Atomic, Molecular, and Optical Science

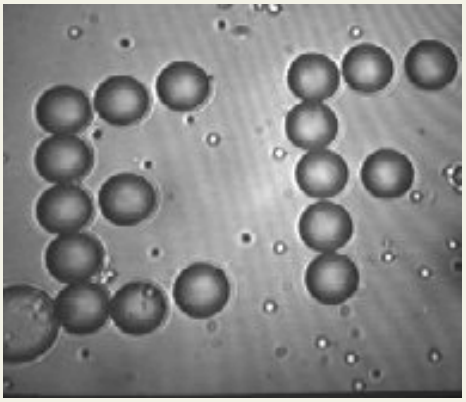
Addressing Fundamental Questions and National Needs

4. Optical Tweezers

- Laser light can exert large forces on microscopic objects.
- A laser beam focused to a spot just a few microns across can be used to trap and manipulate small objects such as cells or even individual strands of DNA.
- These "optical tweezers" are noninvasive and gentle in comparison with mechanical techniques. For example, they can manipulate the internal components of a cell without damaging its cell wall.

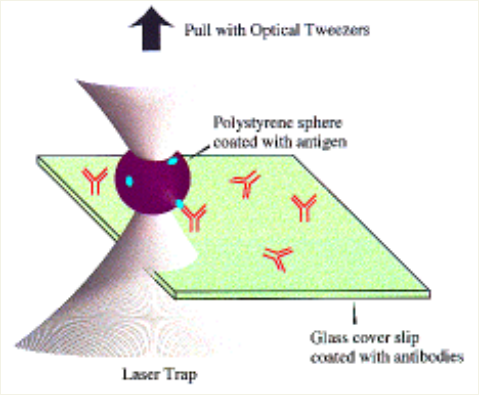
Device Fabrication

This image shows plastic spheres 10 microns in diameter—about one-tenth the diameter of a human hair—that have been plucked from solution with optical tweezers and arranged into a pattern. This type of remote manipulation may eventually enable the fabrication of micron-scale devices.

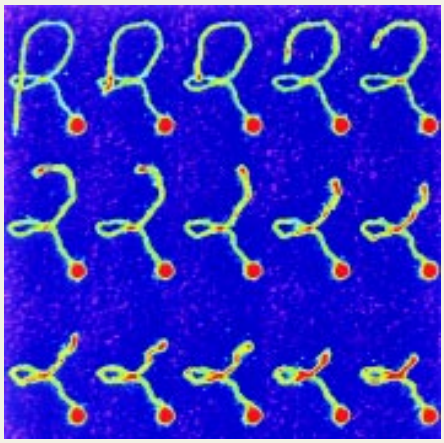


Antibodies and Antigens

Optical tweezers can be used to measure the binding force between antibodies and antigens. An antigen-coated bead is pulled with optical tweezers to measure the force between it and an antibody-coated glass surface.

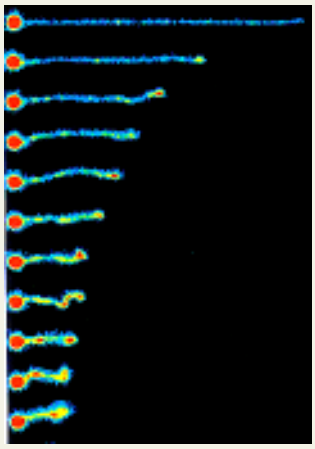


Stretching DNA



A single DNA molecule, with a tiny plastic sphere (1 micron in diameter) attached to one end, can be stretched into any desired shape with optical tweezers. This sequence of images shows the snake-like motion of a DNA molecule 60 microns long as its relaxes after being stretched into an "R" shape.

A single DNA molecule, with one end (red dot) held in place by optical tweezers, can be stretched out straight by a flowing fluid. This series of images, taken every 4.5 seconds after the flow is stopped, shows the molecule's relaxation back to its original coiled shape.



This is one in a series of one-page handouts based on the National Research Council report *Atomic, Molecular, and Optical Science: An Investment in the Future* (National Academy Press, Washington, D.C., 1994). For more information on this report, look on the World Wide Web at http://www.nap.edu/readingroom/books/amo or contact the NRC Board on Physics and Astronomy on the World Wide Web at http://www.nas.edu/bpa, by email at bpa@nas.edu, or by telephone at 202-334-3520.