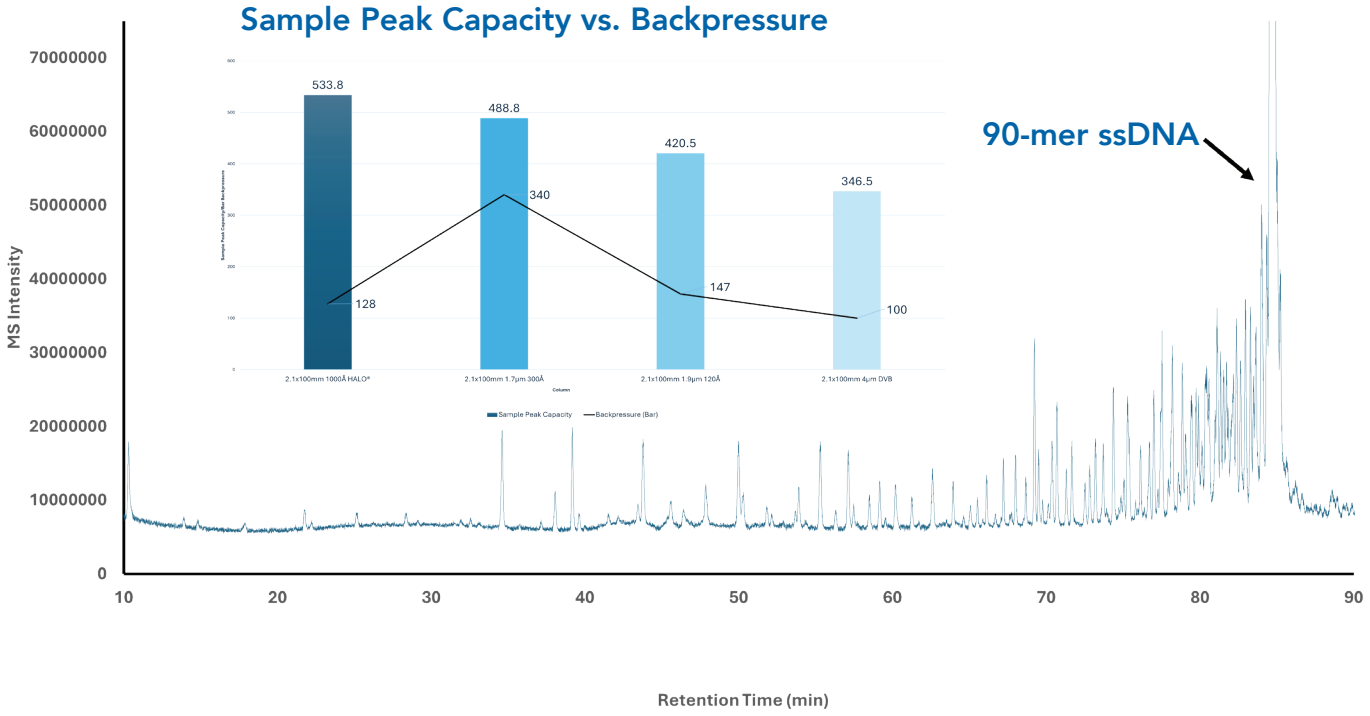
HALO 1000 Å C18



Ligand: DIMETHYLOCTADECYLSILANE
Designation: L1
Available Particle Sizes: 2.7 µm
Pore Size: 1000 Å

DISTINGUISH AND QUANTIFY OVER 100 IMPURITIES IN COMPLEX SAMPLES

The resolution of an oligonucleotide mixture was evaluated using a longer column (25 cm) under a shallow gradient, successfully resolving species up to 100 nucleotides in length. The resolution scaled approximately with the square root of column length (√L), consistent with chromatographic theory when the gradient rate was adjusted proportionally to column length - specifically, comparing 150-minute and 60-minute gradients for the 25 cm and 10 cm columns. The data supports the expected trend that longer columns, when paired with appropriately scaled gradients, enhances resolution for complex oligonucleotide mixtures.



TEST CONDITIONS:

Column: HALO 1000 Å OLIGO C18, 2.7µm, 2.1 x 150mm
Mobile Phase A: 10mM Diisobutylpropylamine(DiBA)/100mM Hexafluoroisopropanol (HFIP)/5% Methanol/5% Acetonitrile
Mobile Phase B: 10mM DiBA/100mM HFIP/5% Methanol/50% Acetonitrile

Gradient:

Time	%B
0.00	0
120	32
125	50
125.1	0
130	0

Flow Rate: 0.2 ml/min.
Pressure: 150 bar
Temperature: 60 °C
Detection: High Resolution MS

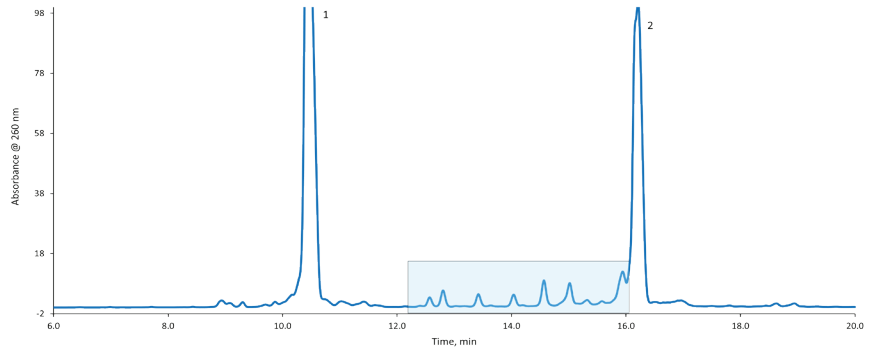
Injection Volume:
10 µl (Sample diluted 1:100 in Mobile phase A)
Sample Solvent: 90-mer crude ssDNA in nuclease-free water
LC System: Shimadzu Nexera X2

MS CONDITIONS:

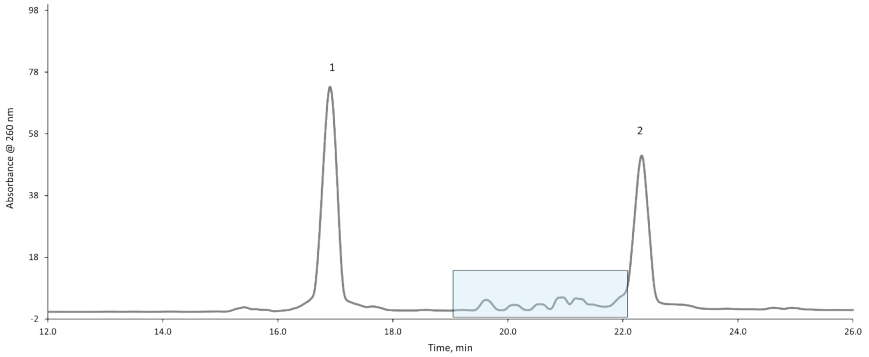
Mass Spectrometer: Thermo Q-Exactive HF
Ion mode: Negative Electrospray
MS1 only Scan Mode
Sheath Gas Flow Rate: 40
Aux Gas Flow Rate: 20
Sweep Gas Flow Rate: 3
Spray Voltage: 3000 V
Capillary Temp: 350 °C
S-Lens RF: 60V
Aux Gas Heater Temp: 400°C
MS1 Resolution 120,000
AGC Target: 3.00E+06
Max IT: 200ms
Scan Range: m/z 450-2000

ADVANTAGE OF THE HALO 1000 Å OLIGO C18 FOR siRNA IMPURITY ANALYSIS

This application note demonstrates the dramatic impact of pore size and particle morphology on the separation of Lumasiran siRNA and its related impurities. Using the HALO® 2.7 µm, 1000 Å OLIGO C18 column, in the highlighted regions, seven distinct impurity peaks are resolved between the antisense and sense strands, compared to only five impurity peaks observed on a fully porous 1.7 µm, 130 Å competitor oligonucleotide C18 column. The larger 1000 Å pore structure significantly improves mass transfer for higher molecular weight oligonucleotides, reducing diffusion limitations that commonly lead to peak broadening on smaller-pore, fully porous particles.



—HALO® 2.7µm, 1000 Å OLIGO C18



—FPP 1.7µm, 130 Å Oligonucleotide C18

PEAK IDENTITIES:

1. Anti-Sense Strand
2. Sense Strand

TEST CONDITIONS:

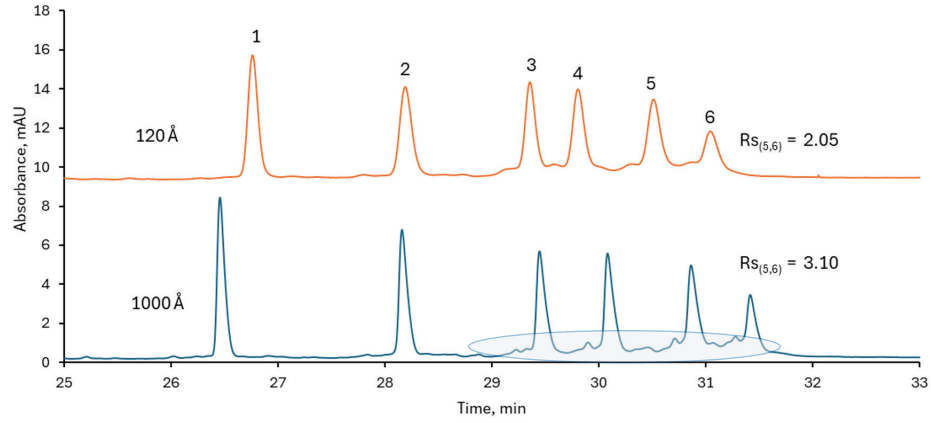
Column: HALO 1000 Å OLIGO C18 , 2.7 µm, 2.1 x 150 mm
Part Number: P2762-702
Column: FPP 1.7 µm, 130 Å Oligonucleotide C18
Mobile Phase A: 3 mM DiPEA/150 mM HFIP/5% MeOH
Mobile Phase B: 40/15/45 Water/IPA/MeOH
Gradient:

Time	% B
0.0	14
25	24
26	50
28	50
29	14

Flow Rate: 0.4 mL/min.
Pressure: HALO® - 288 bar
FPP - 543 bar
Temperature: 70 °C
Injection Volume: 1.0 µL (1 mg/mL of Lumasiran)
Sample Solvent: RNAse Free Water
Wavelength: PDA, 260 nm
Flow Cell: 1 µL
Data Rate: 12.5 Hz
Response Time: 0.100 sec.
LC System: Shimadzu Nexera X2

1000 Å ENABLES IMPROVED RESOLUTION AND SHARPER PEAKS FOR OLIGONUCLEOTIDES > 60 BASES

A very shallow gradient is run using a HALO 1000 Å OLIGO C18 column to demonstrate narrow peak shapes, increased resolution, and more detailed analysis of minor impurities. The 1000 Å pore size allows access to the C18 stationary phase to enhance the separation compared to the smaller 120 Å pore size, which is more suited for shorter length oligonucleotides (<60).



PEAK IDENTITIES:

1. 50-mer
2. 60-mer
3. 70-mer
4. 80-mer
5. 90--mer
6. 100-mer

TEST CONDITIONS:

Column: HALO 120 Å OLIGO C18, 2.7 µm, 2.1 x 100 mm
Column: HALO 1000 Å OLIGO C18, 2.7 µm, 2.1 x 100 mm
Mobile Phase A: 15 mM TEA/50 mM HFIP, pH 8.9
Mobile Phase B: Acetonitrile
Gradient:

Time	%B
0	1.5
40	6.5
41	15
42	15
43	1.5
50	Stop

Flow Rate: 0.5 mL/min.
Back pressure: 226 bar (HALO 120 Å OLIGO C18)
210 bar (HALO 1000 Å OLIGO C18)
Temperature: 60 °C
Injection Volume: 1 µL, 20/100 IDT @ 10ng
Sample Solvent: water
Wavelength: PDA, 260 nm
Flow Cell: 1 µL
Data Rate: 6.25 Hz
Response Time: 0.050 sec.
LC System: Shimadzu Nexera X2

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

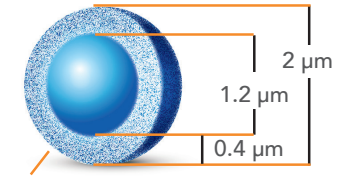
APPLICATIONS

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

FEATURES

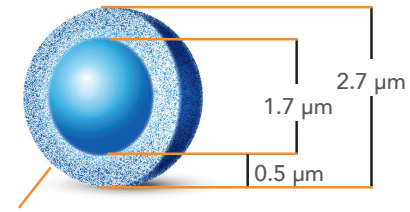
- Fast separations
- High peak capacity
- Rugged, reliable performance
- Alternative selectivity with ES-C18, ES-CN, Phenyl-Hexyl and PCS C18

HALO® 2 µm Peptide



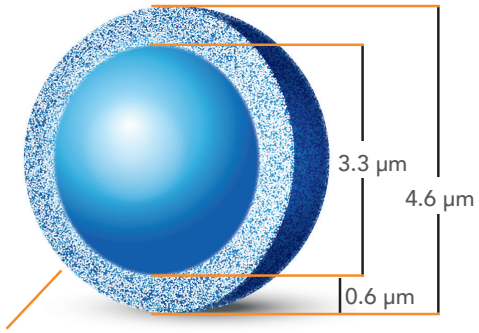
Shell with 160 Å pores

HALO® 2.7 µm Peptide



Shell with 160 Å pores

HALO® 5 µm Peptide

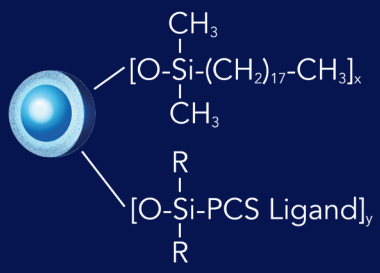


Shell with 160 Å pores

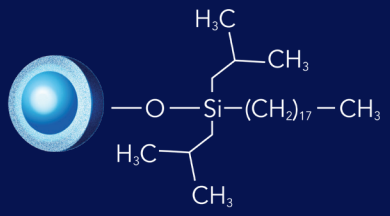
HALO® PEPTIDE BONDED PHASE PORTFOLIO

HALO 160 Å PCS C18 Charged Surface Technology

Ligand: DIMETHYLOCTADECYLSILANE
USP Designation: L1
Available Particle Sizes: 2, 2.7 µm
Pore Size: 160 Å



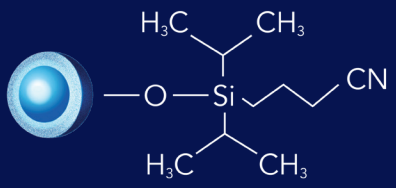
HALO 160 Å ES-C18



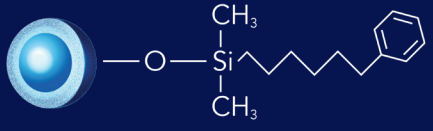
Ligand: DIISOBUTYLOCTADECYLSILANE
USP Designation: L1
Available Particle Sizes: 2, 2.7, 5 µm
Pore Size: 160 Å

HALO 160 Å ES-CN

Ligand: DIISOPROPYLCYANOPROPYLSILANE
USP Designation: L10
Available Particle Sizes: 2.7, 5 µm
Pore Size: 160 Å



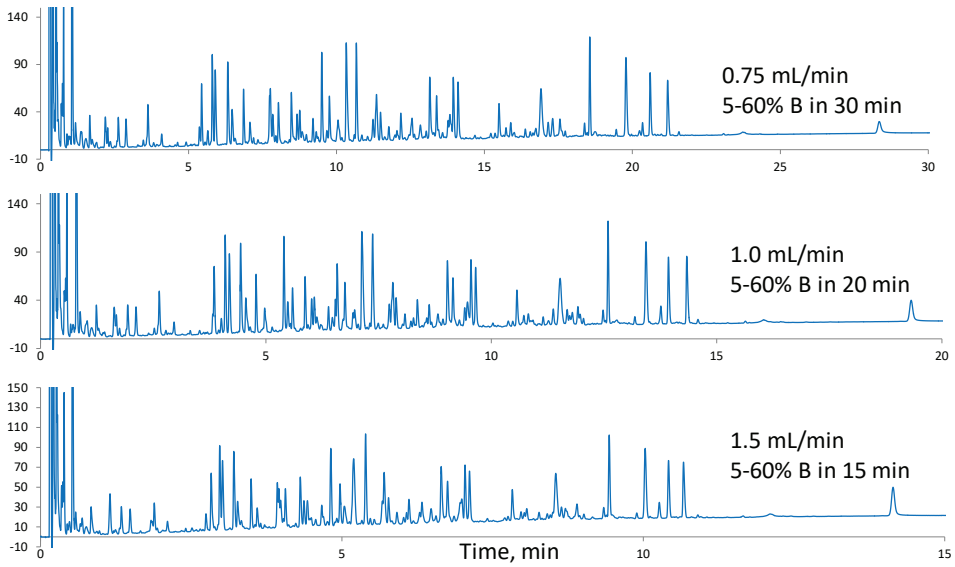
HALO 160 Å Phenyl-Hexyl



Ligand: DIMETHYLPHENYL-HEXYLSILANE
USP Designation: L11
Available Particle Sizes: 2.7 µm
Pore Size: 160 Å

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.

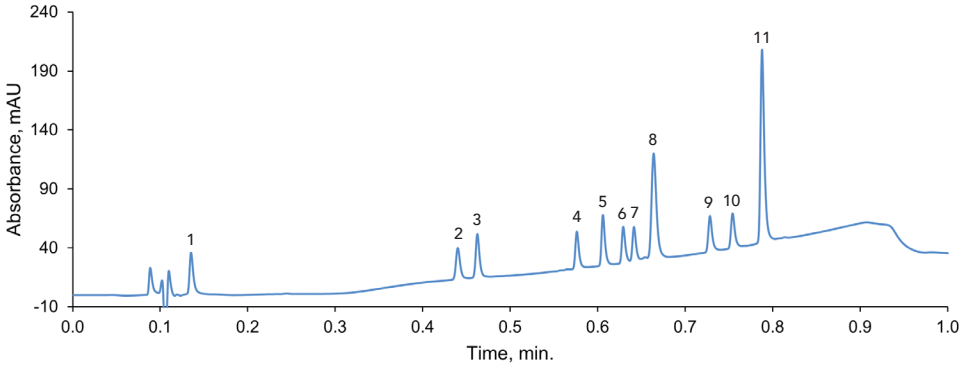


TEST CONDITIONS:

Columns: HALO 160 Å ES-C18, 2.7 µm, 2.1 x 100 mm
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, ultra fast peptide separations are achievable with the HALO 160 Å ES-C18 column.



PEAK IDENTITIES:

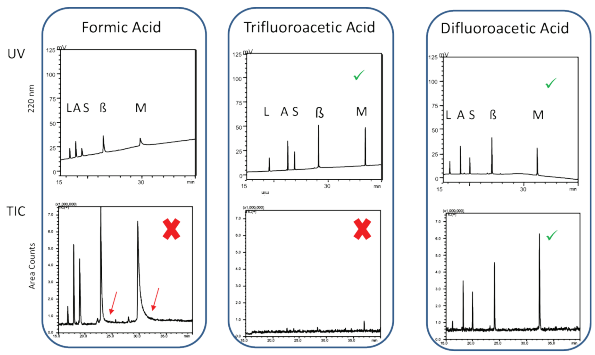
1. Gly-Tyr
2. Val-Tyr-Val
3. Angiotensin 1/2 (1-7) amide
4. Met-enkephalin
5. Angiotensin 1/2 (1-8) amide
6. Angiotensin II
7. Leu-enkephalin
8. Ribonuclease A
9. Angiotensin (1-12) (mouse)
10. Bovine Insulin
11. Angiotensin (1-12) (human)

TEST CONDITIONS:

Column: HALO 160 Å ES-C18, 2 µm, 3.0 x 50 mm
Mobile Phase A: water/0.1% TFA
Mobile Phase B: 80/20 ACN/water/0.1% TFA
Flow Rate: 2.2 mL/min.
Gradient: Hold at 12.5% B for 0.1 min; 12.5% B to 63% B from 0.1 – 1.0 min.
Initial pressure: 556 bar
Temperature: 60 °C
Detection: UV 215 nm, PDA
Injection Volume: 0.5 µL
Sample Solvent: water/0.1% TFA
Response Time: 0.025 sec.
Data Rate: 200 Hz
LC System: Shimadzu Nexera X2
Flow Cell: 1 µL

BENEFITS OF DFA

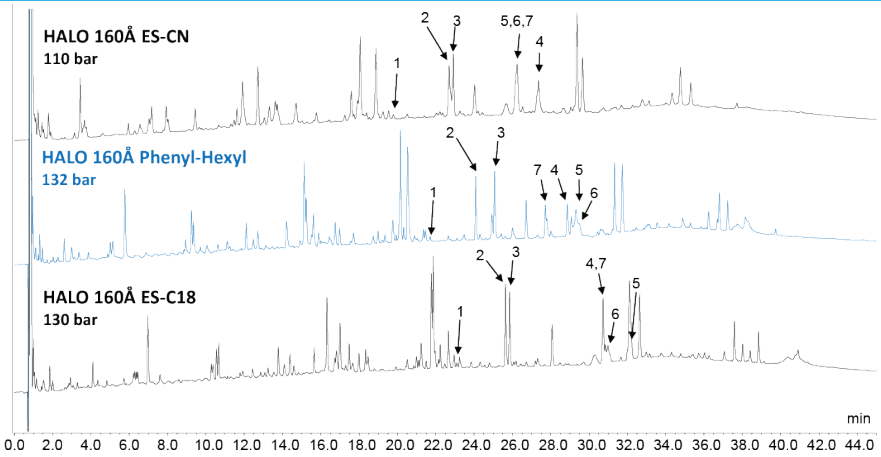
Switching to Difluoroacetic Acid (DFA), a less fluorinated ion pairing acid mobile phase modifier provides MS sensitivity improvement relative to TFA, particularly with small to mid size molecules. DFA has the practical advantage of similar chromatographic benefits of TFA, (including excellent peak shape 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

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.



TEST CONDITIONS:

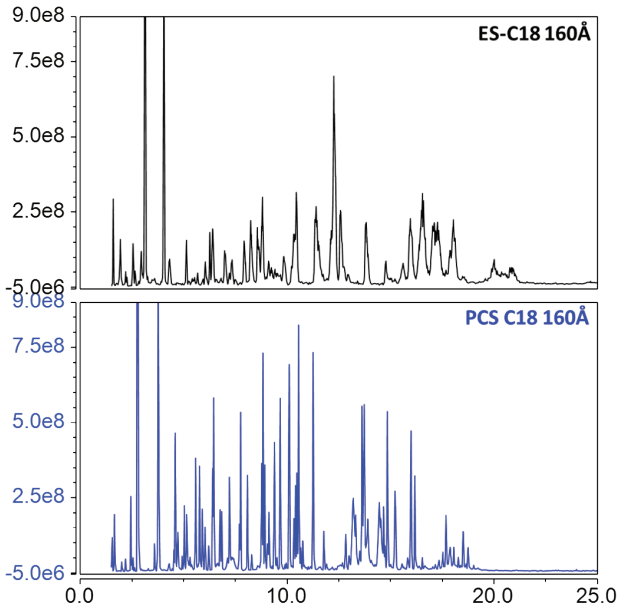
Column: HALO 160 Å ES-CN, 2.7 µm, 2.1 x 100 mm
Column: HALO 160 Å Phenyl-Hexyl, 2.7 µm, 2.1 x 100 mm
Column: HALO 160 Å ES-C18, 2.7 µm, 2.1 x 100 mm
Mobile Phase A: water + 10 mM difluoroacetic acid (DFA)
Mobile Phase B: ACN + 10 mM difluoroacetic acid
Gradient: 2–50% B in 60 min.
Flow Rate: 0.3 mL/min.
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

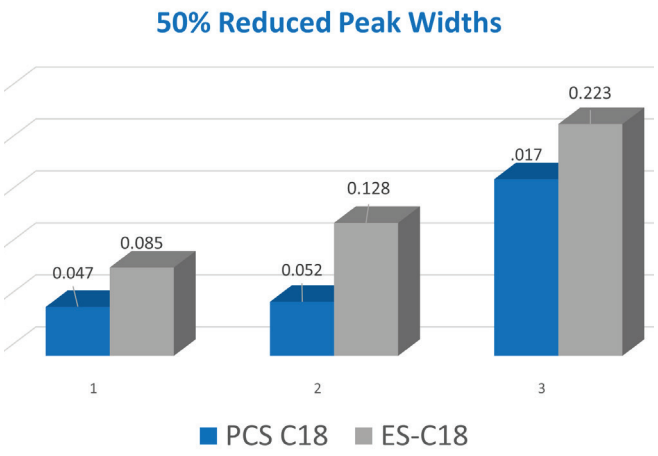
PEAK IDENTITIES:

1. FTISADTSKNTAYLQMNSLR (754 m/z)
2. LScAASGFNIKDTYIHWVR (747 m/z)
3. GFYPSDIAVEWESNGQPENNYK (849 m/z)
4. LLIYSASFLYSGVPSR (592 m/z)
5. SGTASVVcLLNNFYPR (899 m/z)
6. ScDKTHTcPPcPAPELLGGPSVFLFPPKPK (834 m/z)
7. VVSVLTVLHQDWLNGKEYK (1115 m/z)

IMPROVING PEAK WIDTH USING HALO® PCS C18

A separation of Trastuzumab tryptic digest is performed on two HALO® columns, the 160 Å ES-C18 and the 160 Å PCS C18 phases. Significantly narrower peak widths are obtained on the PCS C18 column as shown in the bar graph for three peptides that elute during the beginning, middle, and near the end of the gradient.





#	Tryptic Peptide	XIC	$t_{R\ (min)}$
1	AEDTAVYYC(Carbamidomethyl)SR	667.7877 z=2	ES-C18: 6.41 PCS C18: 4.60
2	TPEVTC(Carbamidomethyl)VVVDVSHEDPEVK	713.6807 z=3	ES-C18: 12.28 PCS C18: 10.11
3	TVAAPSVFIFPPSDEQLK	973.5171 z=2	ES-C18: 17.12 PCS C18: 14.47

TEST CONDITIONS:

Column: HALO 160 Å ES-C18 , 2.7 µm, 2.1 x 150 mm
Column: HALO 160 Å PCS C18 , 2.7 µm, 2.1 x 150 mm
Mobile Phase A: Water + 0.1% Formic Acid
Mobile Phase B: Acetonitrile + 0.1% Formic Acid
Flow Rate: 0.4 mL/min.
Pressure: 465 bar
Temperature: 60 °C
Injection Volume: 1 µL

Gradient:	Time	%B
	0.0	3
	30.0	50
	30.1	95
	33.0	95
	33.1	3
	37.0	3

Sample: Trastuzumab Tryptic Digest (1.25 µg/µL)
Sample Solvent: Refer to Digestion Procedure (halocolumns.com)
LC System: Shimadzu Nexera X2

MS CONDITIONS:

System: QExactive HF
ESI positive polarity
300-2000 m/z
Source voltage: 3.2kV
Sheath Gas: 40
Aux Gas: 20
Aux Gas Temp: 275 °C
Capillary Temp: 320 °C
µscans: 1
Max Injection Time: 200 msec.
S-Lens RF: 50

GLYCAN SOLUTIONS

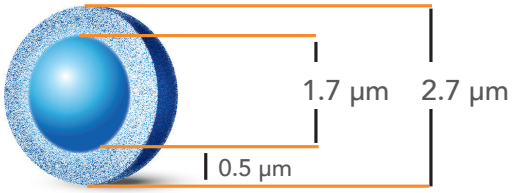
The HALO® Glycan incorporates a highly polar ligand that contains 5 hydroxyl groups tethered to 2.7 µm Fused-Core® silica particles via novel, proprietary linkage chemistry resulting in a high-resolution separation of complex glycan mixtures.

- 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 90 Å GLYCAN

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

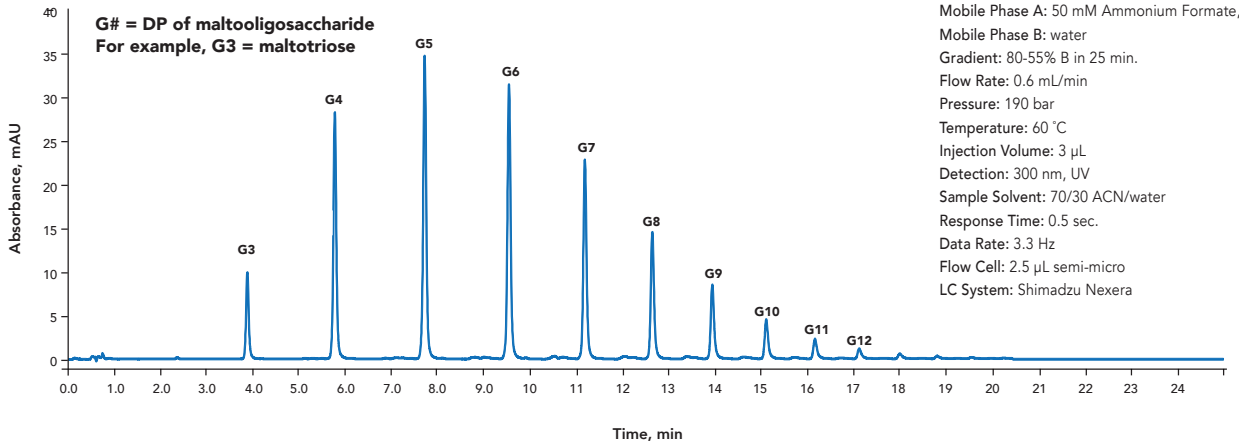
HALO® Glycan



Shell with 90 Å pores

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.

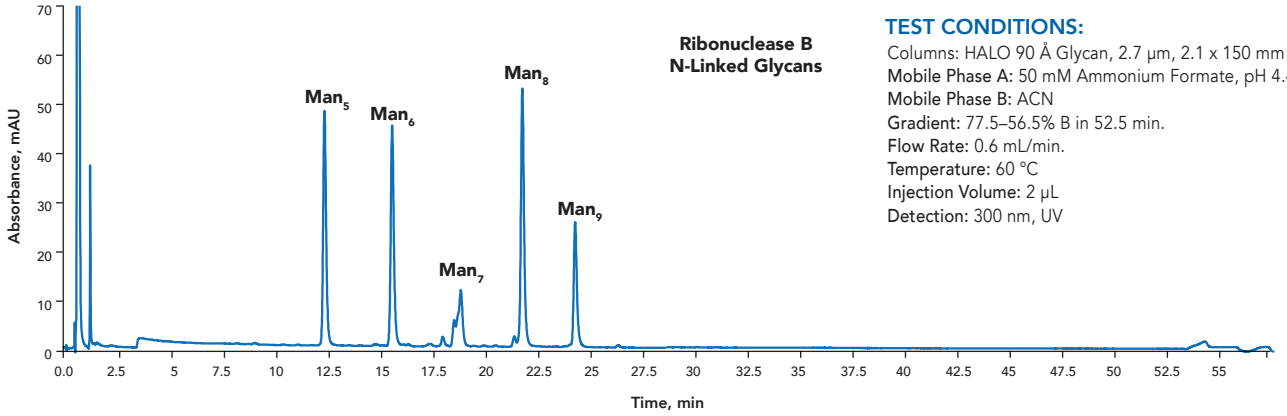


TEST CONDITIONS:

Columns: HALO 90 Å Glycan, 2.7 µm, 2.1 x 150 mm
Mobile Phase A: 50 mM Ammonium Formate, pH 4.45
Mobile Phase B: water
Gradient: 80-55% B in 25 min.
Flow Rate: 0.6 mL/min
Pressure: 190 bar
Temperature: 60 °C
Injection Volume: 3 µL
Detection: 300 nm, UV
Sample Solvent: 70/30 ACN/water
Response Time: 0.5 sec.
Data Rate: 3.3 Hz
Flow Cell: 2.5 µL semi-micro
LC System: Shimadzu Nexera

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.

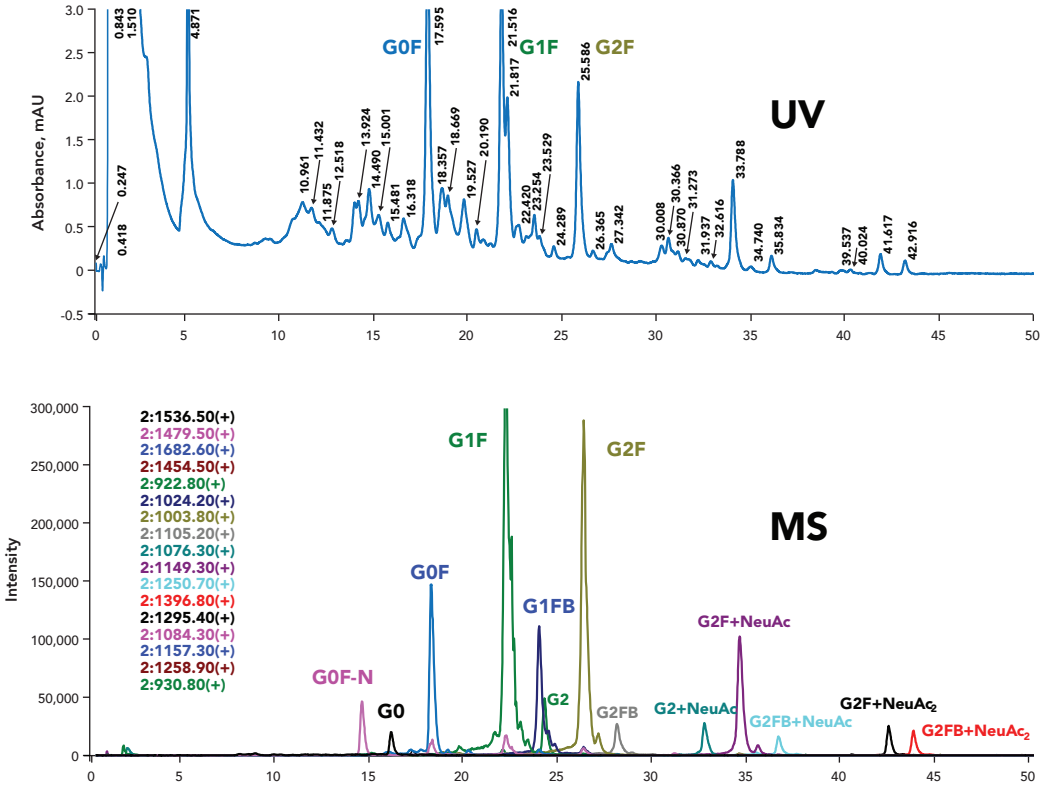


TEST CONDITIONS:

Columns: HALO 90 Å Glycan, 2.7 µm, 2.1 x 150 mm
Mobile Phase A: 50 mM Ammonium Formate, pH 4.45
Mobile Phase B: ACN
Gradient: 77.5–56.5% B in 52.5 min.
Flow Rate: 0.6 mL/min.
Temperature: 60 °C
Injection Volume: 2 µL
Detection: 300 nm, UV

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.



TEST CONDITIONS:

Columns: HALO 90 Å Glycan, 2.7 µm, 2.1 x 150 mm
Mobile Phase A: 50 mM Ammonium Formate, pH 4.4
Mobile Phase B: ACN
Gradient: 77.5–60% B in 60 min.
Flow Rate: 0.5 mL/min.
Temperature: 60 °C
Injection Volume: 4 µL
Detection: 300 nm, UV
LC System: Shimadzu Nexera

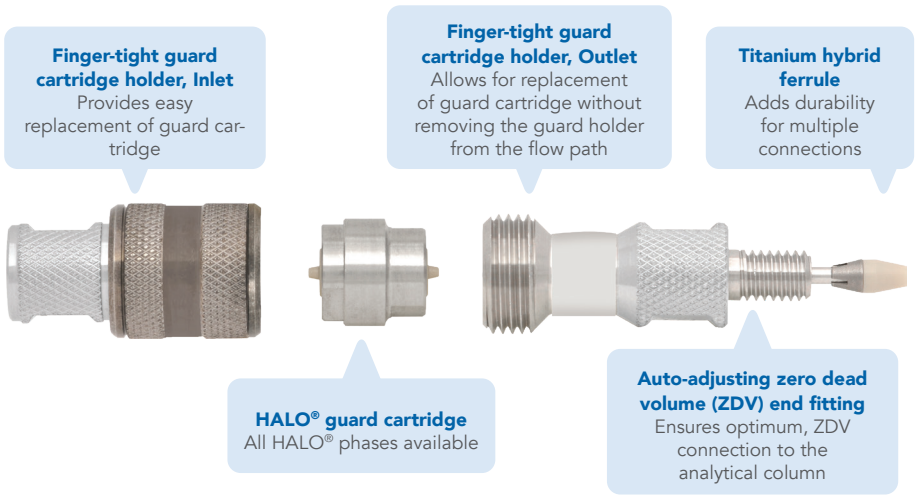
MS CONDITIONS:

MS: Shimadzu LCMS 2020 (single quadrupole)
ESI: +4.7 kV
Scan range: 500-2000 m/z
Scan rate: 2 pps

HALO® UHPLC AND HPLC GUARD COLUMNS

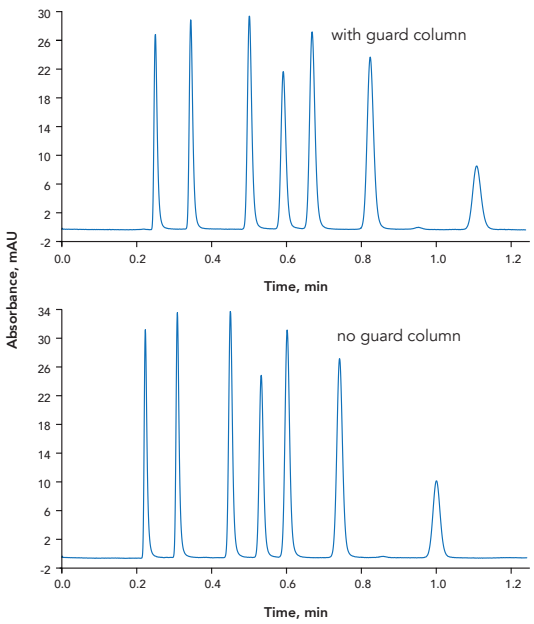
- Collect strongly retained compounds from the sample and minimizes column fouling
- Ultra-low dispersion, easy to use, operate at pressures up to 1000 bar
- Finger-tight, direct-connect units that auto-adjust to any column with a 10–32 inlet port
- Easily replace guard cartridge without removing guard 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.



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 µm, 4.6 x 50 mm
Mobile Phase: 60/40 ACN/water
Flow Rate: 1.8 mL/min
Temperature: 30 ˚C
Injection Volume: 1 µL
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

The Optimize Technologies EXP® Direct Connect Holder: U.S. Patent No. 8,201,854 & 8,696,902 and Foreign Patents Pending.

HALO® BIOCLASS PRODUCT CHARACTERISTIC TABLES

PROTEIN

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
C4	1000 400	2.7 3.4	L26	0.6 0.4	22 15	2/90 °C	9/40 °C	Yes
ES-C18	1000 400	2.7 3.4	L1	1.4 1.0	22 15	1/90 °C	8/40 °C	Yes
Diphenyl	1000 400	2.7 3.4	L11	1.0 0.7	22 15	2/90 °C	9/40 °C	Yes

OLIGONUCLEOTIDE

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
OLIGO C18	120 1000	2.7	L1	5.6 2.4	75 22	2/90 °C	9/85 °C	Yes

PEPTIDE

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 2.7 5	L1	4.0 4.6 4.0	68 75 60	1/90 °C	8/40 °C	No
ES-CN	160	2.7 5	L10	2.2 1.5	75 60	1/90 °C	8/40 °C	Yes
Phenyl-Hexyl	160	2.7	L11	4.7	75	2/90 °C	9/40 °C	Yes
PCS C18	160	2 2.7	L1	4.2 5.1	75	2/60 °C	8/40 °C	Yes

GLYCAN

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.

	400 Å, 3.4 µm			1000 Å, 2.7 µm		
Dimensions ID x Length (in mm)	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 50 INERT	P3412-414	P3412-402	P3412-426	P2712-414	P2712-402	P2712-426
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 100 INERT	P3412-614	P3412-602	P3412-626	P2712-614	P2712-602	P2712-626
2.1 x 150	93412-714	93412-702	93412-726	92712-714	92712-702	92712-726
2.1 x 150 INERT	P3412-714	P3412-702	P3412-726	P2712-714	P2712-702	P2712-726
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 150 INERT	P3414-714			P2714-714	P2714-702	P2714-726
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 OLIGO 120 Å & 1000 Å COLUMNS

All analytical columns are loaded into INERT hardware as standard

	120 Å, 2.7 µm	1000 Å, 2.7 µm
Dimensions ID x Length (in mm)	OLIGO C18	
2.1 x 30		P2762-302
2.1 x 50	P2A62-402	P2762-402
2.1 x 100	P2A62-602	P2762-602
2.1 x 150	P2A62-702	P2762-702
2.1 x 250		P2762-902
4.6 x 50	P2A64-402	
4.6 x 100	P2A64-602	
4.6 x 150	P2A64-702	
Guard Columns, 3-Pack		
Dimensions ID x Length (in mm)		
2.1 x 5 (3PK)		P2762-102
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

If you do not see a part number configuration you are looking for, search www.halocolumns.com/contact-us

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	PCS 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			92121-902	92121-904				
1.5 x 50	9112X-402	9118X-417	9212X-402			9211X-417		
1.5 x 100	9112X-602	9118X-617	9212X-602			9211X-617		
1.5 x 150	9112X-702	9118X-717	9212X-702			9211X-717		
2.1 x 20	91122-202	91182-217	92122-202	92122-204	92112-106		95122-202	95122-204
2.1 x 30	91122-302	91182-317	92122-302	92122-304	92112-206		95122-302	95122-304
2.1 x 50	91122-402	91182-417	92122-402	92122-404	92112-306	92112-417	95122-402	95122-404
2.1 x 50 INERT	P1122-402		P2122-402			P2112-417		
2.1 x 75	91122-502		92122-502	92122-504	92112-406		95122-502	95122-504
2.1 x 100	91122-602	91182-617	92122-602	92122-604	92112-506	92112-617	95122-602	95122-604
2.1 x 100 INERT	P1122-602		P2122-602					
2.1 x 150	91122-702	91182-717	92122-702	92122-704	92112-606	92112-717	95122-702	95122-704
2.1 x 150 INERT	P1122-702		P2122-702			P2112-717		
2.1 x 250	91122-902	91182-917	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	91183-317	92123-302	92123-304	92113-206		95123-302	95123-304
3.0 x 50	91123-402	91183-417	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	91183-617	92123-602	92123-604	92113-506	92113-617	95123-602	95123-604
3.0 x 150	91123-702	91183-717	92123-702	92123-704	92113-606	92113-717	95123-702	95123-704
3.0 x 250	91123-902	91183-917	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 150 INERT			P2124-702			P2114-717		
4.6 x 250			92124-902	92124-904	92114-706	92114-917	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	PCS C18	ES-C18	ES-CN	Phenyl-Hexyl	PCS C18	ES-C18	ES-CN
2.1 x 5	91122-102	91182-117	92122-102	92122-104	92122-106	92112-117	95122-102	95122-104
3.0 x 5	91123-102	91183-117	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