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Single-molecule dynamics in nanofabricated traps

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The Anti-Brownian Electrokinetic trap (ABEL trap) provides a means to immobilize a single fluorescent molecule in solution, without surface attachment chemistry. The ABEL trap works by tracking the Brownian motion of a single molecule, and applying feedback electric fields to induce an electrokinetic motion that approximately cancels the Brownian motion. We present a new design for the ABEL trap that allows smaller molecules to be trapped and more information to be extracted from the dynamics of a single molecule than was previously possible. In particular, we present strategies for extracting dynamically fluctuating mobilities and diffusion coefficients, as a means to probe dynamic changes in molecular charge and shape. If one trapped molecule is good, many trapped molecules are better. An array of single molecules in solution, each immobilized without surface attachment chemistry, provides an ideal test-bed for single-molecule analyses of intramolecular dynamics and intermolecular interactions. We present a technology for creating such an array, using a fused silica plate with nanofabricated dimples and a removable cover for sealing single molecules within the dimples. With this device one can watch the shape fluctuations of single molecules of DNA or study cooperative interactions in weakly associating protein complexes.