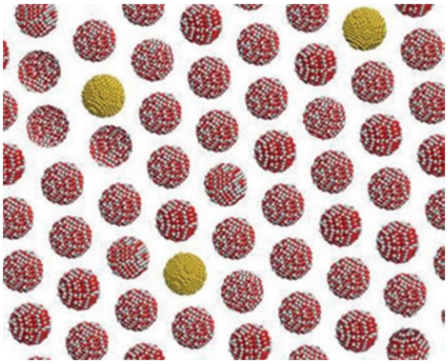
NANOCRYSTAL SUPERLATTICES

Ad hoc replacement

Nature **524,** 450–453 (2015)



NATURE PUBLISHING GROUP

Substitutional doping is a widely used procedure in semiconductor technology and consists of randomly replacing atoms in a crystal with a small portion of different atoms. The doping atoms can be easily ionized and provide extra charges to the semiconductor, enhancing electrical conductivity. Christopher Murray and colleagues at the University of Pennsylvania, Stanford University and the National Institute of Standards and Technology have now shown that a similar process can be applied to materials known as nanocrystal superlattices.

In a semiconductor nanocrystal, the electronic energy levels resemble those of an atom; by assembling nanocrystals of different sizes and compositions in superlattices, it is possible, in principle, to build artificial materials with a desired set of properties. The researchers found that by mixing gold nanoparticles with nanocrystals of either CdSe or PbSe during the assembly of a superlattice, the gold nanoparticles could be integrated in the superlattice, replacing randomly distributed semiconductor nanocrystals. Increasing the portion of gold nanoparticles enhances the electrical conductivity. However, rather than providing extra carriers by ionization, as is the case for standard semiconductor crystals, the gold nanoparticles form some percolative conduction paths, with the net effect of allowing faster charge transport. This allows the electrical conduction to be varied over six orders of magnitude. *FP*

NANOTUBES

One wall at a time

Angew. Chem. Int. Ed. **54,** 11168–11172 (2015)

The bottom-up synthesis of tubular nanostructures with specific composition, morphology and chirality is still an open challenge in nanoscience. Takuzo Aida, Takanori Fukushima, Wusong Jin and colleagues now describe a synthetic protocol for controlling the number of walls of a class of supramolecular nanotubes.

The researchers — who are based at RIKEN, the Tokyo Institute of Technology, and Donghua University — start from a hexabenzocoronene molecule to which they attach two alkyl chains on one side and two perfluorinated chains on the other side. In methylene chloride and at low concentration, the molecule self-assembles into single-walled tubular nanostructures. Through spectroscopic analysis, the team discerned that the nanotube walls adopt a bilayer morphology: the coronene units are stacked to form aggregates in the core and held together by the alkyl chains; the perfluorinated chains extend radially towards the bulk solvent and the inner part of the tube.

When the concentration of the molecule was increased, Aida and colleagues observed the formation of double- and multiwalled nanotubes in a stepwise fashion. Remarkably, the transformation to a higher number of walls goes through an intermediate morphology in which a coiled supramolecular structure self-assembles around the parent nanotube. The researchers also suggest that the ability to build nanotubes one wall at a time could be exploited to functionalize each wall selectively for more complex functional nanostructures. *AM*

SINGLE MOLECULES

Piezoresistivity in DNA

Nature Commun. **6,** 8032 (2015)

DNA is a natural polymer that has emerged as a versatile material for the construction of intricate nanostructures. The conductance of the molecule has also long been a topic of fascination, but a series of contradictory results has stifled many thoughts of developing DNA-based nanoelectronics. Nongjian Tao and colleagues at Arizona State University and Northwestern University have now shown that single molecules of DNA can exhibit piezoresistivity, a result that provides additional insight into the issue of charge transport in DNA.

Piezoresistivity is a change in the electrical resistivity of a material due to mechanical force and has been observed before in single (non-DNA) molecules that were positioned between two electrodes. In such cases, the effect is typically due to the coupling between molecule and electrode. The researchers examined the molecular conductance and piezoresistivity of single double-stranded DNA molecules that had different sequences and lengths by positioning the molecules between a gold surface and the tip of a scanning tunnelling microscope. With the help of calculations, they were able to determine that the observed piezoresistivity is an intrinsic property of the molecule and is due to force-induced changes in the π–π coupling between neighbouring bases and changes in the activation energy of hole hopping.

Tao and colleagues also suggest that the observed effect indicates that DNA nanostructures could be of value in the development of microelectromechanical systems (MEMS) applications. *OV*

START-UPS

How to be an entrepreneur scientist

Lab Chip **15,** 3638–3660 (2015)

High-tech industries — such as nanotechnology, biotechnology and robotics — are driving global knowledge-based economies, and universities around the world are increasingly focused on building an entrepreneurial culture, optimizing licensing strategies, forming academia–industry partnerships and supporting spin-offs. For the scientist entrepreneur interested in bringing their idea from the lab to the market, Ali Yetisen and colleagues now outline the various steps and strategies for navigating this minefield.

The first step in commercialization, according to the researchers — who are from Massachusetts Institute of Technology, Harvard Medical School, University of Birmingham, California Institute of Technology and King Abdulaziz University — is to create a competitive advantage by intellectual property protection. Following this, entrepreneurs must formulate a commercialization strategy that outlines the commitment and time horizon for the business, and develop financing, marketing and exit strategies. In the United States and the European Union, various funding sources exist for different growth stages of a start-up, but in the early stages entrepreneurs are advised to estimate the various costs in detail and conserve money. Because the number one reason for start-up failure is the lack of a market for the product, it is critical to understand the customer base and their perceptions of the benefits of the new technology compared to costs. For a successful exit, the start-up should have a clear vision, a strong leadership team, and the ability to adapt to a backup plan to overcome unexpected challenges. *ALC*

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