Optical Addressing of Polymer Beads in Microdevices

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Integrated ‘lab-on-a-chip’ devices that utilize microfabrication tools are emerging for chemical and biological applications. Facile, robust sample manipulation within these devices will be particularly important for realizing the potential to perform many assays in parallel. Often, biomolecules are manipulated by derivatization to larger ‘carrier beads’; therefore, we have developed a novel optical addressing scheme to localize polymer beads (0.8–10 µm in diameter) on an unpatterned semiconductor surface. This approach utilizes an optical microbeam that is directed on the substrate to create an active ‘virtual’ electrode. The localized charge is defined by the characteristics of the solid-liquid interface in the electrochemical system and serves to attract oppositely charged objects within the solution. Furthermore, to improve patterning efficiency and resolution, a photosensitive polymer coating is used on semiconductor substrates to minimize undesired effects of the dark current. Thus, illumination through a mask or use of multiple beams enables a nonlithographic, dynamic pattern transfer to a uniform substrate. In the future, this approach may be useful for ‘off-chip’, sterile manipulation of arrays of ‘carrier beads’ for high-throughput applications.