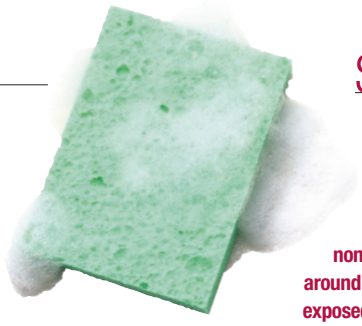
Green sponges



Removal of organic contaminants from water is a major environmental issue that stimulates wide interest among materials researchers. A paper in *Macromolecules* by Regen and colleagues (http://dx.doi.org/10.1021/ma020568n) reports a new approach to making hydrophobic sponges by immobilizing single-chain and double-chain ammonium surfactants on a cation exchange resin. These materials combine the absorptive properties of the surfactants with the practical advantages of an insoluble support — the resin. The authors studied the adsorption of an organic molecule, 4-chlorotetrathydropyran, and found that the affinity of the hydrophobic sponge can be finely tuned by varying the concentration and length of the surfactant molecules. For surfactants up to 12 carbon units in length, the absorptive capacity was proportional to the chain length.
More surprisingly, increasing the concentration of surfactant reduced the absorption of organic contaminant. This was interpreted as an enhancement of the hydrophobic interaction between tightly packed surfactant chains at the expense of the interaction between the chains and the organic molecule.

Security belt for enzymes

Amphipols are a new class of polymers that are able to maintain the native structure (solubility) of membrane proteins in a membrane-free environment. Amphipols generally have a linear structure with alternating polar and non-polar side chains. The non-polar side chains form a belt around the non-polar part of the protein, with the polar side chains exposed to the surrounding aqueous solution.
Amphiphols are also reported to support the activity of membrane proteins, but this always occurs in the presence of other detergents or lipids. Sanders and colleagues, writing in the *Journal of the American Chemical Society* (http://dx.doi.org/10.1021/ja027051b), study an amphipol with long (dodecyl) apolar side chains, and polar side chains that are completely zwitterionic — bearing charged groups of opposite polarity. Both these factors appear to be decisive in supporting the full catalytic activity of a membrane enzyme. Moreover, they show that this amphipol can sustain the enzyme's catalytic activity in the absence of any other lipids or detergents. The authors suggest that such amphipols could be used for novel pharmaceutical or biochemical applications.

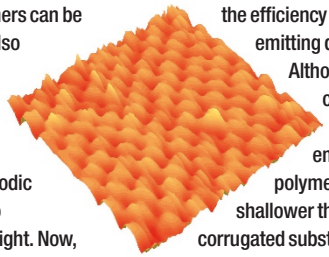
A DIAMOND PERFORMANCE

Diamonds are making a bid for electronic glory in the semiconductor world. Although diamond shares the same crystal structure as silicon — its neighbour in the periodic table — the scarcity and surprisingly poor crystalline quality of natural diamond has prevented its use in semiconductor technology. Diamond electronic devices are expected to perform well in certain niche applications, such as power diodes and high-frequency field-effect transistors, but until now synthetic diamonds suffered from too many impurities and defects. By using a chemical vapour deposition process, Isberg and colleagues (*Science* 297, 1670–1672; 2002) have grown a highly pure single-crystal diamond with unprecedented electronic properties that surpass all previous expectations. Moreover, the mobility of the charge carriers (electrons or holes) in the synthetic diamond and their long carrier lifetimes exceeds those of most industrial semiconductors. The performance of the new single-crystal material suggests that a hole-conducting (*p*-type) diamond device may be superior to existing electron-conducting (*n*-type) SiC and GaN semiconductors for high-frequency and high-power density devices.

Point and 'squeeze'

Optical tweezers — also known as laser tweezers — are useful for manipulating objects at micrometre and submicrometre scales. Most optical tweezers work by optically trapping small dielectric particles at the focus of an optical microscope's objective lens using laser light. Although this approach enables researchers to confine and manoeuvre particles in all three dimensions simultaneously, it only allows them to do so with one particle (or very few closely spaced particles) at a time. Veneranda Garcés-Chávez and colleagues (*Nature* **419**, 145–147; 2002) report a technique that forgoes such three-dimensional confinement, but in doing so allows many particles to be manipulated at once, over a range of several millimetres. The authors believe that their approach could open up new avenues for optical tweezers, extending their potential in the construction and operation of micromachines and microfluidic systems, as well as possible applications in colloid physics and bioengineering.
For more discussion on this story see www.nature.com/materials

A photonic stamp



Devices made from organic materials — such as conducting or light-emitting polymers — are a cheaper alternative to inorganic electronics. The ease with which polymers can be processed also makes them attractive for photonic applications that use periodic structures to manipulate light. Now, Ifor Samuel and colleagues (*Applied Physics Letters* **81**, 1955–1957; 2002) have shown that a simple 'hot embossing' process can be used to pattern a light-emitting polymer in a way that modifies its light emission (see image). The corrugated structure is created by pressing the polymer against a master pattern and heating. In previous work, the authors showed that depositing the polymer on top of a corrugated glass substrate could double the efficiency of a light-emitting diode. Although the corrugation of the embossed polymer is shallower than when a corrugated substrate is used, it is sufficient to modify the emission of light because the refractive index of air contrasts strongly with that of the polymer. With this simple technique, structural features with dimensions of 400 nm and smaller can be created in the polymer film.

Kinetics of polymer ordering

Block copolymer chemistry is deceptively easy: mix copolymers made from dissimilar monomers together and they tend to segregate into well-ordered patterns of spheres, cylinders or lamellae. Unfortunately, this self-assembly process only leads to ordering over small areas — microdomains — whereas applications typically require defect-free ordering over large areas. External electric fields, temperature gradients and patterned surfaces have been used to increase the size of the ordered domains. Electric fields seem to work particularly well when the block copolymers are in solution, and researchers in Germany (*Phys. Rev. Lett.* **13**, 133502; 2002) have investigated why. Using small-angle X-ray scattering experiments they show that two processes are involved in orienting microdomains exposed to an electric field. Migrations of grain boundaries occur at low polymer concentrations and high temperatures when the system is weakly segregated. But at high polymer concentrations and low temperatures, the microdomains order by rotation. The authors suggest that larger grains, which are more easily rotated by an electric field, form at low temperatures, whereas at high temperatures the growth of grain boundaries is thermodynamically more likely. At intermediate temperatures and concentrations both processes can occur.

Image: Justin Lawrence, Univ. St Andrews