360c Phase Separation of Immiscible Liquids Using Capillary Forces for Extraction in Continuous Flow Microchemical Systems

Jason G. Kralj, Hemantkumar R. Sahoo, Martin A. Schmidt, and Klavs F. Jensen

Separation of immiscible liquid-liquid phases for continuous flow processing has been a major obstacle in the development of multi-step micro-chemical synthesis technology. Gravity separation of two phases is often too slow or impossible because of the strong interfacial forces typically found in microfluidic systems. To overcome this, we have developed a microfluidic device that uses a fluoropolymer membrane with pore sizes ~ 0.5 micron to selectively separate the two phases continuously. The benefits of the fluoropolymer include high resistance to chemical attack and high phase selectivity due to the favorable surface properties for low aqueous phase wettability. In addition, the high pore density and small film thickness help keep flow resistance low and allow relatively high throughput.

We demonstrate liquid-liquid extraction using isopropanol/ hexanes/ water and methylene chloride/ N,N-dimethylformamide/ water systems. Despite the inherent difficulty to separate liquids with low interfacial tensions due to high concentrations of partially miscible components, full separation is still possible at flowrates exceeding 30 μl/min in this system. We have also demonstrated separation of aqueous and fluorous phases, making this an attractive tool for performing fluorous chemistry and recovering fluorous-tagged compounds by liquid-liquid extraction.