Which is the strongest?

Bulk diamond is widely considered to be the hardest and strongest known material. Recently, however, theoretical and experimental studies have suggested that measured on their long axis, carbon nanotubes are stronger and stiffer, although a fair comparison between materials properties at different length scales is always difficult to make. Donald Brenner and colleagues, reporting in *Nano Letters* (**3**, 805–809; 2003), now compare the mechanical properties of carbon nanotubes with the predicted properties of an equivalent diamond nanorod. Their computational approach shows that depending on the structural orientation, and above a critical radius of about 1–3 nanometres, the stiffness and the force needed for brittle fracture of a diamond nanorod is actually greater than that of a carbon nanotube. In addition, molecular modelling predicts that their energetic stability is equivalent to carbon nanotubes, thereby making the synthesis of diamond nanorod structures with desirable mechanical properties a highly attractive prospect.

Earthly and alien materials

Rocks and minerals, both from the Earth and outer space, present a challenging opportunity for geochemists, who aim to capture important hints about geological and cosmological events from structure and composition data. Improvements in analytical techniques, such as those reviewed by Lipschutz and colleagues in *Analytical Chemistry* (75, 2797–2811; 2003), are key to these discoveries. This article is not merely a survey of the recent developments in the chemical analysis of terrestrial and extraterrestrial materials, but also a practical guide to useful sources of information, such as tutorials on techniques and new Internet resources that will help young researchers entering the field. The primary analytical tool in this area continues to be the inductively coupled plasma mass spectrometer and all its permutations. The most interesting developments in this well established technique are now focused on procedures for preparing particularly difficult types of samples. Furthermore, the authors highlight the value of consortium studies, which draw on several analytical techniques, and greet the advent in this field of chemometric data analysis.

MIRROR DOMAINS

Magnetic multilayers exhibiting giant magnetoresistance are a key component of devices from magnetoresistive random access memories to spin valves. Writing in *Physical Review Letters*, John Bland and colleagues (90, 217201; 2003) have found that the indirect interlayer coupling that exists between 'hard' and 'soft' magnetic layers separated by a non-magnetic spacer layer, can induce a mirror effect between the magnetic domains in the two magnetic layers. The effect was observed in giant magnetoresistance (GMR) measurements of NiFe/Cu/Co structures with a relatively large (60 Å) Cu spacer thickness. The resistance of these trilayer structures is at a minimum when the magnetic domains in the hard Co and soft NiFe layers are magnetized in the same direction (parallel), and at a maximum when they have opposing magnetization directions (antiparallel). During magnetization reversal of the magnetically soft NiFe layer, the GMR value dropped to an absolute minimum. This sudden drop was found to be due to the formation of a unique configuration in which the many Co and NiFe domains in the magnetic layers have the same magnetization directions, so that the films perfectly mirror each other. Bland and colleagues believe that the mirror-domain effect results from long-range domain-wall pinning through the thick spacer layer.

Nanoparticles for gene therapy

Gene therapy is a controversial treatment — touted as potentially the only cure for many cancers and genetic diseases — with mixed results so far. The basic idea is simple enough: delivering healthy DNA to disease-affected cells. But there are many problems with the delivery process, subsequent expression of proteins and adverse immune reactions. In the August issue of *Nature Biotechnology*, Shun'ichi Kuroda and colleagues (http://dx.doi.org/10.1038/nbt843) report a solution to one of the delivery problems: controlling which cells are targeted for gene transfer. They show that hollow nanoparticles — formed from a protein expressed in yeast by the hepatitis B virus — can be used to deliver genes and drugs specifically and efficiently to human liver cells. The nanoparticles carry a natural 'ligand' on the surface that allows them to target liver cells, and the authors use electroporation to fill the hollow cavity (typically 80 nm in diameter) with DNA or drugs. More importantly, the authors can change the type of cells targeted by the nanoparticles by modifying the ligand on the protein surface. This sort of specificity is needed to prevent the delivery of the correct genes to the wrong cells, as has happened in the past with treatments that used viruses to insert DNA into patients. Research is underway to discover whether these synthetic delivery vehicles can avoid other known pitfalls, such as disruptive immune responses.

Nanoporous metals

Porous metals have an important role in, for example, sensors, microfluidics and catalysis. To date, only metals with single pore sizes have been possible, whereas for microfluidics in particular, having more than one pore size would improve response time and sensitivity. In *The Journal of the American Chemical Society* (**125**, 7772–7773; 2003), Ding and Erlebacher describe the preparation of gold having pores of two different sizes using a process involving the removal of silver from a gold/silver alloy. Silver is first selectively dissolved (dealloyed) by immersion in nitric acid, resulting in a porous network of pure gold, with pore widths of 5 nm to several micrometres, depending on the starting composition. This porous gold is annealed, thus increasing the size of the preformed pores, which are then filled with silver. A second annealing partially melts the internal gold/silver interface, forming a new composition there. A further dealloying step dissolves away the silver filling the main pores, and etches into the gold/silver interface, to produce a membrane

with large pores and nanoporous channel walls. The authors suggest that repeating the process could create even greater pore size variety. It should also be possible with other alloys that show porosity on dealloying.