Assembly and Manipulation of Particles and Molecules in Thin Wetting Films Using Electric Fields

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We will report new methods for electric field control of flow in thin wetting films, where we assemble colloidal structures and characterize individual molecules. We have developed an enhanced method for deposition of colloidal crystal coatings by convective assembly in an electric field. The primary effect of the electric field is electrowetting on dielectric, which extends the length of the liquid film in which particles are packed into a crystal structure. Film extension increases the evaporation-driven flux of particles to the growing crystal and allows better particle rearrangement to form more uniform crystals. We have observed a six-fold increase in the crystal assembly rate and an order of magnitude increase in crystal domain size with this new method compared to convective assembly without an electric field. We will also report a novel nanofluidic system based on flow in aqueous wetting films less than 100 nm thick. Flow in the films is driven by electroosmosis and is readily controlled by modulating the electric field polarity and intensity. Film flow can be directed along “virtual channels” delinatated by microcontact printing of hydrophobic silane patches on the substrate. We will apply this nanofluidics methodology to study the effects of confinement and electric field actuation on polymer brush monolayers and to demonstrate transporting, positioning, and stretching of individual DNA molecules.