352e Study of Molecular Transport in Nanofluidic Channels by Integrated Multiple Internal Reflection Infrared Waveguide

Thomas C. Gamble, Youn-Jin Oh, Chan-Hwa Chung, Dimiter N. Petsev, Steven R. J. Brueck, Gabriel P. Lopez, Cornelius F. Ivory, and Sang M. Han

We have successfully integrated nanofluidic channels into Si multiple-internal-reflection (MIR) infrared waveguides for the purpose of biomolecular separation and detection. Biomolecules, electrolyte solution, and their reactions can be probed by the MIR waveguide, provided that the channel width is substantially less than the IR wavelength. In the regime where the channel width (10 to 100 nm) is comparable to the Debye length (~20 nm) of the electrolyte solution, we have investigated the electrokinetic transport of fluorescent dyes in a range of pH with the application of transverse "gate" bias in the field effect transistor (FET) configuration.‡ The gate bias controls the zeta potential and therefore the electroosmotic flow of dye molecules with a possibility of reversing its flow direction. Fluorescent dyes are chosen for the purpose of initial transport studies and visualization. We will also present the effect of ionic strength on the electrokinetic transport of fluorescent dye molecules. The addition of salt increases the ionic strength, but it also adds mobile ions that can move through the thermal SiO_2 layer that insulates the Si substrate from the electrolyte solution. We evaluate the use of a Si_3N_4 sub-layer as a means of preventing the leakage current due to mobile ions moving through the SiO_2. We compare our observations with fluorescence spectroscopy and current measurements. ‡ U.S. Patent Application was filed on July 19, 2004.