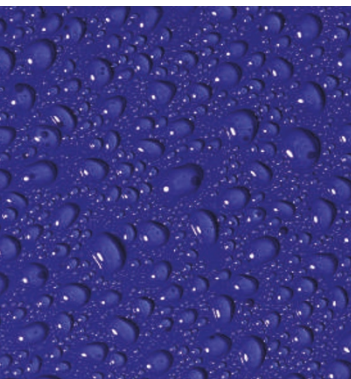


Waterproofing with water

Researchers in Virginia have developed a polymer coating that repels water when wet and attracts water when dry. Although coatings that exhibit amphiphilic behaviour — that is, switching between hydrophilic and hydrophobic states — have been reported before, water exposure has always made such coatings hydrophilic. In direct contrast, Makal and Wynne (*Langmuir* **21**, 3742–3745; 2005) report a polyurethane-based film that becomes hydrophobic when wet. Such behaviour is contrary to that predicted by thermodynamics,

which prompted them to label it ‘contraphilicity’. The authors suggest that this unusual behaviour is due to the way that hydrogen bonds form in their polymer films. The repeat units of the polymer have both amide and semifluorinated groups attached. When the surface is dry, the amide groups form hydrogen bonds with partially fluorinated groups on either the same or another molecule. This disrupts the normally hydrophobic semifluorinated groups at the surface, allowing it to attract water in the dry state. When the surface becomes wet, these amide groups thermodynamically prefer to form hydrogen bonds with water molecules, freeing the semifluorinated groups and making the films water repellent. The process is reversible, so cycling back to the hydrophilic state is achieved by simply drying the film.

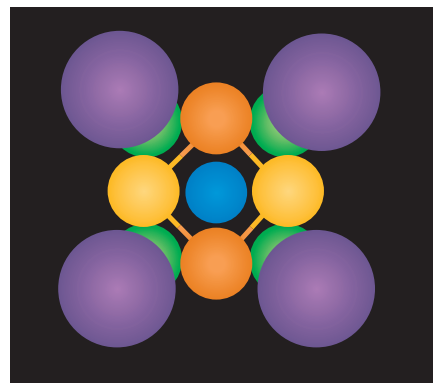


Solving the hopping problem

Charge transport in semiconducting polymers is quite different from that in crystalline inorganic semiconductors. In semiconducting polymers, charges move by hopping between localized sites, which are thought to consist of conjugated polymer chain segments. The influence of electric field and temperature on hopping transport is now fairly well understood, but until recently, the importance of another parameter — the charge-carrier density — had been overlooked. Now, Peter Bobbert and co-workers have established a unified theoretical description of the charge-carrier mobility in disordered semiconducting polymers, which is in excellent agreement with experimental measurements (*Physical Review Letters* **94**, 206601; 2005). The researchers find that at room temperature, mobility is mainly determined by the carrier density, but at low temperatures and high electric fields, the field dependence becomes important. They conclude that a relatively simple model in which there is a gaussian distribution of hopping site energies, with no correlation between the site energies, is sufficient to fully describe the mobilities resulting from hopping of charge carriers in semiconducting polymers. The description should also be applicable to small-molecule-based materials.

Cuboctahedral composite

While making a binary semiconductor-metallic colloidal crystal, E. V. Shevchenko and colleagues stumbled across a new packing mode for crystals with AB_{13} stoichiometry, which normally display an icosahedral lattice structure (*Journal of the American Chemical Society* <http://dx.doi.org/10.1021/ja050510z>). The possibility of a cuboctahedral structure (see figure) rather than icosahedral was considered in 1980 and dismissed as too unlikely because of its lower packing density. Besides, it had never been observed in either intermetallic or colloidal crystals. This new study shows that in a colloidal crystal made of PdSe and Pd nanoparticles, the two structures can coexist. Theoretical models, based on the approximation that nanoparticles behave like hard spheres and pack according to their size, only predict the formation of the icosahedral structure. But it is now clear, thanks to this new observation, that these models overlook important interparticle potentials (van der Waals', dipolar and hydrophobic interactions) that influence the packing process when the particles involved are organically stabilized nanocrystals. The observation of two coexisting nanoparticle superlattices with the same stoichiometry but different packing density suggests that other non-densely packed structures may be achievable, opening up further research into nanoparticle combinations.



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DESIGNER MAGNETIC FERROELECTRIC

Researchers in Japan have used high-pressure synthesis to form a compound — Bi_2NiMnO_6 — that has both ferromagnetic and ferroelectric properties (*Journal of the American Chemical Society* <http://dx.doi.org/10.1021/ja0512576>). Having both properties in the one material is very rare, but has great potential because if the direction of magnetization of a device can be switched by use of an electric field, this would reduce the thermal power needed for magnetic memory. Masaki Azuma and colleagues used X-ray powder diffraction to determine that the crystal structure they synthesized is a distorted perovskite with Ni^{2+} and Mn^{4+} ions in a rock-salt configuration. The six s^2 lone-pair electrons on the Bi^{3+} ions along with the covalent $Bi-O$ bonds provide the ferroelectric property, and the $-Ni^{2+}-O-Mn^{4+}-O-Ni^{2+}-$ paths provide the ferromagnetism. The authors suggest that their design of such Bi-based perovskites, using high-pressure to stabilize the distorted structures, can be applied to other transition metal ions in the search for ferromagnetic ferroelectrics. Using this method, they have also successfully synthesized Bi_2CoMnO_6 and Bi_2CuMnO_6 , which were found to be ferromagnets.

Sensitive atomic displacement

Extended X-ray absorption fine-structure (EXAFS) spectroscopy is a characterization technique based on an internal photoelectron scattering process modulating the X-ray absorption coefficient, and is used to measure interatomic distances in materials. Currently, the accuracy of these measurements is between 0.01 and 0.001 Å and is limited by the statistical precision and stability of the X-ray

energy. To overcome this problem, Robert Pettifer and colleagues used a dispersive X-ray absorption spectrometer at the European Synchrotron Radiation Facility to make rapid measurements with minimal energy drift in an iron cobalt thin film undergoing periodic strain through magnetostriction (*Nature* **435**, 78–81; 2005). Their technique can provide differential interatomic distance

measurements with an unprecedented resolution of a femtometre. Coupled with the power of EXAFS to examine the changes in the local structure surrounding a particular atomic type, the authors believe that, compared with other X-ray-diffraction techniques, this advance could open up new fundamental insights for understanding elasticity and phase transition in a wide variety of materials with complex unit cells.