Organic Monolithic Stationary Phases for Capillary Liquid Chromatography

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Organic monolithic stationary phases potentially offer a wider range of chromatographic selectivity, lower pressure drop, and more control over nonspecific sorption in liquid chromatography compared to columns packed with small spherical particles. However, they currently suffer generally from less homogeneous and reproducible morphology, and lower chromatographic efficiency. Monolith homogeneity depends on the selection of materials and conditions for synthesis, and on how well the conditions are controlled. Considerable progress is currently being made to develop reproducible, robust, selective, and efficient polymer monoliths for a wide range of applications, including reversed phase, ion exchange, hydrophobic interaction, hydrophilic interaction, and size exclusion.

We have improved the performance of poly(ethylene glycol) diacrylate-based monoliths by characterizing and optimizing the monolith morphology. We use statistical principles to optimize pre-polymer compositions to obtain morphologies that lead to improved chromatographic performance. Capillary flow porometry and three-dimensional scanning electron microscopy have proven useful for characterizing organic monoliths as they exist in the capillary columns and identifying the factors governing their morphologies. As would be expected, columns exhibiting better chromatographic performance were found to have uniform and narrow through-pore size distributions along and across the columns. Our results emphasize the importance of developing new approaches to optimize the monolith morphology and reduce the heterogeneity in the columns and, more importantly, to identify the factors responsible for producing specific monolithic structures.

Different polymerization methods (e.g., living polymerization) are being investigated for obtaining more homogenous monolithic bed structures, because they have been reported to provide better control over polymerization conditions. Comparison of monolith morphologies to bed structures and performance of both silica monoliths and very small particle packed columns will be made, with the objective of identifying the most significant aspects of organic monolithic column technology that can be improved to allow this fascinating column form to reach its full potential.

References