Smart surfaces

Angew. Chem. Int. Edn doi:10.1002/anie.200701796 (2007)

Some animals can rapidly switch on and off their ability to stick to a surface — take the gecko or the common fly, for example. Now, it's the turn of polyelectrolyte polymers to show such controllable adhesion and impart their chemical secrets behind how they do this. Mark Geoghegan and colleagues describe how reversible adhesion between a polyacid gel and a polybasic brush-like structure grafted on a silicon substrate can be controlled by changing the surrounding pH. In water and slightly acidic solution, electrostatic interactions bring the gel and brush together and the surfaces adhere. If the pH of the solution is lowered, the electrostatic interactions weaken, the adhesion fails and the surfaces can be pulled apart. As there is no damage to the gel or brush, the process is reversible and the surfaces adhere when the pH is increased. The researchers envisage that this kind of control of surface adhesion could be used in microfluidic components, actuators and drug-delivery agents that could release their load under certain physiological conditions.

MgB_2 on the rise?

Preprint available at <http://arxiv.org/abs/0707.3931> (2007)

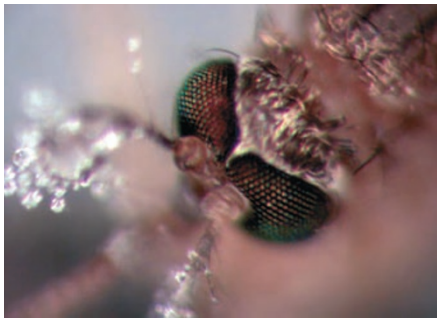
The discovery of superconductivity in magnesium diboride (MgB_2) a few years ago grabbed the attention of the solid-state community. With a transition temperature (T_c) close to 40 K, the material represented an anomaly with respect to standard superconductors that have T_c lower than 30 K, and other high-T_c superconductors, all belonging to the class of layered perovskites. But thoughts of a new class of high-T_c superconductors died out very soon, as efforts to raise T_c by incorporating dopants had limited success. However, A. Palnichenko and colleagues have now observed an increase in T_c after long thermal treatment of MgB_2 with rubidium, caesium and barium. The highest T_c (58 K) was observed in the caesium sample, as indicated by a drop in magnetic susceptibility at this temperature — a signature of the onset of the superconducting transition — while cooling the sample from room temperature. Will these observations bring new life to MgB_2? A few tests of reproducibility and stability are be needed, but there is room for hope.

Efficient reactors

Chem. Mater. doi:10.1021/cm071718h (2007)

Ordered mesoporous materials are being widely explored as supports for catalytic reactions such as oxidation, hydrogenation, desulphuration or enzymatic ones. For liquid–liquid biphasic reactions that contain both oil and water phases, phase-transfer catalysts immobilized onto a solid support are typically used, but usually have low activity. Dongyuan Zhao demonstrate that by instead using ordered mesoporous silica as a nanoscale reactor, a reaction involving the oxidation of benzyl alcohol to benzoic acid by hydrogen peroxide takes place efficiently in the absence of phase-transfer agents. The high activity of this reactionis attributed to the amphiphilic surface of the mesoporous silica that can accommodate both the hydrophilic hydrogen peroxide and the hydrophobic benzyl alcohol molecules. High conversion is observed with a low loading of the silica catalyst,making this green and economical approach attractive. The authors also believe that these porous materials could be adapted for other biphasic reactions by controlling the hydrophilic/hydrophobic characteristics of the mesopores.

Not misty eyed at all



Adv. Mater. doi:10.1002/adma.200601946 (2007)

Fogging of surfaces occurs when droplets larger than 190 nm — half the shortest visible wavelength — accumulate, scattering and reflecting light. Lotus leaves are well-known for their superhydrophobic properties, which are in part due to the arrangement of papillae on the surface of the leaves. However, although millimetre-scale water drops ball up and roll off the leaves' surface, smaller drops can accumulate in the spaces between the papillae, so fogging isn't prevented. In contrast, Xuefeng Gao and colleagues demonstrate that the compound eyes of mosquitoes are resistant to fogging. They find that the eyes consist of hexagonal close-packed microhemispheres, each covered in a pattern of non-close-packed nanoscale bumps; at only ~50 nm apart, the bumps are close enough together to prevent even mist droplets from resting on the surface. The researchers also create artificial mosquito eyes using soft lithography, with polymer mounds as the microhemispheres and silica nanospheres as the nanoscale bumps, although this artificial counterpart still needs some optimization to achieve the same antifogging qualities as nature's own.

Superconducting cement

J. Am. Chem. Soc. **129,** 7270-7271 (2007)

Many superconducting materials have been identified since Onnes' discovery of the effect in 1911. They include metals, metal alloys, ceramics and even semiconductors such as carbon and silicon. A common characteristic of these materials is their packed crystal structure. Now, Masahasi Miyakawa and colleagues demonstrate superconductivity in $12CaO{\cdot}7Al_2O_3$ — a compound also used for aluminous cements. Unusually, the crystal unit cell consists of 12 open cages with a diameter of about 0.4 nm. Normally, such metal oxides are insulating, as electrons cannot bridge across the cages. However, in previous work the group has shown that by chemical reduction treatment that replaces oxygen ions with surplus electrons within the cages, the electrons are able to bridge the voids and the compound can be made conductive. Importantly, the researchers have now found superconductivity at about 0.4 K. Although the value of the superconductive transition temperature is relatively low, the discovery by Miyakawa *et al.* suggests that a number of other exotic superconductors might be discovered in this exciting class of materials.