Moving glass on water

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Moving an object on a water surface can be useful in many research areas such as fluidic drag and mimicking the movements of insects. Locomotion on water surfaces requires harnessing the force generated by an object, but so far methods of creating this force have been limited to specific systems or materials. Wolfgang Knoll and colleagues now present a straightforward and general method that can drive a glass fibre on a water surface by applying an external magnetic field. The glass fibre, made of bilayers of poly(acrylic acid) and Fe_3O_4 magnetic nanoparticles by using layer-by-layer self-assembly were deposited on a water surface and found to float easily. The fibres could be moved at a rate of 10 mm s^{-1}, and one weight unit of Fe_3O_4 was able to drag up to 10,000 times its own weight on the water surface. The authors expect that their work can be extended from macroscopic to nanoscopic scales and prove useful for developing magnetic drug-delivery systems and micromanipulators.

The best zoom ever

Phys. Rev. Lett. **102,** 096101 (2009)

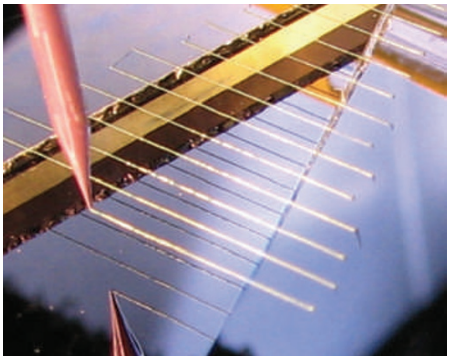
ISTOCKPHOTO / JOSÉ LUIS GUTIÉRREZ

Rolf Erni and colleagues have obtained an unprecedented result by demonstrating a resolution better than 0.5 Å in an aberration-corrected electron microscope. The goal was achieved by using a highly coherent electron probe in a scanning transmission electron microscope to image a germanium foil. The sample was placed at such an orientation that the projection of the germanium crystal seen by the probe was a periodic arrangement of pairs of atoms spaced only 47 pm apart. Formally, the resolution in an imaging instrument is defined as the minimum distance at which two points can be clearly distinguished. A comparison of the experimental image with a simulated one confirmed that the two atoms could be clearly resolved, therefore demonstrating the exceptional resolution of the instrument.

Deeper analysis of the results also provides essential insight for future efforts aimed at further improving the resolution, by showing that attention should be paid not only to electron optics — as might commonly be thought — but also to the characteristics of electron sources.

Printing in all directions

Science doi:10.1126/science.1168375 (2009)



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Directing ink through a cylindrical nozzle onto a substrate is a promising method for printing metallic electrodes for electronic devices. Until now, however, the technique has had several restrictions: nozzle clogging, relatively large features (~100 μm) and deposition that is constrained to the x–y plane. Jennifer A. Lewis and co-workers have created highly concentrated silver nanoparticle inks that can be printed in three dimensions in air without clogging. Mixing silver nitrate, poly(acrylic acid) and diethanolamine creates fine silver nanoparticles. The solution is heated, ethanol added to induce coagulation and centrifuged. Finally, ethylene glycol is added to stop clogging. Flexible silver microelectrodes, with widths as low as 2 μm, are produced that can span unsupported across gaps. The microwires withstand high strain with minimal loss of electrical properties and can be bonded to delicate substrates without damage as only a small amount of pressure is required. The team have established the potential of the technique for large-area, flexible electronic devices by patterning connections for solar microcell and light-emitting diode arrays.

Biomarkers singled out

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Proteins on the surfaces of cells can be useful markers of disease, allowing diagnosis of conditions such as cancer. The method used to detect such proteins needs to be as sensitive as possible to allow the earliest diagnosis, but with current methods at least a few hundred proteins per cell are needed for detection. Haakan Joensson and colleagues report a microfluidic approach to surface-protein detection with very high sensitivity and high-throughput potential. They label the cell-surface biomarkers with biotinylated antibodies, which then bind to streptavidin–enzyme complexes. These enzyme-labelled cells are then injected into the microfluidic device, where fluid flows confine them in droplets with a fluorogenic substrate — a material that fluoresces in the presence of enzymes. This means that, after incubation, the enzyme-labelled biomarkers can be easily detected using laser-induced fluorescence. The authors found that levels as low as 22 enzymes per droplet could be detected, and labelling with different fluorescent markers allowed detection of different biomarkers in a single experiment.

A cup of light

Nano Lett. doi:10.1021/nl900208z (2009)

Metallic nanostructures offer the intriguing possibility of controlling light on a scale much smaller than its wavelength. The promise is that this might, for example, lead to photonics on a chip. Researchers from Rice University have now come up with a structure that offers a solution to one of the problems of on-chip photonics — an antenna to capture and guide incoming light. For this they fabricate nanocups, tiny hemispheres of gold. Latex or polystyrene colloidal particles are placed on a substrate, followed by a directional gold evaporation from a shallow angle. This process uniformly covers the spheres with a hemisphere of gold. An elastomer is then poured on the surface and used to lift the spheres from the metal substrate. Embedded in an optically neutral matrix, the gold nanocups show two plasmonic resonances. One resonance is relatively weak and scatters light along the direction of the incoming laser beam. The stronger resonance, however, scatters light along the axis of the nanocup, independent of the orientation of the incoming beam. At the resonance frequency, this orientation-dependent scattering can therefore be used to fabricate fully three-dimensional nano-antennas.