Premelting at crystal defects

Researchers have used video microscopy to observe premelting — localized loss of order at temperatures below the bulk melting transition — at grain boundaries and dislocations in crystals (*Science* http://dx.doi.org/10.1126/science.1112399). Premelting at the surface is already well observed, and though it has also been proposed to occur at defects, it has not been previously monitored. The authors studied micrometre-sized microgel spheres — approximating to hard spheres, and whose diameters depend on temperature — close-packed into a three-dimensional structure. Increasing the temperature expands these spheres, reducing the close-packing and resulting in a melting transition. The motions of the spheres were imaged during the melting process, and the tracking of individual spheres enabled the study of positional fluctuations both near to and further away from the defects. These fluctuations were found to be greater nearer the defects than in the bulk, and were dependent on the nature of the interfaces involved. These results suggest that premelting around grain boundaries and dislocations is an important effect in the melting process, and that interfacial free energy is the crucial parameter for premelting.

SPHERES UNDER THE INFLUENCE

Assembly techniques can produce patterns that would otherwise be difficult to make, but self-assembly processes can lack flexibility in the designs that can be produced. An approach reported by Winkelman and colleagues (*Advanced Materials* 17, 1507–1511; 2005) takes advantage of electrostatic forces to provide highly flexible patterns of glass microspheres. Patterns ranging from highly ordered arrays to arbitrary designs can be made, and in contrast to other such assembly techniques, it doesn't need to be carried out in solution. In the method of Winkelman *et al.*, a polystyrene substrate is coated with layers of gold and chromium, which are then patterned with a self-assembled monolayer using microcontact printing. The areas of metal not protected by the monolayer are then etched to reveal windows of the substrate. When a high voltage is applied to the gold and the surface is flooded with glass microspheres, electrostatic forces ensure that one microsphere remains in each window, whilst tapping of the substrate minimizes defects. As this method doesn't rely on an assembly process between the microspheres, any pattern can be generated.

Robust carbon aerogels

Ordered mesoporous inorganic materials are widely used as catalysts, adsorbents and molecular sieves for large-scale processes in the chemical and petrochemical industries. Although most synthetic approaches for these ordered materials make use of surfactant supramolecular arrays as templates, more flexible routes such as nanocasting and hard templating are currently being considered for creating mesoporous materials with any desired composition. Ferdi Schüth and colleagues now report on the preparation of monolithic carbon aerogels by a sol–gel process using magnesium acetate as the catalyst for polycondensation, followed by ambient pressure drying and carbonization (*Chemistry of Materials* 17, 3620–3626; 2005). The nature of the metal cation and pH value of the catalyst used in the reaction affect the polycondensation mechanism, and judicious use of the two parameters leads to coarse structures exhibiting improved interconnected pores of different sizes, such as micropore–mesopore or micropore–macropore. The authors believe that these controllable hierarchical structures should prove technologically relevant and advantageous as hard templates for the production of unprecedented porous silica monoliths.

Shapely slipping

Liliane Leger and colleagues (*Physical Review Letters* 94, 244501; 2005) have used a near-field laser technique to throw new light on the behaviour of liquids sheared at solid walls. It has usually been assumed that there is no slip — that is, that the relative fluid/wall velocity is zero. But whether this behaviour applies at microscopic scales is still an open question. The few experimental studies that have been conducted so far indicate that the degree of wall slip strongly depends on both the wettability and roughness of the solid surface. The researchers measured the local velocity of two fluids at surfaces with similar roughnesses but with varying strengths of fluid–solid interactions (wettability). Surprisingly, they find that fluids slip even at a totally wetting surface. The shape of the fluid molecules was also found to be important. Linear cigar-shaped molecules slip much more than branched molecules such as those with methyl groups. The researchers propose that the layering of the fluid is responsible for the observed behaviour: branched molecules lead to larger friction between fluid layers, whereas slipping is much easier if the molecules are oriented parallel to the wall.

Nanocrystals shine as LEDs

Light-emitting diodes (LEDs) are becoming prevalent in our daily lives as devices become cheaper, more efficient and available in a variety of colours. However, a different material system is normally needed for each specific colour required, which leads to high production costs per device. Alexander Mueller and colleagues now demonstrate efficient multicolour light emission from LED structures using nanocrystal layers (*Nano Letters* **5**, 1039–1044; 2005). The CdSe/ZnS nanocrystals are sandwiched between layers of conventional GaN semiconductor material that provides the electrical contact. The emission wavelength of the devices is controllable through the size of the nanocrystals, allowing the fabrication of emitters at different wavelengths from the same materials. To maintain the structural quality of the nanocrystals during the growth of the devices, the authors developed a new low-temperature growth mechanism for the surrounding GaN layers. Whereas previous attempts to produce similar structures used organic contact layers, these first all-inorganic devices show much better efficiencies beyond 1%, promising a cheap alternative to conventional LEDs.