Selectivity of Core Shell Particles in HPLC

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INTRODUCTION

The use of sub 2um fully porous particles in UHPLC is now well established, offering high efficiencies, good resolution and fast throughput. Much is now being made of the ability of core-shell particles to improve speed of analysis and sensitivity but without the high back pressures associated with UHPLC.

In this poster we look at the role that resolution plays when trying to improve speed of analysis, as we go faster and faster selectivity (alpha) plays a large role in the separation process. We look at the alternative phases that are available on core-shell technology and how these can impact how fast we can actually go.

We show that whether using UHPLC or Core-Shell technology it is important to consider the role of stationary phase selectivity when trying to maximise resolution and not rely on efficiency alone.

Improving Resolution

Approaches to improving resolution involve making changes to one or more of three variables; efficiency, retention and selectivity. The move towards using Core-Shell particles has been driven by the theory that the resulting jump in efficiency will lead to significant improvements in resolution. As can be seen in figure 1 efficiency (N) does play a significant part in improving resolution, however by far the greatest factor is stationary phase selectivity (α).

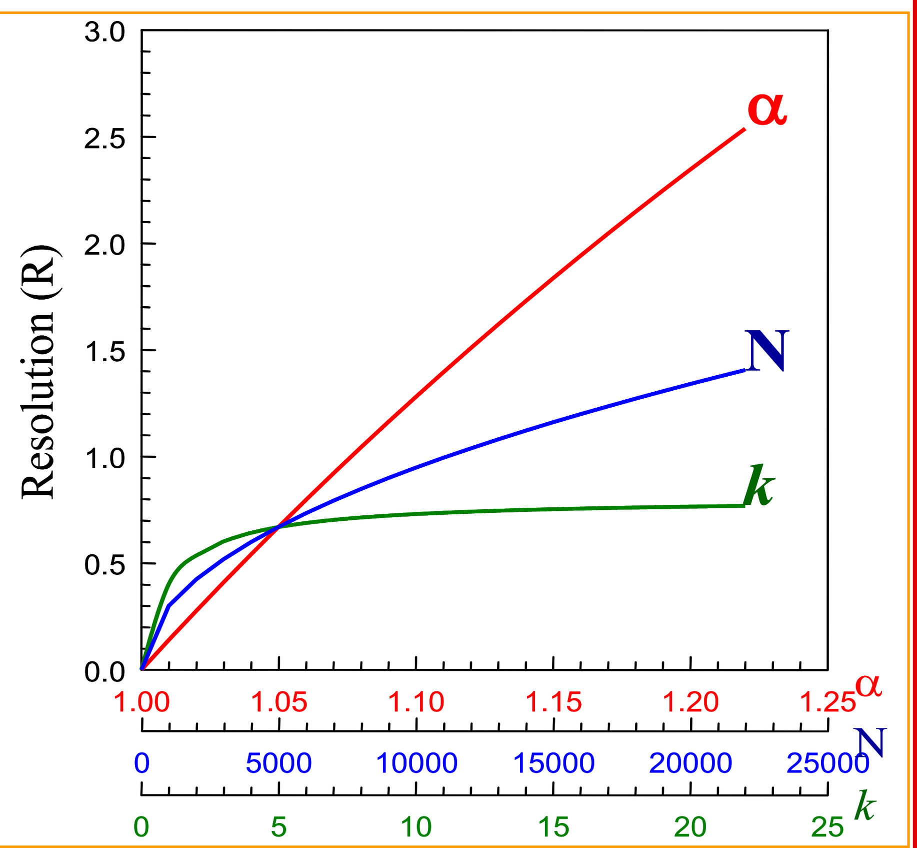
FIGURE 1. Contributions to Resolution

Efficiency Retention Selectivity

$$R = \frac{\sqrt{N}}{4} \quad \frac{k'}{k'+1} \quad \frac{\alpha - 1}{\alpha}$$

$$\alpha = \frac{k_2}{k_1}$$

- Selectivity (α) has the greatest impact on improving resolution.

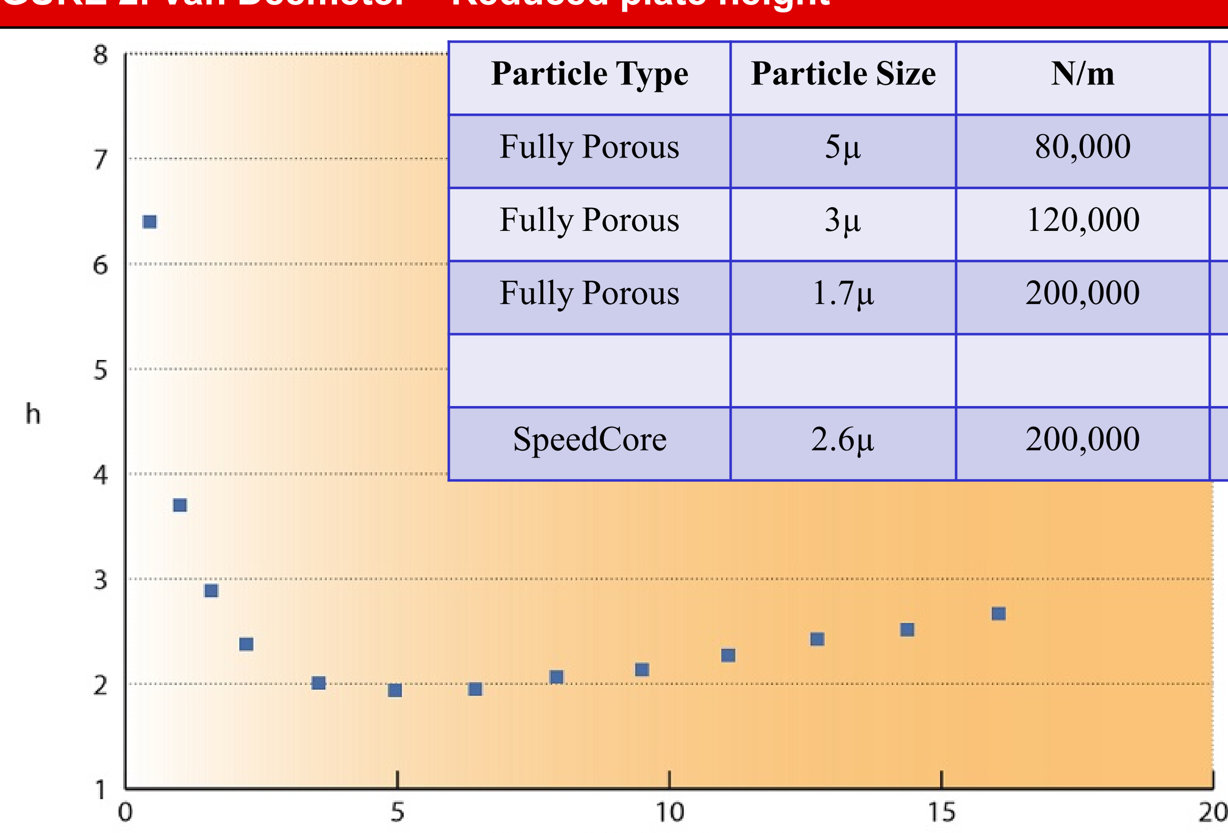


If we compare the performance of a fully porous particle with that of a superficially porous 2.6µm particle we can see that a resolution gain of >25% is possible just through the increase in efficiency of the Core-Shell product (see Table 1).

	3um Fortis® C18	2.6um SpeedCore® C18
Column Plates	13,000	20,000
√N/4	28.5	36.2
Resolution Gain >3u	-	27%
Back pressure	122 Bar	130 Bar

The dimensionless parameters for HETP (Height Equivalent of Theoretical Plate – H) and linear velocity allow for direct comparison of the efficiency of columns packed with different particle size packing materials. According to the theory a well packed column should have a reduced plate height (h) in the range of 2–3.

FIGURE 2. Van Deemeter – Reduced plate height



Particle Type	Particle Size	N/m	HETP	h
Fully Porous	5µ	80,000	12.5	2.5
Fully Porous	3µ	120,000	8.3	2.8
Fully Porous	1.7µ	200,000	5.0	2.9
SpeedCore	2.6µ	200,000	5.0	1.9

The advantage that the core-shell materials have here is that the particle does not lose efficiency at higher linear velocity unlike a 3µ or 5µ particle. This means that you can use higher flow rates to speed up your analysis without losing critical separation. Figure 3.

FIGURE 3. Utilising Higher Flow Rates

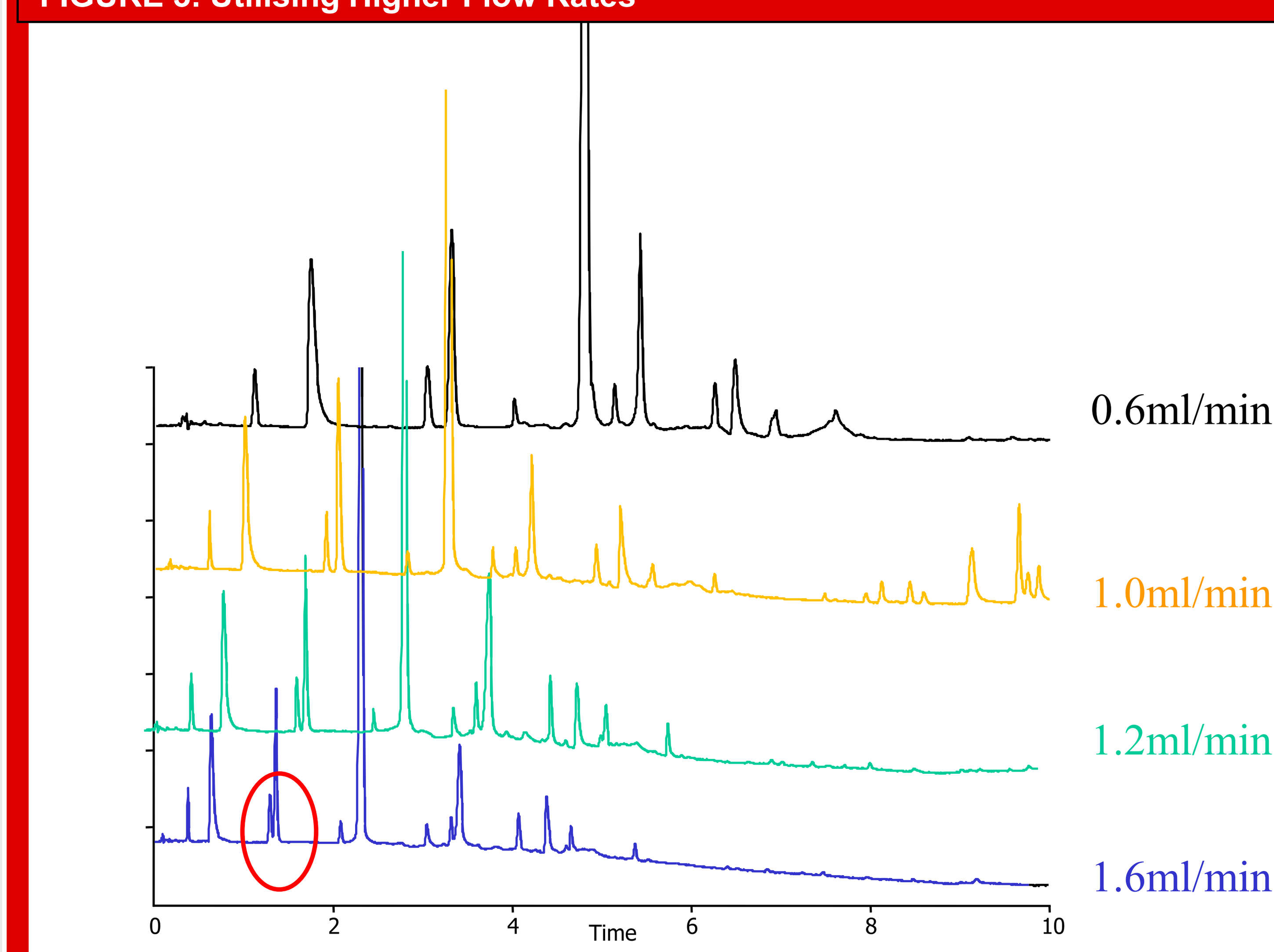
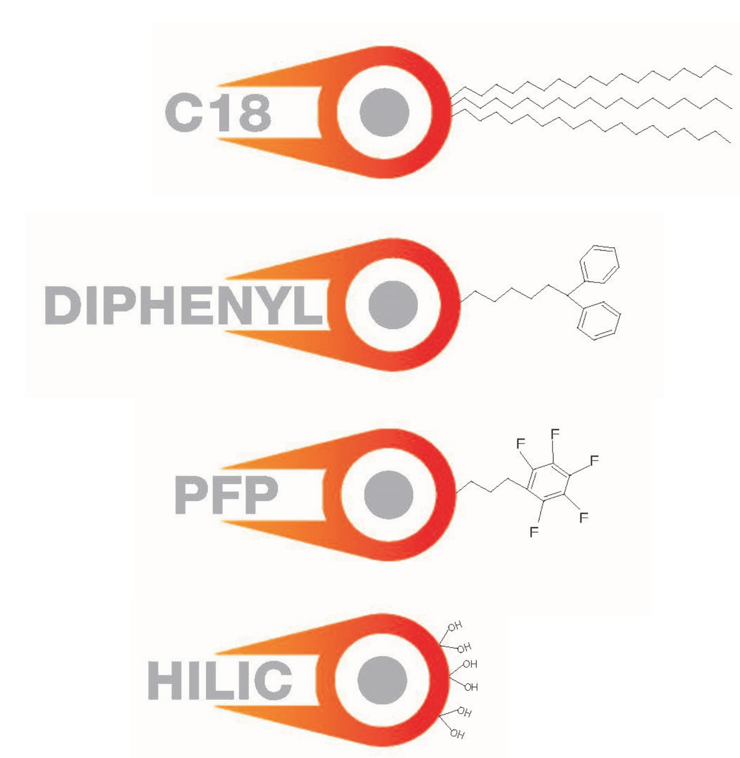


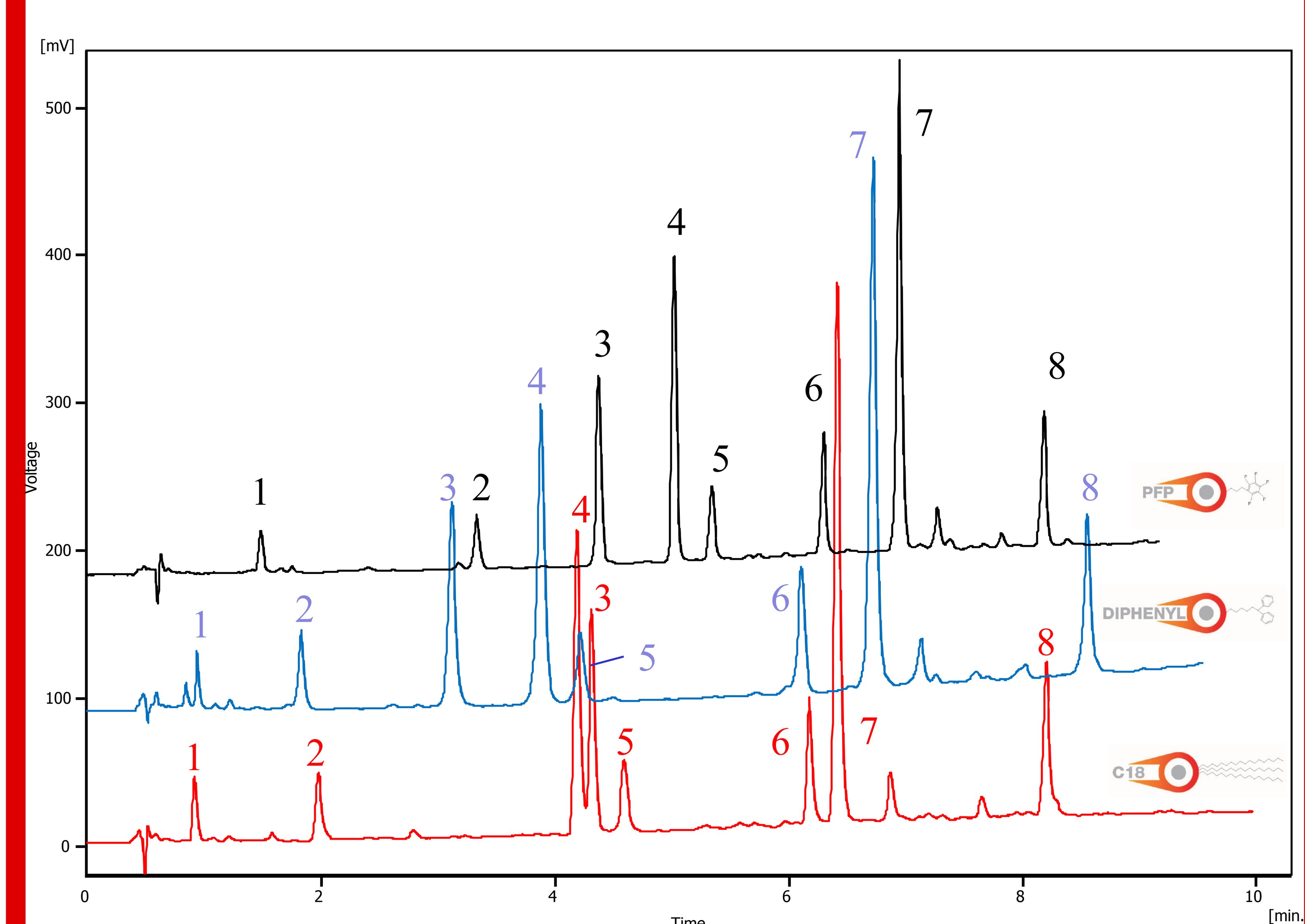
FIGURE 4. Stationary phase Selectivity



As we run faster we now require selectivity of stationary phases to provide increased resolution, so that high resolution between critical pairs is still accomplished.

Speedcore provides an orthogonal selectivity range of hydrophobic, dipole and Hydrophilic stationary phases to ensure that maximum resolution can be combined with the high efficiency of the particle.

FIGURE 5. Chromatographic Selectivity – Stationary Phase Choice



Conclusion

Even though the new core-shell SpeedCore column provides very high efficiency, it is paramount that selectivity as a variable in the separation is not forgotten, since this will provide a powerful method development tool. Having a wide variety of selectivity's available is essential as we run faster analysis whether for method development or redevelopment of older QC methods.

Fortis SpeedCore®

New Core Shell Technology