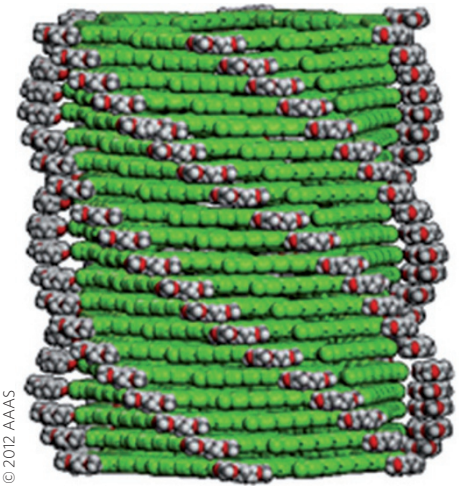
SUPRAMOLECULAR CHEMISTRY

Breathing nanotubules

Science **337,** 1521–1526 (2012)



Tubular structures are ubiquitous in nature and recently, analogous synthetic structures have been synthesized using supramolecular chemistry. However, developing synthetic nanoscale tubules with stimuli-responsive capabilities remains a significant challenge because such structures are typically either too strong to be responsive or too flimsy to remain intact as environmental conditions change. Myongsoo Lee and colleagues at Seoul National University, Nagoya University and Harbin Institute of Technology have now created a supramolecular nanotubule that can reversibly change its diameter in response to changes in temperature.

The researchers start with a molecule with a pyridine centre that has two hydrophobic *p*-phenylene chains arranged in a 120°-bent structure on one side of it, and an alkyl ether dendron on the other. In aqueous solution, the molecule can self-assemble into a hexameric ring and then into a stacked architecture with a hollow interior. The tubule shrinks on heating to 60 °C and swells again on cooling, creating a breathing motion.

Two features make this system functional. First, the *p*-phenylene units in the hexameric ring can slide along one another allowing the entire structure to tolerate changes in diameter. Second, the large diameter of the tubules can be stabilized because the pyridine centre nucleates water molecules through hydrogen bonding in the interior of the tubule. On heating, the water cluster is disrupted and the water molecules are squeezed out of the tubule. Subsequently, the aromatic rings slide on top of each other to maximize hydrophobic interactions and shrink the tubule by as much as 47%. *AM*

BIOCOMPOSITES

Silica replicas of cells

Proc. Natl Acad. Sci. USA **109,** 17336–17341 (2012)

The cell wall of silica-condensing microorganisms such as diatoms has a complex three-dimensional architecture that spans the nanometre- and millimetre-length scales. These structures and the biomineralization process of diatoms have inspired the creation of various functional inorganic nanomaterials. Previously, it was shown that highly concentrated protein hydrogels with a crowded three-dimensional molecular environment and user-defined features can be used as templates for creating porous silica replicas of the hydrogels. Now, Bryan Kaehr and colleagues at Sandia National Laboratories and the University of New Mexico have shown that crowded molecular environments such as mammalian cells can also direct the condensation of silica to form replicas of the cells.

Kaehr and co-workers grew cells on glass substrates and fixed them with formaldehyde before immersing them overnight in silicic acid at pH 3 at approximately 40 °C. Following this, the cells were dried and calcinated at 550 °C. Scanning electron microscopy showed this process coated the interior and exterior of the cell with silica, and that many of the details of the cells were faithfully captured. Moreover, the silicification process made the cellular architectures mechanically stable during drying and calcination. Further experiments revealed that although the lipid components of the cell membrane are gradually displaced during silica deposition, the cell membrane needed to be intact initially to maintain the mechanical integrity of the silica–cell composite. Even though the silica infiltrated all subcellular structures and organelles, the DNA helical structure remained undamaged in the nucleus.

The researchers also explored the transformation of the silica–cell composite into porous carbon structures, which could be useful in fuel-cell, decontamination and sensor applications. *ALC*

NANOPARTICLES

Now you don't

Phys. Rev. Lett. **109,** 126806 (2012)

Nanoparticles scatter light that has a wavelength of the same order of magnitude as their diameter. In semiconductors, conduction electrons have a typical wavelength of 0.1 to 10 nm and therefore most nanoparticles will scatter them. Gang Chen and colleagues at MIT have now proposed a way to prevent this from happening and describe scenarios in which nanoparticles can be used to control the propagation of conduction electrons and thus act as filters or switches.

To make nanoparticles invisible to conducting electrons — a phenomenon known as electron cloaking — all that is needed is core–shell nanoparticles. The potential well and barrier associated with the shell and core of the nanoparticle can be made to minimize the scattering amplitude of the first two partial waves (those with an angular momentum of zero and one), which contribute the most to the total scattering cross-section. Under the right conditions, electrons within just a few tens of electronvolts of energy difference will 'see' only 0.01% of the nanoparticle in front of them. By tuning variables such as the mass of the nanoparticle's core and shell, and potential heights, it is possible to control the cloaking capabilities of the system. *AM*

SILICENE

Long and thick ribbons

Nano Lett. http://doi.org/jj8 (2012)

Like graphene, silicene is a single layer of a material with a honeycomb lattice. Unlike graphene, however, it cannot be obtained by mechanical exfoliation of a three-dimensional stack. The material was first predicted theoretically and then synthesized in the form of sheets and long ribbon structures by evaporating silicon onto silver films. Paola de Padova and colleagues in Italy, Japan and France have now created perfectly aligned multilayer silicene nanoribbons that exhibit properties that may be useful in electronic applications.

The researchers first evaporated silicon onto a Ag(110) surface and then used scanning tunnelling microscopy to reveal high-aspect-ratio zigzag ribbons, perfectly aligned on the surface and separated by areas of single-layer silicon. The ribbons have a triangular cross-section, meaning that rather than lying flat on the substrate they are slightly separated from it. Angle-resolved photo-emission spectroscopy data showed Dirac cones originating from the valence and conduction bands and an electron Fermi velocity comparable to that of free-standing graphene. The Dirac cones are separated by a small gap. Such a gap is also observed in the single layers, but is smaller in the multilayer case, reflecting a weaker effect of the lattice mismatch with the silver substrate. *FP*

Written by Ai Lin Chun, Alberto Moscatelli and Fabio Pulizzi.