Edge smoothing

Science doi:10.1126/science.1150878 (2007)
Graphene might exhibit exceptional transport properties, but using it for devices presents several challenges, the main one being the difficulty of controlling the electrical conductivity. In principle, one of the ways to overcome this is to cut narrow strips — known as nanoribbons — of this two-dimensional carbon lattice, as the lateral confinement will induce a semiconductor gap. Graphene nanoribbons have so far been obtained by lithographic processing of graphene flakes, but the technique produces very rough edges that hamper the electrical quality. Xiaolin Li and co-authors have now obtained impressive results following a chemical route. The single-layer graphene flakes were produced by thermal exfoliation of commercial graphite. In the process, narrow ribbons (less than 10 nm wide) with smooth edges were also produced. All the ribbons characterized were semiconductors. Considering the high-quality transport properties of graphene, the conductivity of the ribbons is not as good as it could be, but there is room for improvement, and the results may indeed represent one of the most important breakthroughs for the application of this carbon sheet.

Stimuli-free release

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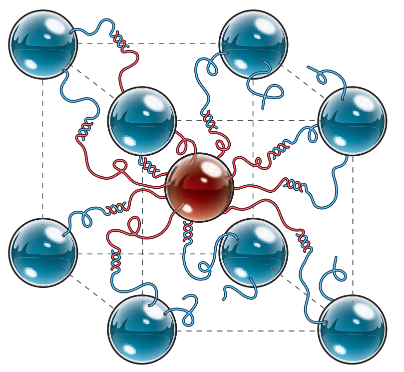
Materials that provide controlled release of their contents are of great importance in applications such as drug delivery. Normally such a material is designed so that a stimulus is needed to provoke the release of its hoard, but Jong-Song Yu and colleagues describe a material that exhibits automodulated controlled-release without the need for a stimulus. The researchers fabricated hollow silica capsules having a 35-nm-thick mesoporous wall, and with 20- or 50-nm silica nanoparticles coating the surface. They formed a thin film using layer-by-layer assembly of the coated capsules and poly(diallyldimethylammonium chloride). Quartz-crystal-microbalance measurements showed that the film released encapsulated water in a stepwise manner — this was reproducible, and was observed for repeated use of the film. A therapeutically important UV absorber and a fragrance exhibited similar release behaviour. The researchers propose that the stepwise release is due to the entrapped moieties evaporating first through the capsule wall, and then through the thin film out to the air phase. Modification of the particle dimensions and wall thickness could offer different speeds of automodulated release.

Designer DNA



Nature **451**, 549–552; 553–556 (2008)
Assemblies of nanoparticles linked together by the binding 'glue' of DNA have been known for more than a decade, but highly ordered assemblies on a macroscopic scale have proved elusive. Now, Dmytro Nykypanchuk *et al.* and Sung Yong Park *et al.* use DNA links to make three-dimensional, well-ordered arrays of gold nanoparticles. This encoded interaction stems from the attachment of complementary DNA strands to the particles — that is, the end sections of the strands linked to the gold nanoparticles depicted as 'red' and 'blue' (see figure) are complementary. When these functionalized particles are at a high enough temperature in solution for the double helices to associate and disassociate in a dynamic fashion, they self-assemble into a regular arrangement, similar to that of the body-centred-cubic CsCl lattice. Park *et al.* show that different DNA sequences can form different crystalline structures — for example, a face-centred-cubic structure can also be made. This use of DNA in the programmable design of assemblies could be applied to monodisperse nanoparticles of various compositions.

Down to the wire

Adv. Mater. doi: 10.1002/adma.200701249 (2008)
D. C. Zou and colleagues report solar cells that can be easily used in a variety of configurations, including ones that require pliability. Their wire-shaped flexible dye-sensitized solar cells consist of a stainless steel fibre working electrode coated with dye-sensitized porous titania and a platinum counter electrode, twisted together to make a helical structure and dipped in electrolyte. The helical structure means the working electrode is accessible to light from any direction so the electrodes do not need to be transparent, greatly extending the variety of materials that can be used. This also makes possible the advantageous use of metal electrodes — they are more conductive than oxide ones, facilitating the extraction of charges to the outer circuit. The completed cells are fine wires with good flexibility, suggesting they could be woven together to make shapes or cloth-type materials. However, the authors haven't yet reported the cells' efficiency, and the liquid electrolyte is only held in place by capillary action, which will need to be addressed before the cells become viable for applications.

Atomic resolution

Nano. Lett. doi: 10.1021/nl073149i (2008)
Understanding the properties of nanoscale materials requires accurate information on the 3D structure and composition at the atomic scale. And although bright-field transmission electron microscopy (TEM) can offer a resolution of 2 Å, the images are 2D projections of the structures. The application of aberration-corrected TEM has shown single-atom sensitivity, but the resolution of tomographic approaches for 3D reconstruction is limited to a volume of 1 nm^3. Knut Urban and colleagues demonstrate that negative spherical aberration imaging at low acceleration voltages can be used for tomography down to the atomic scale with reduced radiation damage. Their approach, based on phase-contrast imaging, enables 3D reconstruction of nested molybdenum disulphide nanoscale octahedra, and provides structural information on defects at the 2–3 Å scale. The authors suggest that their method is applicable to the atomic characterization of a wide range of nanostructures where strong electron channelling is absent, such as inorganic fullerenes.