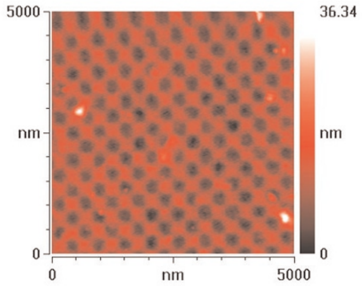
Nanocoatings for arteries

Polyelectrolyte multilayers continue to find new and useful applications. They are made from charged polymers using layer-by-layer electrostatic assembly, and can be used to coat many surfaces, thereby changing the properties of the surface in useful ways. As further demonstration of the versatility of this approach to materials engineering, Benjamin Thierry and colleagues describe in the *Journal of the American Chemical Society* (http://dx.doi.org/10.1021/ja034321x) the creation of biomedical coatings that may repair and possibly heal damaged arteries. They make very thin coatings through sequential deposition of two natural polysaccharides, chitosan and hyaluronan. Conveniently, these coatings adhere better to damaged rather than healthy tissue. When blood flows through the arteries, the presence of the coating reduces platelet adhesion and clot formation on the damaged tissue. This is important because it lowers the chances of restenosis (obstruction of the blood flow) — a major complication following vascular surgery procedures, particularly feared by the frail patients that endure these operations. The authors suggest that, by including biologically active compounds (they add L-arginine, for instance) in the formulation of these coatings, it will be possible to further improve the biomedical performance of these materials.

Quick-write lasers



A high-speed route to laser fabrication has been reported in *Applied Physics Letters* (82, 4023–4025; 2003) by Ifor Samuel and colleagues at the University of St. Andrews, UK. By using soft lithography, the team can make polymer lasers from simple organic materials in less than two minutes. Samuel has reportedly even done it as a quick lecture demonstration. The authors apply a process called solvent-assisted microcontact moulding, first developed by George Whitesides at Harvard University, in which they take a microstructured pattern, coat it with solvent, press it onto the conducting polymer, and the pattern is transferred. A distributed feedback laser made in this way emits light at a wavelength of 638 nm. Existing techniques for making organic photonic devices usually involve spin-coating polymers onto microstructured silica substrates. Although the spin-coating process itself is quick, the silica substrate has to be patterned by electron-beam lithography, and other complex techniques, which makes mass production more difficult. The approach developed by Samuel and colleagues allows them to directly pattern the polymer film using an elastomeric mould to produce an 'eggbox' structure with periodic features of 400 nm (see atomic force microscope image). Owing to the simplicity and speed of processing, the authors hope to make other organic photonic devices this way, including light-emitting diodes and photovoltaic cells.

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Isolated jewels

Naturally occurring hydrocarbon compounds that resemble diamonds in their chemical structure can be found in crude oil. These rare molecules, called diamondoids, are networks of carbon and hydrogen atoms that are superimposable on the diamond lattice. The smallest possible diamondoid, adamantane ($C_{10}H_{16}$), has a cage-like carbon structure capped by hydrogen atoms, but several other diamondoid families with increasing structural complexities and varieties of molecular geometries have also been observed. The stability and structural variety of these rigid diamond-like molecules make them attractive for catalytic and nanoscale electronic applications, but it has proved extremely difficult to synthesize anything larger than four adamantane cages. As they report in *Angewandte Chemie International Edition* (42, 2040–2044; 2003), Jeremy Dahl and colleagues have now isolated from oil deposits a new diamondoid molecule, cyclohexamantane ($C_{26}H_{30}$), which has up to 11 adamantane cages and is equivalent to a nanometre-sized diamond of 10^{-21} carat. It is still a mystery how these diamondoids form from the hydrocarbon chains in crude oil, but the authors suggest that the larger molecules could be made from smaller diamondoids by clay-catalysed reactions with methane gas. These materials are available only in trace quantities in nature, suggesting that geological timescales are required for their synthesis. Nonetheless, commercial supplies of adamantanes and its derivatives are now available at reasonable prices, some of which are already used in drug treatments for Parkinson's disease and viral infections.

COMPOSITE GAP

Photonic crystals — materials that selectively prevent the passage of light at certain wavelengths — can be made from a variety of materials, including colloids, semiconductors and metals. Two- and three-dimensional periodic structures exhibiting photonic bandgaps have so far been created. However, most of these structures have fairly small bandgaps, and a small number of defects can destroy the gap. N. Garcia and colleagues have predicted theoretically that structures consisting of a row of metal cylinders periodically embedded in a dielectric matrix would exhibit a large photonic bandgap. Reporting in *Applied Physics Letters* (82, 3147–3149; 2003), the researchers have now confirmed these results experimentally. For 100-nm Al_2O_3 pores with an average separation of 400 nm, and filled with 6-mm-long Cu wires, a large gap covering the whole visible spectrum (from 250 to 800 nm) was observed. On the basis of the previous theoretical results, the researchers predict that bandgaps can be created at any wavelength by appropriate choice of the pore diameter and separation. In addition, the results show that randomness does not necessarily destroy photonic bandgaps.

Routes to tougher gels

The mechanical properties of hydrogels are crucial to their applications in tissue engineering, thermostatting resins and the like. Mooney and colleagues, reporting in *Macromolecules* (http://dx.doi.org/10.1021/ma034137w), describe a way to control these properties by varying the type of crosslinking within the gel. They used alginates as the base hydrogels, and then synthesized both covalently and ionically crosslinked gels. They tested the response of the gels under stress, strain and shear deformation to see how the elastic modulus and toughness varied with the crosslinked nature. They found that the elastic modulus increased for both types of crosslinking, due simply to the density of crosslinks. However, the ionic crosslinks also increased the toughness of the gels, whereas the covalently crosslinked gels became brittle. The authors suggest that this difference is due to the ability of the ionically crosslinked gels to dissipate the energy of deformation by a partial and stepwise dissociation. The covalent links, however, underwent a catastrophic failure when the stress exceeded a critical value. The ionically crosslinked gels therefore had greater plasticity, making them tougher.