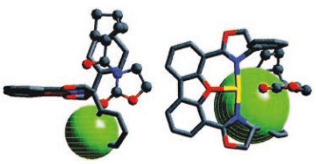
Magic silicon clusters

Magic clusters are particularly stable clusters containing a specific (or 'magic') number of atoms. Since the discovery of 'fullerite' — a bulk material formed from weakly interacting C_{60} magic clusters — scientists have been trying to identify other magic clusters that could be used as building blocks for new materials. Researchers at the University of Konstanz present experimental and theoretical results in *Applied Physics Letters* (**81**, 3810–3812; 2002) that suggest the existence of a new silicon material based on stable Si_4 clusters. Si_4 is one of several well-known magic silicon clusters, but many of these are much more reactive than C_{60}, and would fuse if assembled in the bulk. The Konstanz group investigated the interactions between neighbouring Si_4 clusters deposited on a graphite substrate, and found that the mobile clusters have a repulsive barrier that blocks spontaneous fusion of clusters at sufficiently low temperatures. These results indicate that the Si_4 clusters can survive as individuals when deposited on inert substrates, and thus have the potential to form a new, cluster-based silicon material.

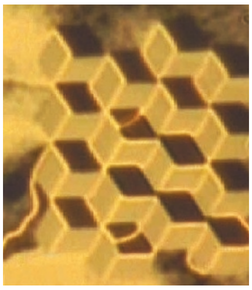
Designing chiral catalysts



What makes a good catalyst? For certain reactions, catalytic materials with chiral reaction centres are desirable, especially if highly pure products are required. But predicting the effectiveness of a chiral catalyst is more often based on luck than sound design principles. Kenny Lipkowitz and colleagues address this problem in a report in the *Journal of the American Chemical Society* (http://dx.doi.org/10.1021/ja0207192). They set out to test the validity of a simple hypothesis: that the performance of a chiral catalyst is linked to how closely the site of chemistry and the region of chirality (site of maximum stereodiscrimination) are located. They compute the area of maximum stereodiscrimination (green sphere in image) for 18 well-known Diels-Alder catalysts and find that, in 17 cases, the overlap between that region and the reaction site was a good predictor of catalyst performance. If this result holds true for other reactions, such knowledge could be used to design new and better catalysts.

Low power LCDs

Over the past decade, vast improvements have been made in the speed, size, resolution and quality of liquid-crystal displays (LCDs). Today, LCDs have progressed to a level of quality that easily rivals the best conventional cathode-ray-tube monitors, and are beginning to dominate the desktop display market. Despite these recent developments, both the power consumption and cost of LCDs remains high. One of the reasons for this is that the pixel elements on which these displays are based are monostable — in the absence of an applied electric field they can only exist in the 'on' state. There is great interest, therefore, in the development of multistable LCD devices that can remain stable without the need for a constant electric field. Jong-Hyun Kim and colleagues (*Nature* **420**, 159–162; 2002) report the construction of such a device — an LCD that can be switched between three stable states (see image). The authors hope that their approach to achieving multistable LCDs will lead to new developments in electro-optical applications. **For more discussion on this story see www.nature.com/materials**



Porphyrin nanoparticles

Materials at the nanoscale often have different properties to the bulk. Porphyrins are organic molecules based on 16-atom rings, and contain four nitrogen atoms that can bind metal ions. These macrocycles occur naturally in heme proteins (involved in oxygen transport in the body) and chlorophyll in plants, and they have useful photochemical, catalytic and molecular recognition properties. Porphyrins have been incorporated into functional materials by molecular engineering and can self-assemble into nanostructured arrays with interesting macroscopic properties. Charles Michael Drain and colleagues have now succeeded in synthesizing highly stable porphyrin nanoparticles with an average diameter of 54 nm, as they describe in the *Journal of the American Chemical Society* (http://dx.doi.org/10.1021/ja027405z). The nanoparticles were prepared by mixed solvent techniques that use a stabilizer to prevent agglomeration of the nanoparticles and to control their eventual size. Initial tests show that the porphyrin nanoparticles have much greater catalytic activity than free porphyrins in solution — probably as a result of increased surface area and the structure of the aggregate.

Rapid soft lithography

Microelectronic components are conventionally fashioned down to nanometre size using photolithography. Although this process is automated, and inexpensive enough to support an industry with an annual turnover of hundreds of billions of dollars, soft lithography offers a much cheaper and simpler alternative. One of the most technologically attractive of these approaches for printing nanoscale patterns, micromoulding in capillaries (MIMIC), uses microfluidic principles to ensure adequate contact between the mould and the substrate. The main drawback of this technique for large-scale applications is the speed of pattern formation, which is governed by the pressure difference driving the capillary motion of polymeric fluids used to fill the mould or channels. Dario Pisignagno and co-workers, writing in *Advanced Materials* (**21**, 1565–1567; 2002) have developed a simple microfluidic approach to improve the speed of patterning by a factor of 60 at 80 °C. This process is not governed by pressure differences but uses the temperature gradient (up to 80 °C) to reduce the viscosity of their polyurethane filling fluid. This simple and flexible approach to nanoscale printing is not limited by resolution or choice of inorganic substrate, making it suitable for industrial mass production.

BLOOD VESSELS GET IN SHAPE

Shape-memory polyurethane foam may soon find itself in the hands of cardiovascular surgeons. Annick Metcalfe and colleagues report results in *Biomaterials* (**24**, 491-497; 2003) from using this material in the treatment of aneurysm (an abnormal enlargement of a blood vessel wall that can be fatal if it ruptures). This, like other vascular diseases, is best treated by endovascular procedures — interventions carried out through the blood vessels rather than invasive surgery. Shape-memory polyurethane foams, when compressed to a small fraction of their original size, are practical, ultra-light devices that can be easily handled during endovascular treatment. Once implanted, body heat causes them to expand to their original size, so that they completely block the hole in the vessel wall. The unique physical properties of these foams, together with their biocompatibility and open porous structure, make them ideal for designing new surgical products.