electronic properties that can be used in carbon-based devices.

The most common type of bonds between carbon atoms are sp^2 bonds (as found in the flat hexagonal networks in graphite) and sp^3 bonds (as found in diamond). Usually graphite can only transform into diamond at extremely high pressures, but theory predicts that similar transformations might be induced by electronic excitations.

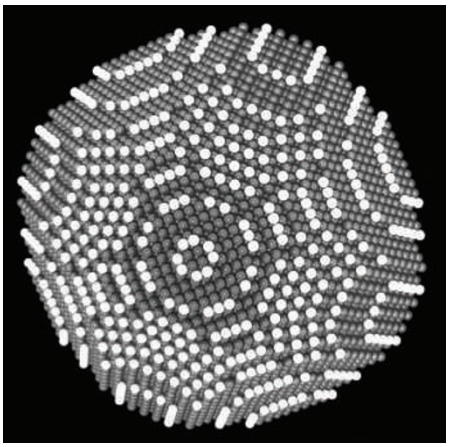
Katsumi Tanimura and co-workers focused femtosecond laser-pulses on graphite samples, and found that the laser created bright protrusions about 5 nm in diameter. They examined these protrusions with scanning tunnelling microscopy, and found that neighbouring pairs of carbon atoms had moved positions to form sp^3 bonds — but in a different structural form to diamond.

The sp^3 bonds introduce three-dimensional peaks and troughs to the individual graphite layers, and might increase the interactions between adjacent layers. Moreover, the new structure is stable at room temperature. This study opens up the possibility of finding more new phases of carbon through simple optical methods.

OSCILLATORY REACTIONS

Patterns surface

Proc. Natl Acad. Sci. USA **106,** 3006–3010 (2009)



Oscillatory chemical reactions, in which a rate or concentration varies periodically in time, are an important example of non-equilibrium chemistry. When they occur on surfaces, they are also associated with self-organizing patterns that can be as small as tens of nanometres. The origin of these patterns is, however, not well understood.

Now, Norbert Kruse and colleagues at the Université Libre de Bruxelles have shown how surface structure governs pattern formation. The researchers carried out catalytic water production from hydrogen and oxygen on the surface of a field ion microscope tip, which approximated a single nanoscale metal-catalyst particle. They were able to explain the observed patterns by assigning different reaction kinetics and electric-field intensities to the various planar orientations that exist over the curved tip surface. Furthermore, they showed that the oscillations are governed by the interplay between two populations of oxygen, one on the surface of the tip and one just underneath. Each of these populations is in turn influenced by both surface properties, and the applied electric field.

These results may help achieve control of the reaction rates and patterns formed by oscillatory chemical reactions on surfaces, something that could be useful for a variety of proposed technologies.

NANOMAGNETISM

Going beyond Faraday

Nature doi: 10.1038/nature07879 (2009)

Generations of students have been taught that the electromotive force in a closed circuit is equal to the rate of change of the magnetic flux through the circuit. However, this formula, first published by Michael Faraday in 1831, has been extended in recent years to take account of the intrinsic magnetic moments or spins of electrons, and in 2007 Stewart Barnes and Sadamichi Maekawa predicted that spin effects in magnetic devices could lead to electromotive forces even when the magnetic flux did not change with time. Now a team led by Masaaki Tanaka of the University of Tokyo and the Japan Science and Technology Agency has confirmed these predictions in experiments on magnetic tunnel junctions, and also observed magnetoresistance effects of up to 100,000 per cent.

Tanaka and co-workers, including Barnes and Maekawa, used the magnetic semiconductor manganese arsenide (MnAs) for the magnetic elements in their multilayer device. The electrons tunnelled from a bottom electrode, made of MnAs nanoparticles, through a 2.1-nm-thick insulating layer to a top electrode, which was a 20-nm-thick layer of MnAs. The team argue that magnetic energy is converted into electrical energy as a result of the motion of magnetic domains inside the device, even though the applied magnetic field in their experiment remained static.

Top down Bottom up

Joining the dots

DNA derived from salmon can improve the performance of quantum-dot devices.

It was at a seminar in May 2007 that Liming Dai, a professor of materials engineering at the University of Dayton, decided it would be a good idea to put salmon DNA into his quantum-dot light-emitting diodes (LEDs). James Grote of the Air Force Research Laboratory was describing the use of a complex made of DNA and cetyltrimetylammonium (DNA-CTMA) in LEDs based on small organic molecules, and both researchers recognized that this unique material could help solve a problem that was hindering the development of quantum-dot LEDs.

Dai's group had previously worked on polymer-based LEDs, and was attracted by the narrow, tunable emission of quantum dots. However, an energy barrier between the materials transporting charge to the quantum dots and the dots themselves was reducing the efficiency of the LEDs. The introduction of DNA-CTMA reduced the size of the barrier, and also reduced the amount of charge that was leaking from the dots without generating light. Combined with an annealing step to remove ligands from the dots, the collaboration — which also included Ocean Nanotech, who supplied the quantum dots — was able to demonstrate improved colour purity, brightness and efficiency (*ACS Nano* doi: 10.1021/nn8009079; 2009).

Each partner in the collaboration had different goals, according to Dai: university researchers were looking for a "detailed understanding of the underlying physical mechanism"; the Air Force was focused on accomplishing specific mission goals; and Ocean Nanotech concentrated on production. Nevertheless, says Dai, the collaboration allowed all three parties "to rapidly achieve results that cannot be easily worked out by a single group". However, Dai stresses that it is important that the overall objective of the project is not lost amid these different goals. To this end, he recommends the use of project websites that "allow all researchers in the team easy access to the latest progress status of all research components".