Trapping and manipulating single molecules in solution

Adam E. Cohen, W. E. Moerner
Department of Chemistry, Stanford University, Stanford, CA 94305

To study a single molecule in solution, one would like to hold the molecule still without perturbing its dynamics along internal degrees of freedom. We have addressed this challenge by building a new machine we call an Anti-Brownian Electrokinetic trap (ABEL trap).[1,2] The ABEL trap consists of a nanofluidic cell mounted in a fluorescence microscope. A real-time tracking system follows the Brownian motion of a single fluorescent molecule, and a feedback system generates a time-dependent electrokinetic drift that cancels this Brownian motion.

The heart of the ABEL trap is a fused silica nanofluidic cell. The cell was created by a) depositing a Si etch mask on a fused silica wafer, b) two steps of patterning the Si followed by HF etching, c) stripping the remaining Si, and d) bonding the patterned wafer to a clean fused silica coverslip. The tracking system uses a modified confocal microscope to provide an analog readout of the position of a single fluorescent object, with spatial and temporal resolution limited by diffraction and shot-noise, respectively. A high voltage amplifier transmits the output of the tracking system back to the microfluidic cell.

The ABEL trap has been used to manipulate individual proteins, virus particles, strands of DNA, and semiconductor nanocrystals.[3] I will discuss what information can be obtained from a trapped molecule, and speculate on ways the ABEL trap could be used to fabricate nanostructures.

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[1] A. E. Cohen and W. E. Moerner, "Method for Trapping and Manipulating Nanoscale Objects in Solution," *Appl. Phys. Lett.* **86**, 093109, (2005).
[2] A. E. Cohen, "Control of nanoparticles with arbitrary two-dimensional force fields," *Phys. Rev. Lett.*, **94**, 118102, (2005).
[3] A. E. Cohen and W. E. Moerner, "Suppressing Brownian motion of individual biomolecules in solution," *PNAS*, **103**, 4362-4365, (2006).