Infiltration rules

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Template synthesis is one of the simplest and most easily scalable methods for making one-dimensional polymer nanostructures. These structures, however, are highly dependent on the synthesis parameters, which can be an advantage when looking for variety, but not if exact structures are required. Martin and Mijangos have investigated the range of polymer nanostructures available via template synthesis and produced guidelines for achieving different results. The authors used the widely studied porous anodic aluminium oxide templates. They found that the structures obtained depended on infiltration method — wetting-based, vacuum or spin — and the diameter of the template: narrower pores resulted in nanofibres rather than nanotubes being created. Composite tubes containing magnetic nanoparticles were created by melting a bulk polystyrene/iron–platinum composite on the surface of the template. The small size of the particles (3–4 nm) compared with the thickness of the nanotube walls (70 nm) enabled the particles to infiltrate the template with polymer. The rules should prove valuable in simplifying the creation of arrays of polymer nanostructures of various aspect ratios.

From graphene to graphane

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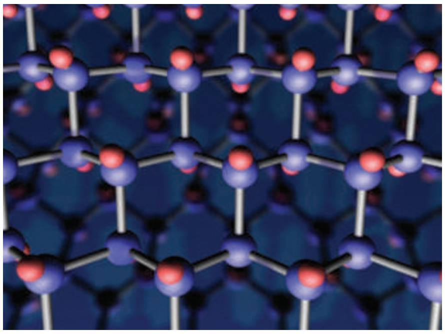
Among the various routes for controlling the electronic properties of graphene, chemical modification seems to be the least investigated. Kostya Novoselov and colleagues have now demonstrated that hydrogenation enables the electronic structure of this single layer graphite to be modified, transforming it into an insulator. The secret is that on attaching hydrogen atoms to graphene, the carbon bond is transformed in such a



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way that conducting electrons are removed and an energy gap is opened. The pristine material investigated shows a resistivity independent of temperature, which is typical of graphene. After exposure to hydrogen plasma, however, the resistivity increases considerably and shows a temperature dependence typical of insulators. Most importantly, the modification can be perfectly reversed by annealing the hydrogenated sample. Transmission electron microscopy images indicate that the structure of the hydrogenated samples is comparable to that of graphene, a material that had previously only been studied theoretically. Aside from the clear potential for electronic applications, the result demonstrates the possibility of creating a range of two-dimensional molecules by chemical modification of graphene.

Vertical nanocavities

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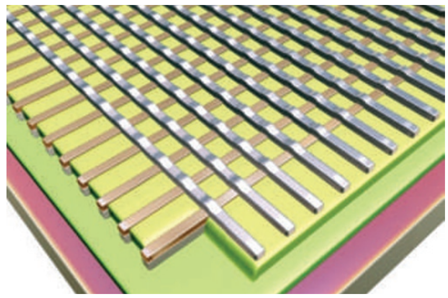
Single-crystalline ZnO nanowires behave as lasing nanocavities — affording a gain medium and a resonant cavity owing to the reflectivity of the planar end-facets. Usually the wires are produced in closely packed arrays, so characterizing the optical properties of a single wire requires the transfer of one wire from its initial growth substrate onto another substrate. This process can damage the wire, altering its properties. Furthermore, the wire is normally placed horizontally onto the new substrate and the interaction between the two interferes with the lasing capabilities. By placing a low density of gold catalytic seeds on the growth substrate, Peidong Yang and colleagues produced vertical ZnO nanowires far enough apart to allow the characterization of individual wires still attached to their native substrate. Not only were they able to uncover lasing properties such as the Fabry–Pérot lasing modes, they also produced the first height-selective 3D maps of the photoluminescence emission of nanowires by using UV-laser scanning confocal microscopy. Such detailed characterization of heterogeneous nanostructure optical properties should aid research aimed at using them in optoelectronic and solar applications.

Crossbar memories

Nano Lett. doi:10.1021/nl8037689 (2009)



With the end of Moore's law looming in the not-too-distant future, researchers are intensively researching alternatives to silicon electronics. One of the more promising approaches is to use self-assembled nanostructures to complement existing top-down technology. In particular, crossbar arrays promise very high integration densities that can easily exceed those achieved with the present technology. Researchers from the University of Michigan have now realized a non-volatile crossbar memory array capable of storing up to 1 kbit of information. The array is based on silver nanowires crossing sandwiched amorphous/p-type silicon nanowires. At their intersections, Ag/a-Si/p-Si structures form. The amorphous silicon acts as a memristive switch, so that a voltage applied between Ag nanowire and p-Si layer is able to switch the material between a high and low resistance state. This crossbar array has write speeds faster than 10 ns, good endurance and long retention rates. With a yield of 92% and the possibility of scaling the size of a single element below 30 nm, the devices establish the potential of these arrays for non-volatile memory applications.

Transparent paper

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As well as being optically transparent, glass has a low thermal expansion coefficient making it suitable for use in electronic devices. Conversely, it is fragile; therefore a stronger, flexible material that retains the thermal expansion coefficient of glass is desirable. Now Masaya Nogi and colleagues have produced a material satisfying these requirements from the main constituent of paper — cellulose. A suspension of wood nanofibres is filtered, producing a wet sheet of uniformly positioned fibres. Slowly drying this while it is compressed between meshwire/filter paper layers gives a highly dense sheet of nanofibres bound by hydrogen bonds with few or no cavities. The lack of interstices between fibres suppresses light scattering, and once the surface has been smoothed by polishing, the sheet becomes up to 71% transparent at a wavelength of 600 nm. The 'cellulose nanofibre paper' can be folded and has good mechanical properties. Alternative ways of smoothing the surface can prevent cellulose deterioration, making it a prime candidate for roll-to-roll processing for the production of flexible electronic devices such as solar cells.