PLASMON RULERS
Measuring in 3D
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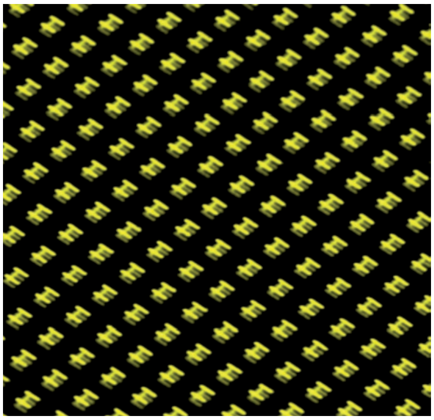

The plasmon resonance wavelength of metal nanoparticles such as gold is affected by changes in the particle's immediate environment, and these changes can be measured using scattering or absorption spectroscopy. Moreover, two nanoparticles placed in close proximity can exhibit a shift in resonance wavelength that depends on the separation between them. This effect has been used to make plasmon rulers, which measure nanoscale distances in one dimension and have been employed to study DNA hybridization. Laura Na Liu and colleagues have now created a three-dimensional plasmon ruler from a stack of five gold nanorods.

The researchers — who are based at the University of California, Berkeley, Lawrence Berkeley National Laboratory, the University of Stuttgart and the University Blaise Pascal — used electron-beam lithography and layer-by-layer stacking techniques to create nanorod structures in which one nanorod was perpendicularly stacked between two parallel rod pairs. Strong coupling between the sandwiched nanorod and the two nanorod pairs permits the excitation of two sharp quadrupolar resonances in the broad dipolar resonance profile. This allows high-resolution plasmon spectroscopy to be carried out, and for the exact position of the middle nanorod with respect to the others to be detected.

Liu and colleagues suggest that the approach could also be applied to metal nanoparticles joined together by oligonucleotides or peptides, and that 3D plasmon rulers could be used to study biological processes in the future.

CELL COLLECTION
Catapulting with light
ACS Nano doi:10.1021/nn2012767 (2011)

Selective separation of cells in culture is useful for single-cell studies in stem-cell research, organ culturing and tissue engineering. Current methods such as aspirating cells with capillaries are tedious and are at risk of contamination. Now, Tsuyohiko Fujigaya, Naotoshi Nakashima and colleagues of Kyushu University and the Japan Science and Technology Agency have shown that cultured cells can be selectively removed and collected using near infrared laser.

The Japanese team coated a conventional cell culture dish with single-walled carbon nanotubes and allowed cells to grow as they would on a control glass substrate. Because carbon nanotubes are responsive towards a near infrared laser and biological tissues are transparent in this region, cells that were irradiated with short pulses of the laser detached from the culture dish immediately. By focusing the laser using different objective lenses, it is possible to detach either large numbers of cells or single cells, suggesting that this method can be used to 'catapult' and pattern cells on substrates. Cells that were detached in this way retained their morphology and genetic information. However, Raman mapping of the irradiated area revealed that carbon nanotubes were detached along with the cells.

Although it is thought that the irradiation induced a photoacoustic effect that detached the cells, the exact mechanism of cell removal and the implication of the detached nanotubes on subsequent studies need to be explored further.

BATTERIES
Lithium finds its flow
Adv. Energy Mater. doi:10.1002/aenm.201100152 (2011)

Although the reduction and oxidation of lithium allows large amounts of energy to be stored in a given mass, about half of the volume of a lithium battery consists of inactive components such as foils, binders and packaging. This reduces energy density and increases cost. Flow batteries, however, store energy in liquids kept in external reservoirs, and pump them into a 'power stack' where ions are exchanged and power extracted. Although this scheme reduces the need for inactive materials, it has also traditionally offered low energy densities. Now, Yet-Ming Chiang and colleagues at the Massachusetts Institute of Technology have shown that the best features of these technologies can be combined.

The researchers replaced the aqueous components of a traditional flow battery with semisolid storage compounds consisting of suspensions of active materials in an electrolyte. This approach allows for a variety of chemistries to be implemented (the MIT team chose a lithium chemistry). A percolating network of nanoscale conductors was also added to the suspensions to facilitate electron flow to current collectors. The resulting cells operate with low mechanical energy dissipation, and have theoretical capacities ten times higher than traditional flow batteries. If successfully scaled, the technology could allow the rapid refuelling of electric vehicles by filling a tank, rather than direct electrical charging.

SEMICONDUCTOR DEVICES
X-rays feel the strain
Nano Lett. doi:10.1021/nl2013289 (2011)

Strain is often employed in the semiconductor industry to increase the speed of transistors, but it is difficult to measure the strain fields in devices after they have been fabricated. X-ray nanodiffraction is a promising technique for this task because it offers good resolution, elemental sensitivity and the large penetration depths needed to 'see' inside devices containing many layers of different materials. Now Nina Hrauda of Johannes Kepler University in Linz and co-workers have used this approach to measure the strain fields inside a working field-effect transistor.

Hrauda and co-workers focussed hard X-rays from the European Synchrotron Radiation Facility in Grenoble to produce a beam with a diameter of 400 nm. This X-ray beam was then directed at devices in which a nanoscale island of SiGe was used to induce tensile strain in the silicon channel above it. The team found that various nanostructures in their devices, notably the gatestack (which contains a thin layer of SiO_xN_y and a thicker layer of Al) and a SiO_2 isolation layer, tend to reduce the strain induced by the island. An improved understanding of the strain distributions inside devices should lead to improvements in performance.