Microfabricated Fluidic Systems for Biochemical Analysis

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Tremendous interest in microfabricated fluidic channel structures (microchips) has grown over the past decade due to the large number of powerful demonstrations that have appeared in the literature. The diversity of chemical and biochemical measurement techniques implemented on microchips is large including various electrophoretic and chromatographic separations, chemical and enzymatic reactions, noncovalent recognition interactions, sample concentration enhancement, and cellular manipulations. In addition the types of samples addressed by microchips has been broad in scope, e.g., small ions and molecules, single and double stranded DNA, amino acids, peptides, and proteins. These devices have low cost and small footprints while consuming miniscule quantities of reagents and producing rapid results. Moreover, the manufacturing strategy used to make these devices, i.e., photolithography, allows convenient fabrication of devices that perform parallel processes or serial interconnected functions while maintaining low cost. All of these features suggest the possibility to perform chemical experimentation at a massive scale at low cost on a bench top. Serial integration of chemical separation processes have allowed comprehensive two-dimensional separations to be performed in ≈ 10 min. and the lysate of individual cells to be analyzed automatically. More recently, we have been investigating the prospects of shrinking channel lateral dimensions by a factor of ≈ 1000, i.e., to molecular length scales. A number of interesting capabilities are possible with nanoscale channels and pores including the structural characterization of single molecules. Fundamental studies of electrokinetic fluid transport in nanoconfined spaces have been investigated allowing the first experimental benchmarking of continuum theories for such phenomena that were developed decades ago. In addition, potential applications of devices with ≈ 100 nm features have been demonstrated. Examples will be presented showing various chemical and biochemical experiments that have been successfully transferred on these miniature platforms. Prospects for the future will also be discussed.

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