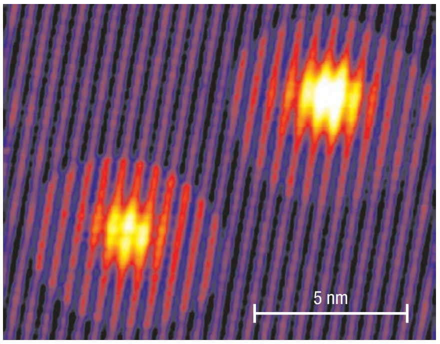
Surprise rings



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Phys. Rev. Lett. **101,** 076103 (2008)

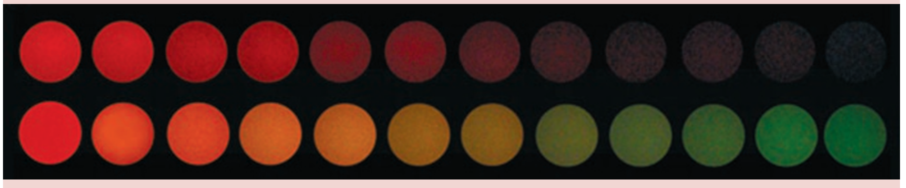
Karen Teichman and co-workers have investigated the effects of a very sharp scanning tunnelling microscope (STM) tip on the charge of a single impurity atom in a host matrix. When performing topographic images (constant applied voltage) around a single Si atom acting as electron donor in a GaAs host they observed rings centred on the impurity. The researchers ascribe this to the ionization of the Si atom when the STM tip is close enough. They suggest that the modification of the charge state of the impurity affects the local energy environment, inducing an abrupt rise in the tunnelling current at a distance from the Si impurity corresponding to the ring radius. This was validated in several ways, for example by verifying that the ring diameter changes with the applied voltage. Far from being purely aesthetic, the results show the possibility of directly probing and influencing the charge state of a single impurity, as the researchers demonstrated by using the modification of the tunnelling current due to ionization to map out the complete electrostatic potential of the Si impurity.

Rare toughness

Nano Lett. doi:10.1021/nl8017884 (2008)

SiC is a lightweight ceramic that is widely studied for its possible use in high-temperature applications where it might replace the metallic alloys that are currently used. However, although ceramics such as SiC may increase the operation temperatures possible by several hundred degrees, at the same time they are brittle and prone to fracture. To enhance their fracture toughness, intergranular rather than intragranular fracture needs to be promoted. In intragranular fracture, a crack propagates straight through the grains, whereas in intergranular fracture cracks do not enter grains and are instead deflected at the surface. This allows the bridging of the crack through interlocking grains, enhancing overall toughness. In their high-resolution transmission electron microscopy study, Aaron Kueck and colleagues have studied crack propagation in rare-earth-doped SiC. They show that the rare-earth dopants predominantly aggregate as a thin phase at the grain boundary, and that these grain-boundary phases lead to efficient crack deflection. Confirming earlier experiments, crack deflection was particularly enhanced for large-ion rare-earth dopants such as lanthanum. The study demonstrates how modifications at the nanoscale can significantly alter macroscopic behaviour.

Green for go



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Angew. Chem. Int. Ed. doi:10.1002/anie.200801733 (2008)

A reusable optical strip for sensing oxygen has been developed that could provide the basis of portable devices for rapid, quantitative determination of this important gas. The strip contains a layer of cadmium telluride quantum dots underneath the fluorophore $PtF_{20}TPP$, which is sensitive to oxygen. The $PtF_{20}TPP$ fluoresces with an intensity proportional to the concentration of oxygen present, resulting in a change of colour. But the naked eye cannot easily detect the full range of the colour change (top row of image) — this is where the CdTe quantum dots come in useful; they provide a background of green, which enhances the colour variations (bottom row). Handily, the colour changes from red at low oxygen concentration to green at high, which indicates an obvious use as a warning function in potentially hazardous confined spaces. The stability and homogeneity of the two-layer film ensures that the oxygen can also be measured quantitatively. The film can be reused, with the fluorescence intensity being rejuvenated by placing the film in oxygen-free conditions.

Seeing double

Nature **455,** 85–88 (2008)

Water-in-oil-in-water (WOW) emulsions comprise water droplets inside larger oil droplets within a sea of water, with each compartment stabilized by surfactants. To date, the formation of these double emulsions has required the combination of surfactants that can coexist stably, and so making WOW emulsions has been challenging. Moreover, for many applications such as drug delivery, the fabrication of WOW emulsions in which both inner and outer droplets are under 100 nm is desirable, whereas previous methods have resulted in the formation of only micrometre-sized droplets. Now, Jarrod Hanson *et al.* have used just one type of surfactant, amphiphilic diblock copolypeptides, to make WOW emulsions by simply passing the mixture through a high-pressure microfluidic homogenizer. The double emulsions remain stable for many months and can be made with droplets in the nanoscale range. Furthermore, the aqueous and oil compartments of the emulsions can encapsulate water-soluble and oil-soluble molecules, respectively, and are shown to retain their cargoes for several months, thus demonstrating the unique stability of these systems.

Preventing a blow

Adv. Mater. doi:10.1002/adma.200800890 (2008)

Hydrogen is being investigated as a replacement for fossil-based energy-storage materials. Its high flammability necessitates devices for concentration measurement and leak detection. Optical transducers provide a prudent approach — no electrical circuitry is required for signal output, eliminating waste heat energy and electrical sparking during use. Previously, fibre optics covered with a H_2-sensitive thin-film have been used. However, long response times, long waveguide–gas interaction lengths and film cracking make these problematic. Donald J. Sirbuly *et al.* have fabricated a new H_2-sensing platform consisting of Pd nanoparticles, stabilized by octa(propylammomium)-olyhedral oligomeric silsesquioxanes, attached to a SnO_2 semiconductor nanowire (the waveguide) embedded in poly(dimethylsiloxane). The porous nanoparticles provide a quick route for H_2 to reach the Pd. They have a higher surface area and are more optically transparent than thin films, so multilayers can be used without affecting the response times of less than 1 s, which is up to 30 times faster than other optical H_2 detectors. The waveguide interaction length of 50 μm is smaller than the previously published 2 mm to 1 cm.