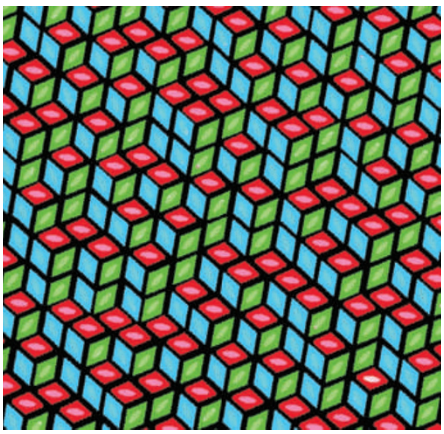
Andrew Smith and Shuming Nie combined the nanocrystal precursor metal ion solutions with a solvent and an amphiphilic multidentate polymer — a polymer with multiple binding points, consisting of an oily chain with a charged group on one end — at elevated temperatures. The metal ion precursors bind to the charged part of the polymer and grow into a nanocrystal with an oily coating. The arrangement of the polymer, with the oily part facing outside, allows the nanocrystals to be soluble in any nonpolar solvent. When the nanocrystals are exposed to a polar solvent, any excess polymer in the reaction solution encapsulates the nanocrystals, thus making them soluble. The nanocrystals prepared in this way retain their characteristic optical properties when dissolved in any of the polar and nonpolar solvents.

The universal solubility of these nanocrystals is expected to have applications in biology, catalysis and devices.

MOLECULAR NETWORKS

Random rhombuses

Science **322,** 1077–1081 (2008)



Molecules routinely self-assemble into close-packed arrays and periodic structures. The scientific and device-specific relevance of such ordered networks is clear. However, networks with weaker order are important to systems such as quasi-crystals, glasses and antiferromagnetics.

Now, Neil Champness, Peter Beton and colleagues at the University of Nottingham have succeeded in creating a near-ideal, random tiling of a graphite surface with the organic molecule TPTC (a molecule with an aromatic backbone and four carboxylic acid groups). Two TPTC molecules can bond to each other in two different configurations: parallel, and 'arrowhead', which introduces randomness into the resulting network. Furthermore, the geometry of TPTC bonding is unique: if each molecule in the network is inscribed into a rhombus, the intermolecular bonds fall on the rhombus edges. This mathematical correspondence causes the TPTC network to have hexagonal orientational order (all voids fall on a hexagonal lattice), without translational symmetry (translation will not necessarily give the same atomic arrangement).

The structure of the network also allows the Nottingham team to do some interesting things. They observe a triangular void defect moving through the molecular network, and are able to determine the energetics of the two bonding configurations from the network's spatial correlations. They also suggest that such systems may be useful analogues for other materials, such as glasses.

Having achieved high degrees of order, scientists are thus pursuing a new frontier in self-assembly: the re-introduction of disorder.

TITANATE NANOTUBES

Chemical-killing clothes

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doi:10.1002/anie.200802932 (2008)

Nanotubes made of titanate have been proposed for applications such as solar cells and gas sensors, due to their excellent abilities to absorb light and adsorb gases. Now they could provide a new line of defence against chemical weapons. Valérie Keller at Louis Pasteur University in Strasbourg and co-workers have shown that sheets containing titanate nanotubes can greatly speed up the degradation of common chemical warfare agents by sunlight.

The researchers prepared sheets containing networks of titanate nanotubes encapsulated in tungsten oxide crystal. They sprayed the sheets with dimethylmethylphosphonate (DMMP), one of the components of sarin nerve gas, and diethylsulphide (DES), which represents the main blistering agent in mustard gas. The sheets were then exposed to visible solar light.

The titanate/tungsten oxide sheets acted as efficient photocatalysts, helping the light to break up the toxins. Almost all the DMMP degraded in around 5 minutes and DES levels were greatly reduced in a few hours.

Keller and co-workers propose weaving their new titanate nanotube materials into clothes. These clothes could provide immediate protection on the battlefield, unlike current decontamination measures (such as incineration or neutralization with chemicals), which tend to be applied 'after the event'.

The definitive versions of these Research Highlights first appeared on the *Nature Nanotechnology* website, along with other articles that will not appear in print. If citing these articles, please refer to the web version.

Top down
Bottom up

Classified research

Researchers from the US military have teamed up with academics from Europe to propose a new method of classification for nanomaterial risk.

How do you bring a geochemist, an ecotoxicologist, two decision-scientists and two risk-assessors together to develop a system for classifying nanomaterial risk? Igor Linkov of the United States Army Research and Development Center started by organizing a NATO workshop "Risk, Uncertainty and Decision Analysis for Non-Chemical Stressors" in Lisbon, Portugal in April 2007.

During the workshop, Linkov and some of the speakers — Tommi Tervonen, José Figueira, Jeffery Steevens, Mark Chappell and Myriam Merad — held a brainstorming session that came to fruition a year later in the form of a paper classifying a given nanomaterial into one of five risk categories (*J. Nanopart. Res.* doi:10.1007/s11051-008-9546-1; 2008).

The model uses both quantitative and qualitative factors as inputs, as well as uncertainty parameters. Linkov and co-authors, who are now based in France, the Netherlands, Portugal and the United States, looked at five nanomaterials: CdSe quantum dots were deemed to be most hazardous, falling into the 'high-risk' category with high confidence; aluminum nanoparticles were the safest.

"This was one of the most challenging papers for me", says Linkov. "The concept was novel to all of the co-authors. Decision analysts and risk assessors are accustomed to the development of elaborate models from purely theoretical grounds, whereas the 'hard' scientists on the team argued for more extensive data collection before modelling began."

A major breakthrough, he said, was getting everyone to accept that even classical statistical analysis requires expert judgement, and that the present work simply called for a different set of expertise. Patience, mutual respect and an iterative process were the key to success, Linkov adds.