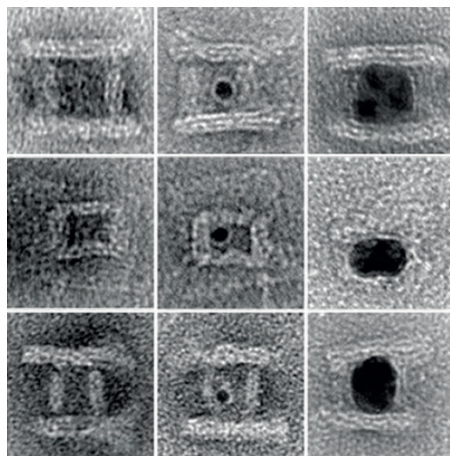


## NANOCASTING

### In all shapes and sizes

Science <http://doi.org/wf2> (2014)



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Shape-controlled inorganic nanostructures have many applications, ranging from biosensing to nanoelectronics. There are a number of ways to synthesize these nanostructures, but creating an arbitrarily prescribed three-dimensional shape remains a significant challenge. Peng Yin, Mark Bathe and colleagues have now shown that DNA nanostructures can be used as moulds to create a variety of three-dimensional inorganic nanostructures with tunable shapes and sizes.

The researchers — who are based at Harvard University, Harvard Medical School and Massachusetts Institute of Technology — used computer software to design a DNA mould with appropriate mechanical stiffness. The mould consists of four walls composed of two or three layers of parallel DNA helices, a cuboid cavity that holds a small metal 'seed' attached by single-stranded DNA handles, and two lids made of three layers of DNA. Under certain experimental conditions,

the metal seed, which is made of either gold or silver, grows and fills the entire cavity, thereby replicating the three-dimensional shape of the mould. Transmission electron microscopy images show that the mould continued to surround the metal nanoparticle after its growth. In moulds without one lid, nanoparticles grew out of the cavity, confirming that the moulds served to confine the nanoparticles. The nanoparticles displayed plasmonic properties, suggesting their potential use in biosensing.

The shapes and sizes of the nanoparticle could be controlled by changing the shape of the mould or the size of the cavity, respectively. When different moulds were combined, composite structures could also be made. *ALC*

## GRAPHENE

### Better on MoS<sub>2</sub>

Phys. Rev. Lett. **113**, 156804 (2014)

The electronic properties of pristine graphene, such as its high charge-carrier mobility, are what make it a promising material for the next generation of information-processing devices. However, interactions with the substrate on which graphene sheets are grown, or transferred to, usually have detrimental effects on the electronic properties, by, for example, reducing the carrier mobility or mean free path. So far, hexagonal boron nitride has been considered the most suitable insulating substrate for preserving the intrinsic properties of graphene in devices. On the other hand, the small mismatch in the lattice constants of the two materials gives rise to a moiré potential, which influences the charge carriers in graphene. Chih-Pin Lu and colleagues at Rutgers University, National Taiwan University and the National Institute for Materials Science in Tsukuba now report that MoS<sub>2</sub> could in fact be a better choice of substrate.

MoS<sub>2</sub> is atomically flat, has a large lattice mismatch with graphene and is a semiconductor. The researchers studied the properties of graphene on exfoliated sheets of MoS<sub>2</sub> by scanning tunnelling and Landau-level spectroscopy, and found that the MoS<sub>2</sub> substrate allows the intrinsic electronic properties of graphene to be retained, without inducing modifications in its band structure. The researchers also showed that the screening of charges in the graphene layer could be tuned by changing the Fermi level of the MoS<sub>2</sub> via voltage gating, resulting in longer mean free paths. *ED*

## MAJORANA FERMIONS

### Now in atomic chains

Science <http://doi.org/wdr> (2014)

In the 1930s, the theoretical physicist Ettore Majorana predicted the existence of a special type of fermion that is its own antiparticle. These Majorana fermions have never been observed experimentally, but in recent years the existence of Majorana bound states has attracted considerable research interest. Majorana bound states are analogous to Majorana fermions but can be found in topological superconductors, which are formed when a strong ferromagnet is placed in contact with a standard superconductor. Interest in these states is fuelled both by fundamental reasons and by the potential use of Majorana states in quantum information.

Ali Yazdani and colleagues at Princeton University and the University of Texas at Austin have now observed signatures of Majorana states in chains of Fe atoms on a superconducting Pb surface. With the help of scanning tunnelling microscopy and spectroscopy, they found that the Fe atomic chains are ferromagnetic and become superconducting below 1.4 K, just like Pb. Furthermore, they observed a peak in the tunnelling current when no bias was applied — known as a zero-bias peak — when the tip of the scanning tunnelling microscope was placed on top of either edge of the chain. This is a clear sign of the existence of Majorana states, which are supposed to emerge in pairs, at the ends of a topological superconducting wire. Zero-bias peaks have previously been observed in semiconducting wires adjacent to superconductors, but there was no confirmation that the peaks were located at the ends of the wires.

The next step will be to study the interaction among three or more Majorana states, which is a fundamental ingredient for quantum information based on these exotic states. *FP*

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

## BLOCK COPOLYMERS

### Nanostructured by immersion

ACS Nano <http://doi.org/wf3> (2014)

Block copolymers that have the tendency to self-assemble into nanostructures with a spatial resolution of less than 10 nm are of potential value in the semiconductor industry. To induce self-assembly, thin films of these block copolymers need to be exposed to solvent vapours that promote their swelling and formation into nanostructures. However, this step is incompatible with the established fabrication procedures of the semiconductor industry and researchers are working to find a more viable approach. Yeon Sik Jung and co-workers now report a protocol to create controlled morphologies of block copolymers in the sub-20-nm regime without the need to expose the polymers to vapours.

The researchers — who are based at KAIST and the R&D Center for Hybrid Interface Materials in Korea — simply immerse a block copolymer film into a mixture of two liquids, one of which promotes swelling and nanostructuring. By changing the relative proportions of the two solvents, the temperature and the exposure time, the researchers can controllably induce the formation of spheres, cylinders or lamellae. Furthermore, on immersing in a third solvent, the team could form unusual core-shell nanostructures by direct self-assembly. *AM*