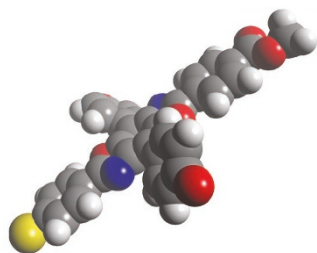


A cross to bear electrons



For molecular electronics to meet its goals, new molecular structures are required to add functionality to electrodes or to act as potential circuit components. Fortunately, there are many chemists, including Colin Nuckolls and colleagues at Columbia

University, busy making them. Their latest creations, described in the *Journal of the American Chemical Society* (<http://dx.doi.org/10.1021/ja0350942>), are cross-shaped molecules that can assemble into ordered monolayer films on the surface of gold electrodes. These molecules are made from orthogonal terphenyl and bis-phenyloxazole arms by a new synthetic route that allows surface-reactive groups, such as thioesters or carboxylic acids, to be added to the ends of the bis-phenyloxazole arm.

When they form monolayer films, the bis-phenyloxazole arm serves as a conjugated (that is, conducting) portion, while the terphenyl arm provides the film with structure. Owing to twisting of the phenyl groups in the terphenyl, the bis-oxazole groups end up oriented upright from the monolayer surface. Such vertical orientation may be useful in molecular electronic structures, such as monolayer devices, that require electron conduction perpendicular to the electrode surface.

MICROWAVE-BAKED CERAMICS

The microwave revolution is over in the kitchens but is still raging in materials laboratories. Mullite, a refractory material with wide industrial applications (especially in the steel and glass industries) is normally produced through the high-temperature sintering of kaoline and alumina mixtures. Now researchers at the Indian Institute of Science in Bangalore propose the use of microwaves to save time and energy (Panneerselvam, M. & Rao, K. J. *Chemistry of Materials* <http://dx.doi.org/10.1021/cm0301423>). Indeed, through this alternative route it took them only an hour to obtain intact mullite pellets, already sintered to 98% of the theoretical density and free of secondary products. The method not only showed practical advantages, but it also yielded a superior quality product. The authors used X-ray diffraction, nuclear magnetic resonance and infrared spectroscopy to investigate the structural evolution during the process. The results clearly suggest that a microwave-specific phenomenon might cause a direct, one-step reaction occurring between alumina and the amorphous silica that results from the decomposition of kaoline.

Surfactant–surfactant interactions

Surfactants have many applications ranging from pharmaceuticals and cosmetics to household cleaning products. Their properties result from their aggregation behaviour under different conditions, which becomes more complex when mixtures of surfactants are used — usually the case in commercial applications. This makes it tricky for researchers to predict the surfactant–surfactant interaction parameter,

β , when designing a new product. As they report in *Langmuir* (<http://dx.doi.org/10.1021/la020789>), Milton Rosen and Qiong Zhou combine theory for regular solutions and experimental data for area-per-molecule at both the air–aqueous interface and in micellar aggregates, to explain the β values observed in surfactant mixtures. Previous research only used data after mixing, leading to misinterpretation of

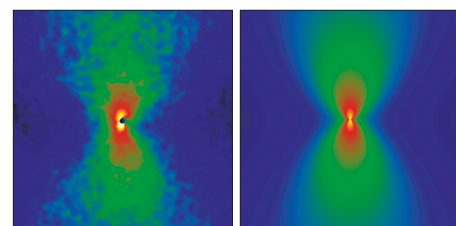
negative β values as describing attractive interactions between the two surfactants. However, Rosen and Zhou also use self-interaction data from before mixing, and thus suggest that the negative β values found after mixing indicate an interaction that is either more attractive or less repulsive: a subtle difference that may help to make development of products containing surfactant mixtures less ‘blind’.

Single-molecule magnets

The idea that a few molecules, or even a single molecule, could be embedded between electrodes and perform the basic functions of digital electronics — rectification, amplification and storage — has been around since the mid-1970s. Recently, it has been shown that, in principle, single molecules such as manganese clusters could also be used to store magnetic information. However, using single-molecule magnets as molecular components for information storage or quantum computation requires manipulating, probing and imaging these individual components. Scanning probe microscopy techniques are particularly useful to study the interaction between magnetic and electronic properties of these clusters, but obtaining such information has proved to be extremely difficult, because the clusters have to be deposited on conducting substrates. Andrea Cornia and colleagues now report (*Angewandte Chemie International Edition* **42**, 1645–1648; 2003) a methodology that allows them to deposit manganese-type clusters on gold films (conducting surfaces), and to observe them directly at the molecular level using a scanning tunnelling microscope. This experimental *tour-de-force* clarifies some aspects of the magnetic behaviour of these single molecules, and opens exciting perspectives for the storage of magnetic information in individual clusters.

Masters of metrology

Mapping stress and strain in materials at the atomic scale is crucial, for example, in the semiconductor industry where crystal defects can have a strong influence on device operation. As they report in *Nature* (**423**, 270–273; 2003), researchers in France have now used a combination of high-resolution electron microscopy and image analysis inherited from optical interferometry to measure displacements in an atomic lattice to an accuracy of 0.01 Å, or 1 picometre, more than 100 times the resolution of the microscope used. The target for this experiment was a single edge dislocation seen end-on in silicon. The agreement between the displacement fields calculated from experiment and anisotropic elastic theory was better than 0.03 Å (experiment, left image; theory, right image). As devices and materials shrink to the nanometre scale, and materials scientists turn increasingly to atomistic modelling to predict their properties, the ability to measure strain so accurately will be invaluable.



Growth starts at the cap

There are many different ways of growing single-walled carbon nanotubes: laser ablation, chemical vapour deposition and arc discharge methods among them. Most of these techniques require a metal catalyst (such as Ni particles) to initiate nanotube growth. Although it has been established from electron microscopy studies that carbon nanotube growth is initiated on the catalyst particles, the details of the growth process are still rather sketchy. In particular, researchers have long puzzled over whether growth of carbon nanotubes takes place at the tip or at the root of the nanotube. Reporting in *Physical Review Letters* (**90**, 145501; 2003), X. Fan and colleagues present first-principles calculations showing that, in the presence of a metal surface, nucleation of a cap or a capped tube is overwhelmingly favoured over a graphene sheet, a fullerene or an open tube. The nucleation process begins with the formation of pentagonal carbon rings in clusters containing ten or more carbon atoms. This is because structures containing pentagons have fewer dangling bonds per atom, and can deform into a dome to saturate the dangling bonds at their edges. The lowest-energy carbon nucleus is therefore a cap, and as growth proceeds, a tube is formed.