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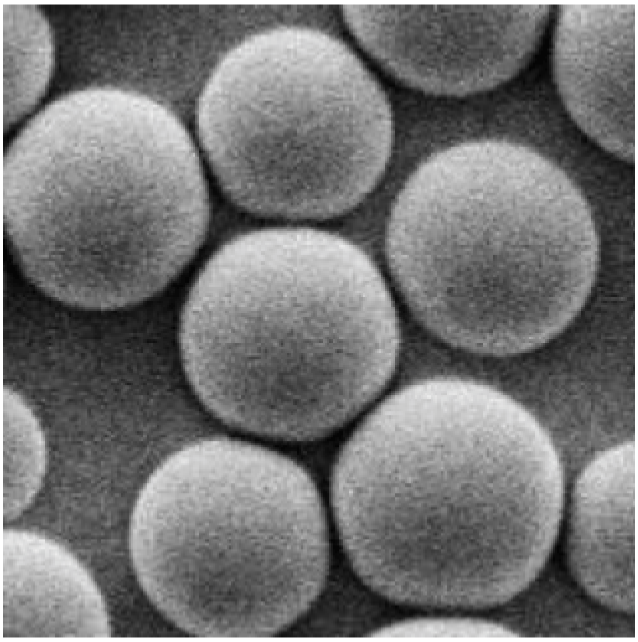
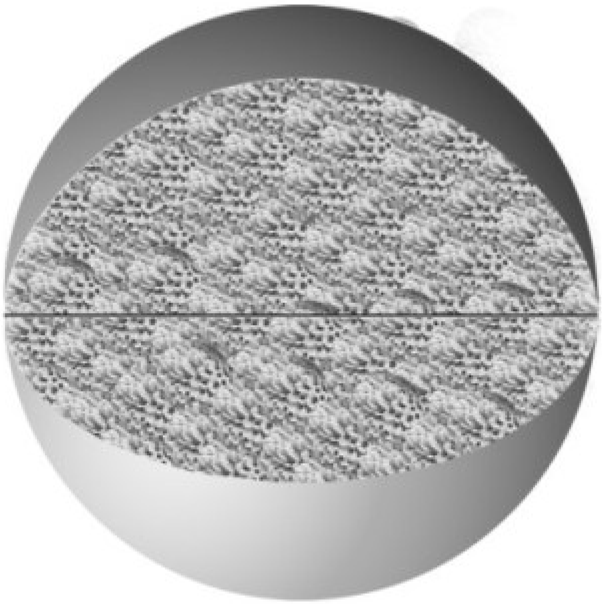
Silica media in HPLC columns were originally irregular shaped particles of silica. Then silica based HPLC columns moved to the traditionally filled, fully porous spherical particles of silica that offered improvements in chromatography over irregular shaped particles.

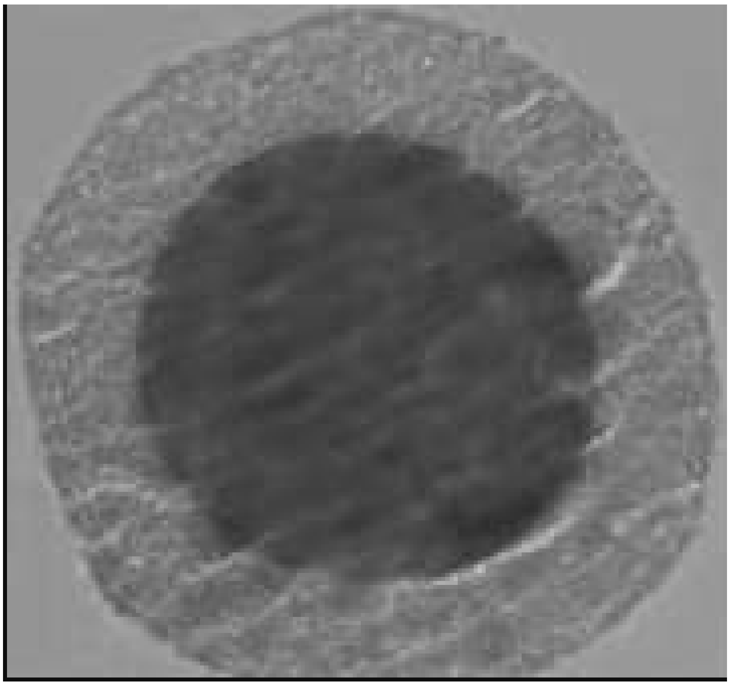
Figure 1: Fully Porous Particles

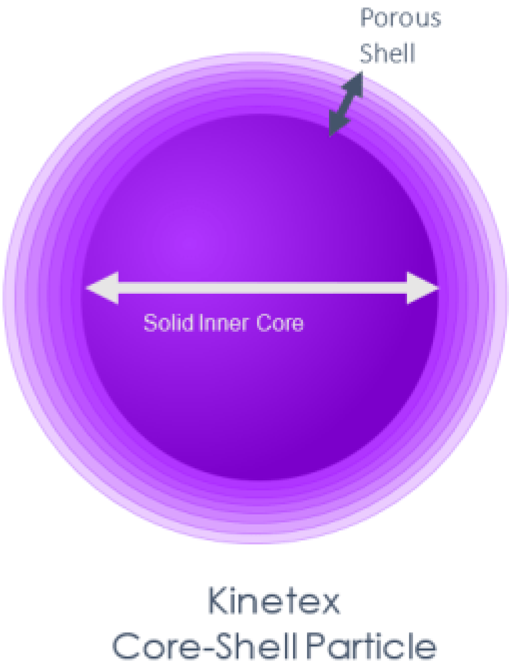




As the industry evolved, the particle technology did as well. Over 10 years ago, a particle was developed that consisted of a solid, impermeable inner core of silica with layers of fully-porous silica grafted on top. Core-shell technology, also known as superficially porous technology, was born. In the below image, **Figure 2**, you see a TEM micrograph of the Kinetex® core-shell particle with the dark, solid inner silica core surrounded by layers of porous silica.

Figure 2: Core-shell Particle



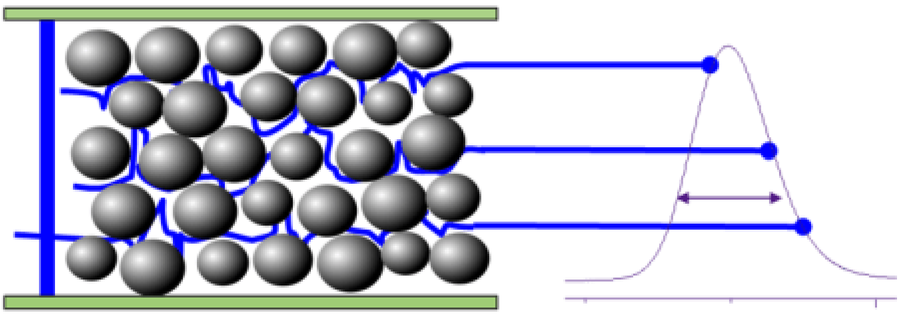


What does this new core-shell particle do for chromatography?

The unique core-shell morphology has some very significant advantages in chromatographic performance over fully porous particles, specifically increasing column efficiency and reducing retention time.

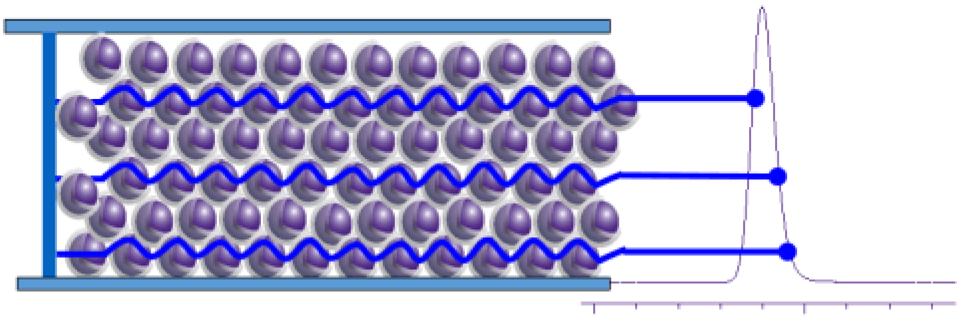
Figure 3 below, it shows how an analyte moves through a column with fully porous particles. Unwanted widening of peaks is caused by the wide particle size distribution and slow movement of the analytes into and out of fully porous particle leading to eddy dispersion.

Figure 3



If you look at **Figure 4** below, you'll see how an analyte moves through a column with core-shell particles. On a column packed with Kinetex core-shell particles, the sample bands travelling through the column exhibit significantly less band broadening during the run from the reduced diffusion path. As a result, the peaks are eluted as much narrower bands, resulting in increased peak height and resolution.

Figure 4



• Increased resolution and peak capacity: The core-shell particle decreased band broadening, making the peaks narrower. Therefore, an increase in resolution and peak capacity is seen.
• Higher sensitivity: Again, the reduction in band broadening leads to a higher sensitivity, allowing chromatographers to see lower detection limits.

Using 5µm core-shell particles will result in the efficiency, resolution, and sensitivity of a 3µm fully porous particle. Also, for those with only an HPLC system and needing UHPLC performance, the 2.6µm core-shell particle is a hybrid particle that can straddle the HPLC and UHPLC worlds. This 2.6µm core-shell particle will provide the performance of a sub-2µm fully porous particle. The resulting shortened run time will increase productivity and save time and money.

To fully take advantage of the hybrid 2.6µm particle, the HPLC system needs to be optimized for the lowest dwell volume delivered to the column. Otherwise, the extra column will lead to band broadening and lower efficiency through peak dispersion before and after the column. The fraction of time that an analyte spends inside the HPLC column during a run is productive: analytes are being separated with high efficiency. Steps that should be taken to optimize the HPLC system include the following.

1. Use a lower volume needle seat.

2. Use a low volume injection loop.
3. Column switching valves are a great method development tool that adds significant volume to the system. Therefore, bypass the switching valve.
4. Use zero volume finger-tight fittings.
5. Most HPLC systems come with 0.010in ID tubing which has a solvent volume of 1.3µL/inch adding to a significant amount of dead volume. Use 0.005in ID tubing which only adds 0.3µL/inch in volume.
6. The volume after the column is also important and using a lower volume UV flow cell will show a difference in chromatography.
7. Increase detector sampling rate to 20Hz (typically set at 5Hz).
8. A slow detector time constant is normally set to filter out high frequency noise. Unfortunately, this noise filtering can also filter out the sharp peaks and high resolution that core-shell columns deliver. Therefore, increase the detector time constant.

In general, the core-shell particle revolutionized the chromatography industry by providing faster methods without sacrificing resolution. This specialized particle provides higher efficiency and throughput which leads to a reduction in solvent consumption. And finally, the higher sensitivity allows chromatographers to obtain lower levels of detection without using higher amounts of sample.

Any questions about core-shell technology? Please email us at info@phenomenex.com

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