Development of Fiber-Based Stationary Phases for Liquid Chromatography

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The development of new stationary phases for liquid chromatography (LC) has been an active field of research for over 40 years; and continues to be so. While there are many choices available to the bench chemist or biochemist, there are still opportunities for continued development if the capital and operational costs of stationary phase materials can be reduced. In this laboratory, we are developing a new family of stationary phases based on capillary-channeled polymer (C-CP) fibers. These fibers are unique in that each one incorporates eight (8) capillary channels running their entire length. A typical fiber of 30-50 μm diameter, will have channels ranging 5-20 μm in depth. Any spin-melt polymer can in principle be extruded in this format, providing a range of surface chemistries to affect chemical separations. To date, the fiber phases have shown particular promise in the separation of macromolecules including proteins and water-soluble polymers. High efficiency is realized due to the amorphous nature of the fiber surfaces, such that the effects of intra-phase diffusion processes are drastically minimized.

Because of the limited time frame and desire to get “positive” outcomes, summer undergraduate projects will involve basic method development and column characterization. For example, class-specific separation strategies will be developed for oligonucleotides, proteins, or polymeric species based on the individual student’s interests and background. The versatility of the C-CP column materials allows for investigations involving classical reversed-phase, hydrophobic interaction, and ion exchange separation mechanisms. Students will learn that there are many metrics and practical considerations involved in a “successful separation”. For example, in the case of protein separations, enzymatic assays will be employed to assess the extent of protein denaturation during the course of the separation. The C-CP fiber surfaces also serve as very interesting surrogates to study many types of solute-surface interactions. For example, liquid chromatography can be used to evaluate the kinetics and thermodynamics related to shampoo-hair interactions. These sorts of studies are well-suited to undergraduates who have completed the Chemistry core courses and can be tailored to a student’s particular interests such as biological or environmental chemistries.