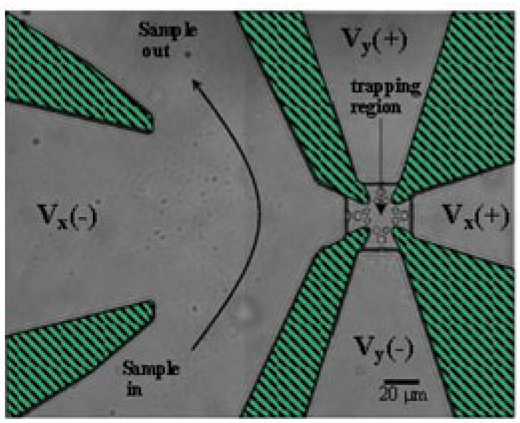
Docket #: S04-213

Trapping Nanoscale Objects in Solution

W.E. Moerner and Adam Cohen have patented the Anti-Brownian ELectrokinetic trap (ABEL trap) which can trap, measure, and manipulate sub-micron objects (e.g. single molecules) in solution at ambient temperature. The ABEL trap uses high-speed fluorescence microscopy to track the Brownian motion of a single fluorescent molecule. A feedback circuit applies carefully timed electric fields to the solution to induce an electrokinetic drift that cancels the Brownian motion. The ABEL trap is non-invasive, gentle, and can trap objects far smaller than can be trapped with laser tweezers. Applications include precise single-molecule measurements and nanomanfacturing.

News article - "Building a Better Molecule Trap", Science, Feb. 18 2005.

Figure



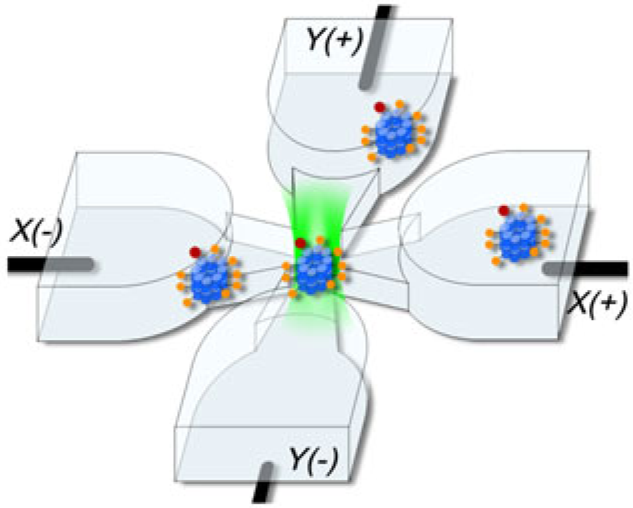


Figure description - Trapping region of the ABEL trap showing biomolecules in a microfluidic cell

Stage of Research

- **Proof-of-principle device** trapped fluorescent polystyrene nanospheres with diameters down to 20 nm.
- The ABEL trap was used to examine the photophysics of a single fluorescent protein, allophycocyanin (APC), the bacterial light-harvesting complex LH2, and the enzymatic behavior of single nitrite reductase enzymes. The technique allowed the observation of single molecules of solution-phase biomolecules for more than one second. The trap allows simultaneous measurement of brightness, excited state lifetime, and emission spectrum of the trapped object.
- The trap has been developed extensively to trap ever smaller objects, down to the ultimate limit of one single fluorescent molecule.
- The trapping algorithm and analysis have been extensively refined to allow real-time estimation of the diffusion coefficient and the electrokinetic mobility of the object, which enable binding and association events to be sensed.

Applications

- **Research tool for studying single molecules**
    - Nanomanipulation of objects in microfluidics
    - Identification of biological particles and nanoparticles
    - Single-molecule spectroscopy
    - Sorting of individual proteins

    - Photodynamics
    - Association and binding events
- Nanomanufacturing
- Studying bacterial photosynthetic regulation and biomaterials for solar energy harvesting

Advantages

- Traps sub-micron objects then can position the object with nanoscale resolution
- Can trap any object that can be imaged optically and that can be dissolved in non-corrosive solvent (e.g. water)
- Provides real-time information on fluorescence intensity, excited state lifetime, emission spectrusm, mobility, drag coefficient, and charge of a single nanoscale object
- Non-invasive, non-destructive
- Gentler than laser tweezers
- Scales more favorably for small objects than laser tweezers

Publications

- Cohen, Adam E., and W. E. Moerner. Method for trapping and manipulating nanoscale objects in solution." Applied Physics Letters 86.9 (2005): 093109.
- Cohen, Adam E., and William E. Moerner. "The anti-Brownian electrophoretic trap (ABEL trap): fabrication and software." Biomedical Optics 2005. International Society for Optics and Photonics, 2005.
- Goldsmith, Randall H., and W. E. Moerner. "Watching conformational-and photodynamics of single fluorescent proteins in solution." Nature Chemistry 2.3 (2010): 179-186.
- A. P. Fields, A. E. Cohen, "Electrokinetic trapping at the one nanometer limit," Proc. Natl. Acad. Sci. USA, 108, 8937-8942 (2011)
- Research Highlights: "Nanotechnology: Stop for brownian motion", Nature, Mar 10 2005.

Patents

- Issued: 8,057,655 (USA)

Innovators

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