The Center for Probing the Nanoscale Image Contest
Winner Announcement January 30, 2006

First Place Scientific Merit: Adam Cohen
(from W.E. Moerner's Lab)

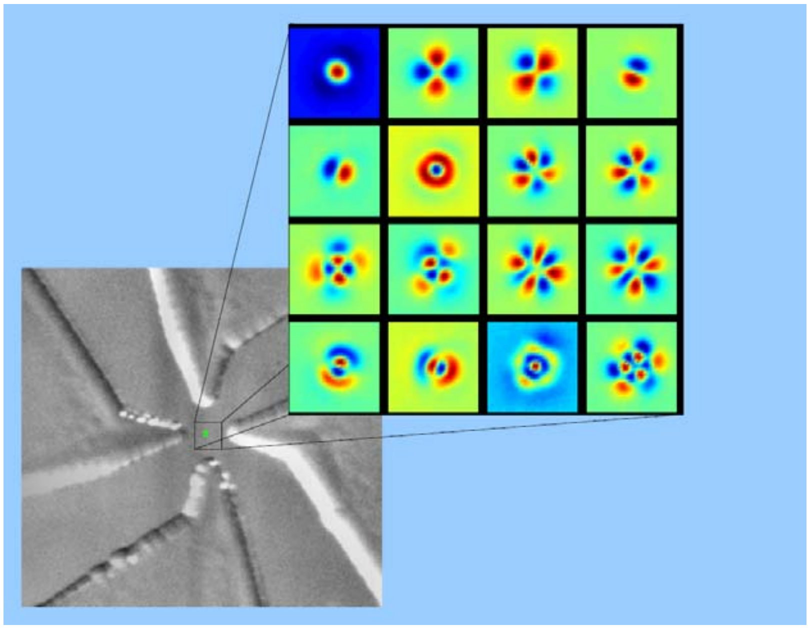

Figure Explanation:

The Anti-Brownian ELectrokinetic trap (ABEL trap) is a device that allows researchers to trap and manipulate individual fluorescent molecules in solution, at room temperature. Normally, molecules in solution flit and jiggle around due to countless collisions with solvent molecules. This jiggling is called Brownian motion and becomes more pronounced the smaller a molecule is. The ABEL trap is a device that tracks the Brownian motion of one molecule (using fluorescence videomicroscopy), and then applies a series of electrical kicks to the molecule to induce a motion that exactly cancels the Brownian motion. So if the molecule hops to the left, the ABEL trap kicks it back towards the right, and so on. This way the molecule is held in one place, allowing us to get a good look at it and to study its properties. The first image shows the trapping region of the ABEL trap. The four objects shaped like a bird's beak extending to the edges of the image are microfluidic channels that connect the trapping region to the electrodes used to keep the molecule trapped.

One of the things we trapped is a molecule called lambda-DNA. Lambda-DNA is the entire genome of a virus that preys on bacteria. If pulled tight, the molecule would be about 20 microns long, or roughly one fifth the width of a hair. But in solution, the molecule is randomly coiled in an ever-changing configuration, a little like a strand of angel hair pasta in a pot of boiling water. We coated the DNA with a fluorescent dye so we could see the shape of the molecule, and then took about 60,000 images of the molecule using a high speed camera. We applied a statistical technique called Principal Components Analysis (PCA) to these images to identify the characteristic motions of the lambda-DNA. The second image shows these characteristic motions. The dominant motion (shown on the upper left) is one in which the molecule as a whole expands or contracts radially. Then there are two motions in which the molecule stretches along one axis, and compresses along a perpendicular axis (shown in the top row). Then there are more complex motions. By analyzing the dynamics of these motions we are learning about the underlying interactions that give DNA its physical properties and testing the assumptions underlying the Zimm theory of polymer dynamics.

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First Place Artistic Rendering: Guangyu Zhang

(From H. Dai's Lab)

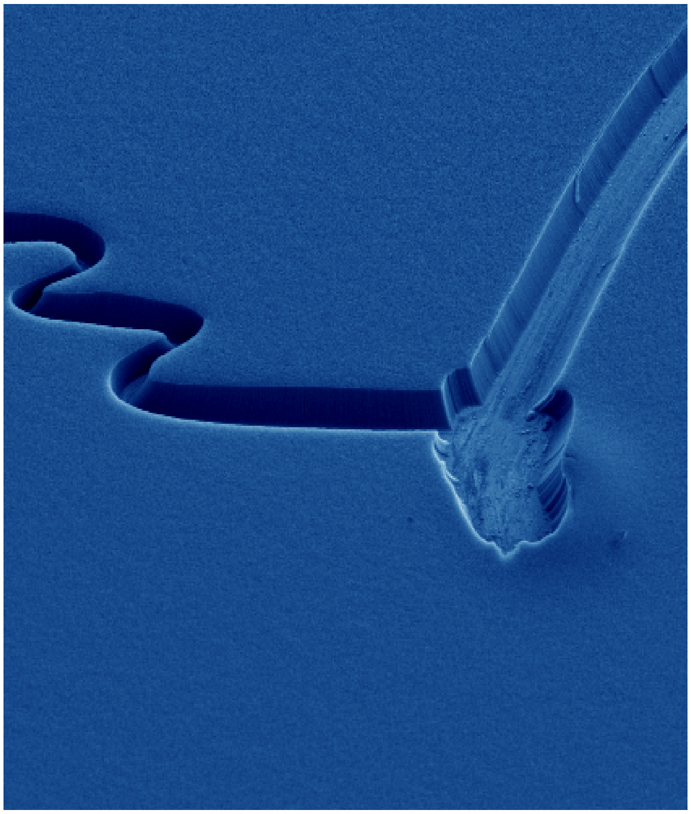

Figure Explanation:

Carbon nanotubes are cylindrical molecules with diameters around 1 or 2 nanometers. Since their discovery in 1991, multi-walled carbon nanotubes have been easily synthesized using several methods. Yet, large-scale production of single-walled nanotubes into ordered films has remained intractable.

Recently, we developed a novel plasma-enhanced chemical vapor deposition (PECVD) method for growing vertical single-walled carbon nanotubes (SWNTs) on a large scale. PECVD works by exposing substrates densely seeded with catalytic iron particles to hydrocarbon gas plasma, which can produce a plush carpet of SWNTs. In the image, the canyon in the film was formed by scratching the iron catalyst off the substrate before growth. The key component to attaining vertical SWNTs is adding oxygen to the reaction. By adding oxygen into the plasma thus scavenging up the hydrogen radicals, a carbon-rich and hydrogen-deficient growth environment is created, spawning a vertical forest of SWNTs.