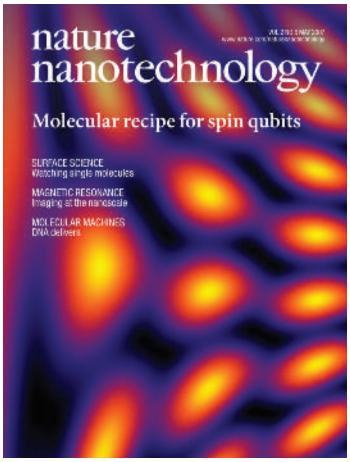


Cover story

Vol.2 No.5 May 2007

Identifying suitable two-state systems to act as quantum bits or 'qubits' is an important first step in any effort to design and build a quantum computer. One approach is to use a voltage to control the direction of electron spins (which can point up or down) in semiconductor quantum dots. However, spin qubits based on molecular magnets could have a number of advantages, including the possibility of using chemical methods to assemble large numbers of identical qubits, if they could be controlled by all-electrical methods. Daniel Loss and colleagues propose that polyoxometalate molecules containing two magnetic vanadium oxide units separated by a molybdenum oxide core may be a viable system. They predict that a voltage applied with a scanning tunnelling microscope could switch and read out the state of the electron spins on the vanadium atoms.
[Article p312; News & Views p271]

CATALYST CLOSE-UP

The study of chemical reactions often involves measuring the ensemble properties of a large number of molecules. However, Johannes Elemans and co-workers have now used a scanning tunnelling microscope to visualize individual catalysts at work at a solid–liquid interface. Arrays of porphyrin molecules were formed on a gold surface, and the metal atom at the centre of each molecule was allowed to react with oxygen to form a catalytic site, which was then able to convert one organic compound (an alkene) into another (an epoxide). Using a scanning tunnelling microscope, individual porphyrins were observed at each step of the process, offering a unique insight into how these reactions work at the single-molecule level and also revealed information about catalyst activity, stability and distribution across the surface. **[Letter p285; News & Views p270]**

IMPROVE YOUR IMAGE

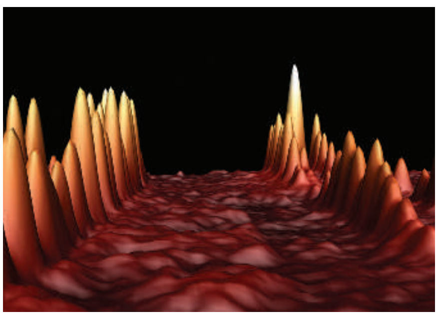
Magnetic resonance imaging (MRI) is widely used in science and medicine, but the resolution of the technique is limited to micrometres at best. Magnetic resonance force microscopy (MRFM) is an alternative approach that relies on the detection of forces to overcome some of the limitations of conventional MRI. John Mamin and colleagues have now shown that the two-dimensional imaging of nuclear spins can be extended to a resolution of 90 nm with MRFM by using high-moment magnetic tips and a new measurement protocol. The resulting detection volume is less than 650 zeptolitres, which is 60,000 times smaller than previous values for such experiments. **[Article p301; News & Views p267]**

PLANTS FOR A CHANGE

Silica nanoparticles are routinely used to deliver genes and chemicals to animal cells and tissues, but less frequently to deliver such cargos to plant tissues as it is much more difficult for the particles to pass through the walls of plant cells. Victor Lin and co-workers have used a honeycombed mesoporous silica nanoparticle system with 3-nm pores to deliver genes and chemicals into isolated plant cells and intact leaves with greater efficiency than standard methods. Gold nanoparticles are used as caps to keep the cargo inside the silica. When these caps are removed, the genes and chemicals released from the nanoparticles can trigger gene expression in both transgenic (genetically modified) and non-transgenic plants. The work could have applications in plant biotechnology.
[Letter p295; News & Views p272]

JOIN THE NANODOTS

Ion beams are widely used to modify surfaces on the nanometre scale. Low-energy ions are mostly stopped by nuclei, dissipating their energy into a large volume. High-energy ions, on the other hand, are stopped by electronic excitations and deposit their energy locally, leading to the creation of nanosized 'hillocks' or nanodots when the beam is normal to the surface. The nanodots tend to be randomly distributed, with each one resulting from the impact of a single ion. Now Marika Schleberger and colleagues have demonstrated that multiple equally-spaced dots can be created if a single high-energy xenon ion grazes the surface. Moreover, the number of dots can be controlled by varying this angle. **[Letter p290]**



Making multiple nanodots with single ions.

p290

SEE CARBON GROW

Carbon nanotubes can be grown from metal nanoparticles that act as catalysts, but the way in which this happens is not fully understood. Now, Florian Banhart and co-workers have used high-resolution transmission electron microscopy to directly monitor the nucleation and growth of nanotubes, and they go on to propose a growth model to explain their observations. Multiwalled tubes containing metallic cores were subjected to electron-beam irradiation, and new single- or multiwalled carbon nanotubes were seen to grow from the metal particles inside the host structure. The results suggest that carbon atoms diffuse through the metal catalyst, rather than along its surface, and that similar mechanisms might be at work in the chemical vapour deposition technique that is widely used for nanotube synthesis.
[Article p307]

A SENSE OF IDENTITY

Because some diseases, including cancer, are characterized by abnormal concentrations of certain proteins, the ability to accurately and quantifiably detect these biomolecules is important for early diagnosis and treatment. The diversity and complexity of proteins makes them a difficult sensing target, but working with assemblies of gold nanoparticles that are coated with fluorescent polymers, Vince Rotello and colleagues have made detector arrays that can correctly identify and quantify proteins with high accuracy. The fluorescence of the polymers is quenched by the gold nanoparticles. However, proteins can displace the polymers from the nanoparticles, resulting in distinct fluorescence response patterns when six different polymer–nanoparticle conjugates were tested. Similar approaches could prove useful for biomedical diagnostics.
[Article p318]