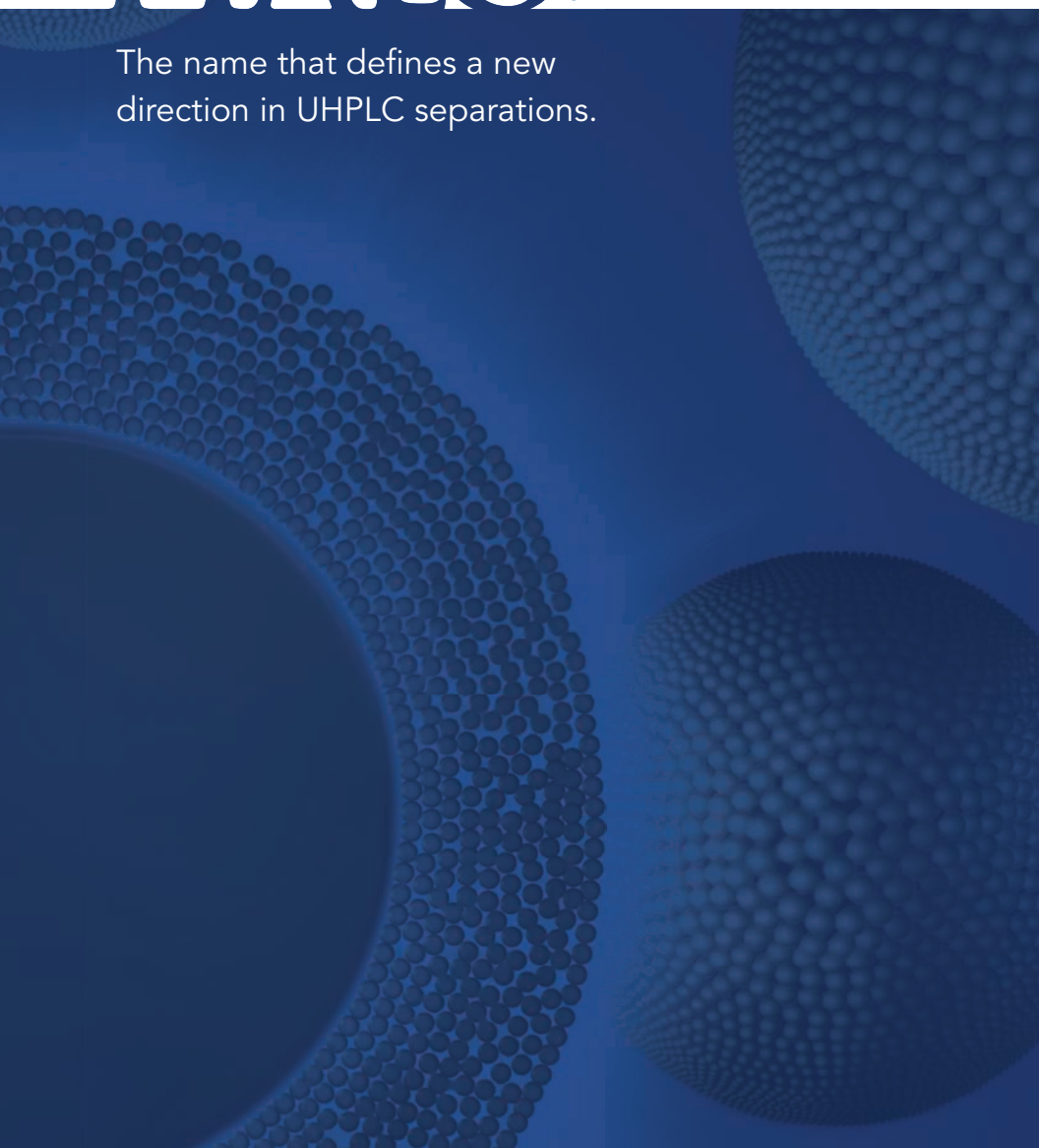
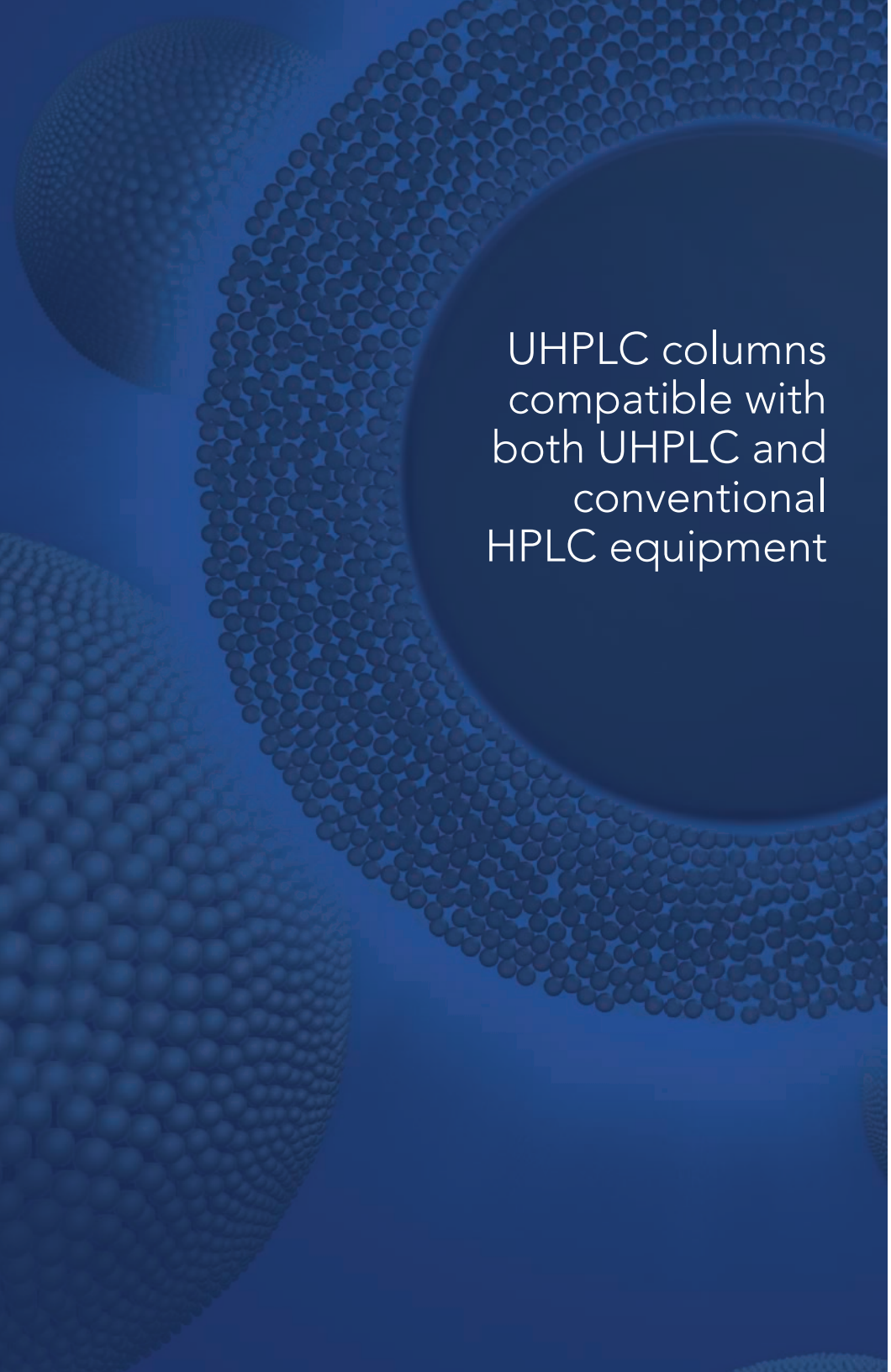
HALO PFP UHPLC COLUMNS

HALO®

The name that defines a new direction in UHPLC separations.





HALO® PFP UHPLC Columns

- Versatile UHPLC columns that can be used with either UHPLC or conventional HPLC equipment
- An alternate bonded phase selectivity to achieve separations not possible with other bonded phases
- Particularly recommended for bases and halogenated compounds
- Compatible with highly aqueous mobile phases to facilitate the retention and separation of polar compounds
- Stable bonded phase provides durable, long-lived performance plus minimum bleed for LC/MS applications
- Base-deactivated for good peak shape when separating basic compounds
- Moderate back pressure places less stress on UHPLC equipment and permits these UHPLC columns to be used with conventional HPLC equipment.
- The use of 2 µm porosity column inlet frits reduces the inconvenience caused by pressure increases from plugged frits and makes HALO columns more forgiving and easier to use than columns packed with sub-2 µm particles.

HALO Fused-Core® particle technology facilitates ultra-fast, high resolution UHPLC separations with either UHPLC or conventional HPLC equipment. Now HALO columns packed with a pentafluorophenyl phase (PFP) join HALO C18, C8, RP-Amide, Phenyl-Hexyl and HILIC phases to offer a wide range of powerful selectivity choices to accomplish the most demanding separations. HALO PFP is particularly well suited for the separation of halogenated compounds, nitro-aromatic compounds, and polar bases. HALO PFP definitely should be considered when a C18 or C8 phase fails to provide an adequate separation. HALO PFP columns are also well suited for the separation of highly water soluble compounds that require high aqueous mobile phases and generally provide greater retention for bases than C18 phases.

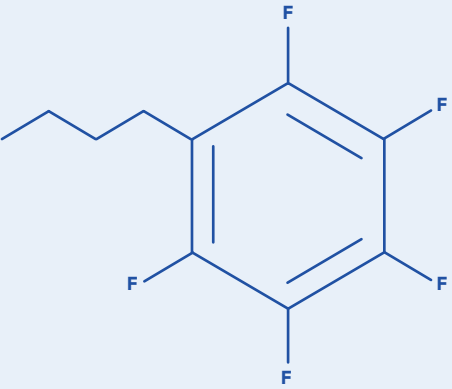
HALO PFP uses proprietary bonding chemistry to achieve excellent stability and long column life. The extremely low bleed characteristics of the HALO PFP phase make it particularly well suited for LC/MS applications.

As with all HALO phases, the combination of ultra-pure reagents, "Type B" silica, dense bonding technology, and optimized endcapping produce a base-deactivated stationary phase that provides excellent peak shape for basic compounds.

Mechanism of Separation

Reversed phase separations on HALO PFP columns are primarily influenced by hydrogen bonding and dipole-dipole interactions. However, π–π interactions and mild hydrophobic binding interactions often contribute to retention and selectivity. In addition, the polar PFP group makes the HALO PFP phase a suitable choice for HILIC applications. (See Figure 1 for the structure of the PFP bonded phase.)

FIGURE 1: Structure of HALO PFP bonded phase



Pentafluorophenylpropyl is the bonded phase used for HALO PFP.

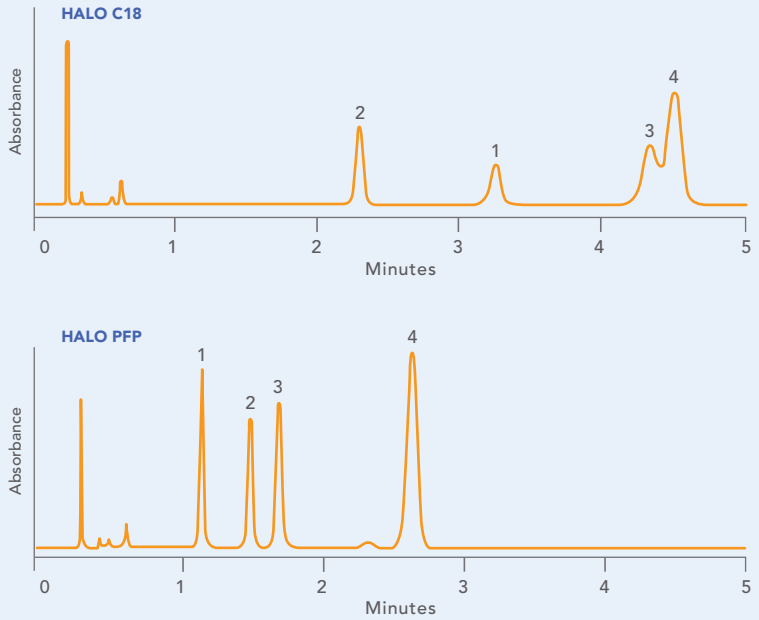
> *"The fused-core silica column providing the reduced diffusional mass transfer path allows the use of shorter columns and higher flow rates to achieve remarkably fast high-resolution separations."*
>
> Analytical Chemistry, August 2007

Figure 2 illustrates the difference in selectivity offered by HALO PFP versus HALO C18. The improved separation of 1-phenylnaphthalene and pyrene on HALO PFP is due to π–π interactions. The stronger hydrophobic binding interaction on the HALO C18 is responsible for the longer retention of butylbenzene and for the dramatic difference in selectivity represented by the change in elution order between butylbenzene and acenaphthene on HALO C18 versus HALO PFP.

FIGURE 2: HALO PFP offers an alternate selectivity to HALO C18

TEST CONDITIONS:
Column Dimensions: 4.6 x 50 mm
Mobile Phase: 30/70 water/methanol
Flow Rate: 2.0 mL/min.
Pressure: approximately 250 Bar
Temperature: 40 °C
Detection: UV 254 nm, VWD

PEAK IDENTITIES:
1. Butylbenzene
2. Acenaphthene
3. 1-Phenylnaphthalene
4. Pyrene



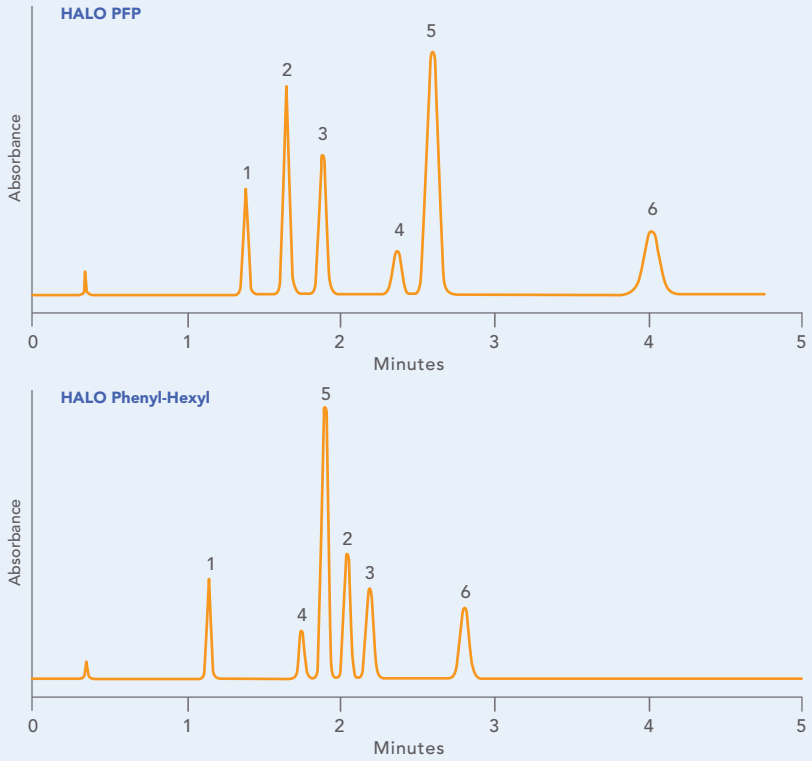
This separation of neutral aromatic compounds illustrates the differences in selectivity between HALO PFP and HALO C18. The π-π interactions offered by the PFP phase and the stronger hydrophobic interactions of the C18 phase lead to significant differences in band spacing and even peak elution order on the two phases. This difference in selectivity makes HALO PFP an extremely useful alternate selectivity to the HALO C18 phase that should be evaluated when developing separations.

Figure 3 illustrates the role that dipole-dipole interactions and π–π interactions play in achieving a separation. Although it is difficult to identify which interaction is most dominant for each analyte, these comparison chromatograms clearly show that these different mechanisms of separation (dipole-dipole interactions more dominant with the PFP phase and π–π and hydrophobic interactions more dominant with the Phenyl-Hexyl phase) can be used to develop a satisfactory separation.

FIGURE 3: HALO PFP and HALO Phenyl-Hexyl offer different selectivity

TEST CONDITIONS:
Column Dimensions: 4.6 x 50 mm
Mobile Phase: 45/55 water/methanol
Flow Rate: 1.5 mL/min.
Pressure: approximately 200 Bar
Temperature: 40 °C
Detection: UV 254 nm, VWD

PEAK IDENTITIES:
1. Nitrobenzene
2. 1-Cl-4-Nitrobenzene
3. 2,6-Dinitrotoluene
4. 4-Nitrotoluene
5. 3-Nitrotoluene
6. 4-Cl-3-Nitroanisole

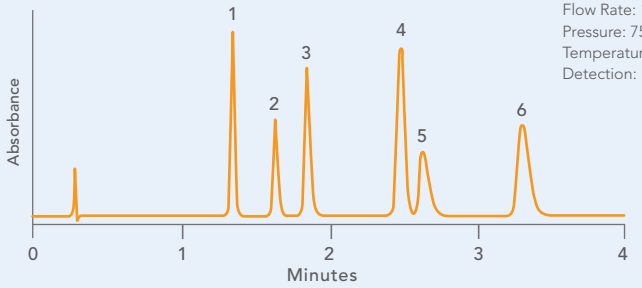


These comparison chromatograms clearly show the effect of different mechanisms of separation: dipole-dipole interactions more dominant with the PFP phase and π-π and hydrophobic interactions more dominant with the Phenyl-Hexyl phase. These differences in interaction between analytes and stationary phase can be utilized to achieve superior separations.

Figure 4 provides an example of the great versatility of HALO PFP. Here, basic drugs are separated using HILIC mode. This can be particularly useful for separating polar compounds that are poorly retained in reversed phase mode. In addition, HILIC mode typically involves operating with higher amounts of organic component in the mobile phase than reversed phase mode, thus enhancing sensitivity when using LC/MS.

FIGURE 4: The versatility of HALO PFP is shown in this separation of basic drugs using HILIC mode of separation

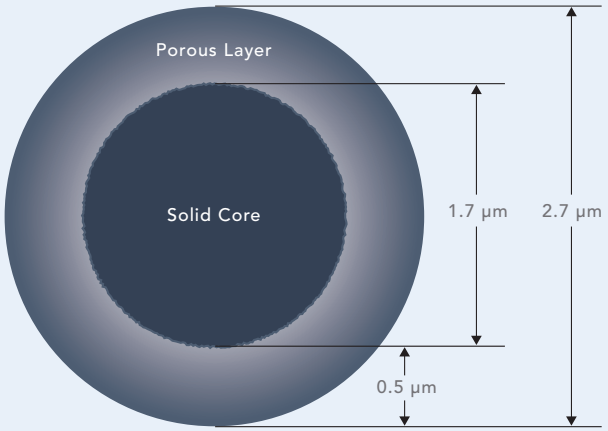
TEST CONDITIONS:
Column Dimensions: 4.6 x 50 mm
Mobile Phase: 12/88 0.01 M ammonium formate buffer, pH=3.0 /Acetonitrile
Flow Rate: 1.5 mL/min.
Pressure: 75 Bar
Temperature: 30 °C
Detection: UV 254 nm, VWD



PEAK IDENTITIES:
1. Phenylephrine
2. Trazadone
3. Procaine
4. Amoxapine
5. Propranolol
6. Desipramine

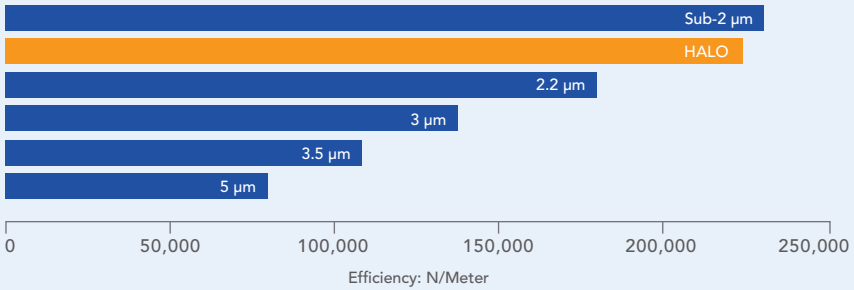
Highly polar compounds that are poorly retained in reversed phase mode can be strongly retained on HALO PFP using HILIC mode. HILIC often provides higher sensitivity for LC-MS applications due to the higher concentration of organic component in the mobile phase.

FIGURE 5: Fused-Core Particle Technology



Fused-Core particle technology was conceived of and developed by Dr. Jack Kirkland to produce HPLC columns that deliver UHPLC performance with conventional HPLC equipment. As the name implies, Fused-Core particles are manufactured by fusing a porous silica layer onto a solid silica particle.

FIGURE 6: HALO columns deliver more separating power



HALO columns deliver over 90% more separating power (theoretical plates) than columns of the same length packed with 3.5 µm particles and almost three times the separating power of columns packed with 5 µm particles.

Note: N/Meter values were calculated at the optimum mobile phase linear velocity for each of these stationary phases.

HALO UHPLC Columns | High resolution, Hyper-fast, Super-rugged

HALO Fused-Core particles are designed for high speed, high resolution liquid chromatography. They are unique particles consisting of a 0.5 µm porous silica "halo" fused to a 1.7 µm solid silica core (Figure 5). The high density and extremely narrow size distribution of these Fused-Core particles facilitate the packing of columns with unexpectedly high efficiencies—efficiencies more in line with what you would expect from columns packed with sub-2 µm particles. The reason for this unexpectedly high efficiency is apparently the unusually well-ordered packed bed that minimizes the eddy diffusion contribution to band broadening. HALO columns do, however, generate the back pressure that one would expect from columns packed with 2.7 µm size particles. This pressure is low enough to permit HALO columns to be used effectively with conventional HPLC equipment, avoiding the need to purchase expensive UHPLC equipment. However, to take full advantage of the UHPLC performance offered by these columns, the use of UHPLC equipment is encouraged.

HALO columns deliver over 90% more separating power (theoretical plates) than a column of the same length packed with 3.5 µm particles and almost three times the plates of a column packed with 5 µm particles (Figure 6). And, because of Fused-Core particle technology, HALO columns maintain their resolving power at high mobile phase velocity. This means that shorter columns and higher flow velocities can be used to achieve remarkably fast high resolution separations.

The combination of extremely narrow particle size distribution and very dense particles allows for the production of columns that are incredibly rugged and reliable, even when used under conditions of high pressure and high flow velocity. In addition, the narrow size distribution of the Fused-Core particles permits the use of 2 µm porosity inlet frits on HALO columns. This is the same inlet frit porosity typically found on columns packed with 5 µm particles. As a result, HALO columns are capable of delivering speed and resolution similar to columns packed with sub-2 µm particles, but with the ease of use and durability of columns packed with 5 µm particles.

HALO® Specifications

Stationary Phase Support

- Ultra-pure, "Type B" silica
- Particle Size: 2.7 microns (1.7 micron solid core particle with a 0.5 micron porous silica layer fused to the surface)
- 150 m^2/gram surface area
- 90 Å pore size

Bonded Phase

- Pentafluorophenylpropyl
- Densely bonded phase (ca. 3.6 µmoles/m^2)
- Optimized endcapping

Maximum Pressure: 9,000 psi, 600 Bar
pH Range: 2 to 8

HALO® PFP Ordering Information

HALO® 2.7 µm Fused-Core® Columns

Description (mm)	Part Number
2.1 x 20mm	92812-209
2.1 X 30mm	92812-309
2.1 X 50mm	92812-409
2.1 X 75mm	92812-509
2.1 X 100mm	92812-609
2.1 X 150mm	92812-709
3.0 X 30mm	92813-309
3.0 X 50mm	92813-409
3.0 X 75mm	92813-509
3.0 X 100mm	92813-609
3.0 X 150mm	92813-709
4.6 X 30mm	92814-309
4.6 X 50mm	92814-409
4.6 X 75mm	92814-509
4.6 X 100mm	92814-609
4.6 X 150mm	92814-709

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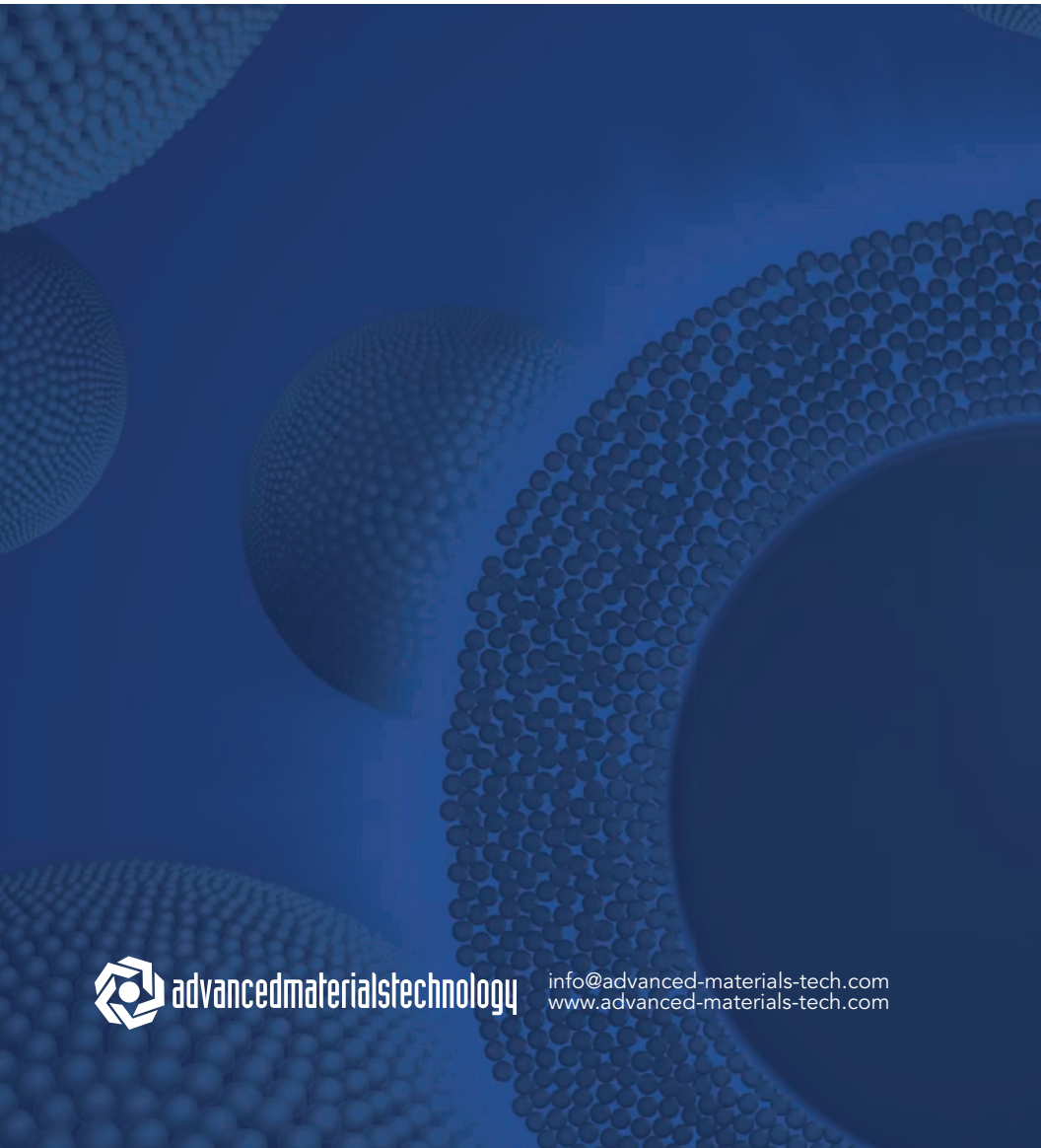

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