THE FLUIDS, THERMAL AND CHEMICAL PROCESSES GROUP
OF
THE DIVISION OF ENGINEERING
AND
THE CENTER FOR FLUID MECHANICS

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Laser-fabricated polymer elements for protein dialysis and high-pressure microfluidic control

Miniaturization of bioanalytical devices is of high interest for counteracting bioterrorism, enhancing drug discovery, and speeding biochemical research. Microchip-based analytical techniques have allowed increases in the complexity of microanalytical systems, primarily through the development of more sophisticated geometries.

Nanostructured and nanoporous materials are beginning to find application for miniaturized analytical systems and will doubtlessly find increased use in the future. Here, applications will be presented in which nanoporous polymer materials in different configurations create new capabilities for manipulation of biological samples in microanalytical systems.

We will first present novel techniques for high-pressure (10-300 bar) microfluidic control. In-situ laser-induced polymerization is used to fabricate fluorinated nanoporous polymers inside silica microchannels, whose actuation (actively voltage-addressed or passive) can be used to rout high pressure flows in a wide variety of solvents for chemical synthesis or chromatography. While any number of valving approaches have been proposed and implemented in microanalytical systems, we have developed the unique capability to valve high pressure flows with both aqueous and organic analytes. Application of these flow control elements is demonstrated in an integrated microchip HPLC system that can perform on-chip injections of 200 pl samples and has performed simple HPLC protein separations in 40 s, using standard water-ACN mixtures and ion-pairing reagents.

We will also present laser-fabrication techniques for photopatterning nanoporous dialysis membranes inside microchannels. Zwitterionic, nanoporous polymers with 5-50 μm thicknesses and 5-150 kDa molecular weight cutoff are fabricated inside microchannels using shaped laser light and used for protein concentration or counterflow dialysis. These membranes allow buffer ion flow and, in the presence of electric fields, can be used to trap proteins at the interface—with standard pinched electrokinetic injection schemes, proteins can be concentrated by 2-4 orders of magnitude. In the absence of electric fields, these membranes can be used for desalting or other dialysis applications in counterflow configuration. The ability to pattern multiple membranes with arbitrary pore size opens up exciting possibilities for rapid dialysis of nascent analytes on chip.

Tuesday – March 23, 2004
Barus & Holley, Room 190
4:00pm