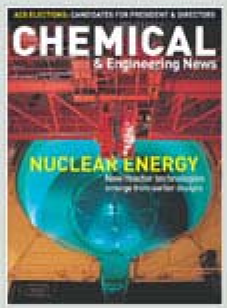

Latest News

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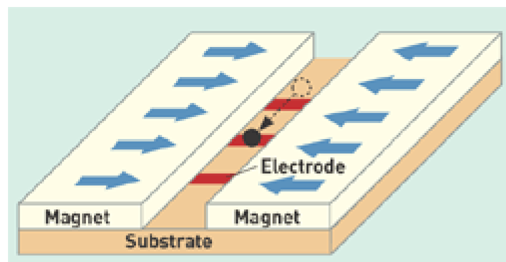
MICROFLUIDICS

FLOATING DROPLETS

Magnetic levitation technique could have uses in crystallization, synthesis

STU BORMAN

In a new approach to microfluidics, tiny droplets and particles are levitated magnetically and then moved, merged, and rotated in open channels on chip surfaces in a highly controllable manner. The technique could make it possible to take precise physical measurements, perform chemical syntheses, and crystallize substances in droplets and particles of pico- to femtoliter size.



MOVING EXPERIENCE Droplet (circle) is levitated magnetically between two fixed magnets and moved by current pulses through electrodes embedded in substrate.

Developed by physicists Igor F. Lyuksyutov, Donald G. Naugle, and K. D. D. Rathnayaka of Texas A&M University [*Appl. Phys. Lett.*, **85,** 1817 (2004)], the method is the latest step in efforts to develop microfluidic devices in which discrete droplets or particles can be manipulated on planar surfaces or in open channels. Such techniques can enable better control of reagents and operations than can be achieved with conventional microfluidic devices that use solutions flowing in closed channels.

The new technique uses magnetism to levitate droplets in shallow channels between tiny, permanent magnets. The droplets are also moved magnetically, using induced forces from current pulses in electrodes beneath the channels. The Texas A&M team has used the devices to levitate and manipulate a range of items, including aqueous and alcohol solutions, oils, polystyrene microspheres, inorganic microparticles, nanotube powders, and red blood cells.

The devices, which the researchers call magnetic micromanipulation chips, "open the way to perform chemical and biochemical reactions with only one pair of molecules confined in femtoliter droplets," Lyuksyutov says. Other possible applications include crystallizations, measurements of tiny forces (in the femtonewton range), and incorporation of specific compounds into cells, he notes.

In previous studies of droplet microfluidics, groups such as those of Richard B. Fair at Duke University and David Quéré at the College of France, Paris, have used electrical manipulation or particle coatings to ease the handling of droplets on solid surfaces. Other groups--such as those of Peter R. C. Gascoyne at the University of Texas M. D. Anderson Cancer Center, Houston, and Orlin D. Velev at North Carolina State University--have controlled tiny droplets suspended in immiscible liquids by polarizing them electrically. The new technique eliminates contact with both solid and liquid media.

Magnetic levitation of droplets "is an interesting phenomenon," Fair comments. But he believes that some of the claimed applications may be impractical, that tiny levitated droplets might evaporate too rapidly to be useful, and that it's better in any case for droplets to be moved around freely on surfaces instead of being confined to channels.

Quéré and Gascoyne, on the other hand, believe the lack of droplet-surface contact is a key advantage. Contacts can have unwanted effects on small droplets, and levitation avoids such problems, Quéré says.

Velev notes that "droplets have to be maintained in saturated vapor" to prevent rapid evaporation, and that could interfere with biological applications. Nevertheless, he believes the technique "is going to make a difference in microfluidics and could be specifically important for biomolecular crystallization."

Photos, videos, and descriptions of the Texas A&M work are at http://levitation.physics.tamu.edu.

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