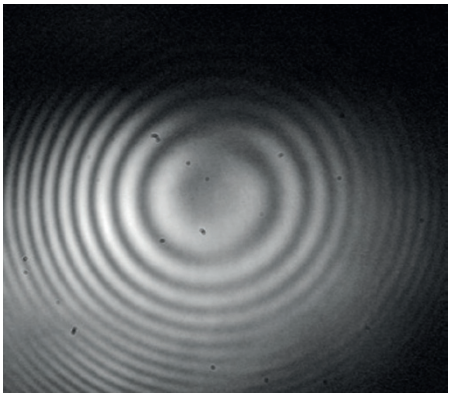
NANOWAVEGUIDES

Light beams with a twist

Nano Lett. http://doi.org/sb3 (2014)



A light beam with orbital angular momentum has a helical wavefront, and these optical vortices could be of use in applications such as imaging and quantum cryptography. Inducing angular momentum in a typical laser beam is, however, a relatively cumbersome procedure, requiring bulky components that cannot be easily integrated into optical circuits. Natalia Litchinitser and colleagues at the University at Buffalo have now created a waveguide array with compact dimensions that can spin a linearly or circularly polarized light beam into a beam with optical angular momentum.

To generate a helical wavefront it is necessary to induce a phase delay of 2π around the plane of the beam. To achieve this, the researchers first studied the effect that a single waveguide, which consisted of a hole with a radius of tens of nanometres milled in a metal plate, would have on an incident light beam. They found that the waveguide induces a phase delay that increases as the radius of the hole increases. A waveguide array was then fabricated that had a circular distribution of waveguide radii, designed to create the 2π delay. Interference experiments between a beam modified by the waveguide array and a reference beam confirmed that the array can create an optical vortex. *FP*

GRAPHENE

Learning how spins relax

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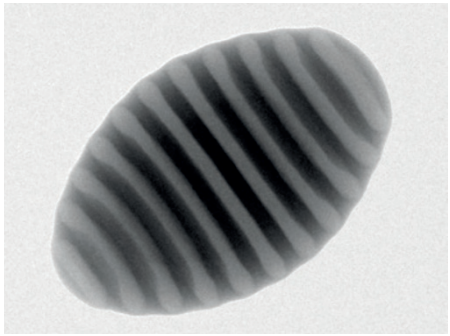
Graphene is of potential use in spintronic applications because of its predicted long spin lifetimes, which are on the order of microseconds and result from a low spin–orbit coupling in the light-element material. However, all experimental measurements of the spin relaxation times have so far been around the 100 ps mark, and the reasons for this large discrepancy are not yet fully understood. Jaroslav Fabian and colleagues at the University of Regensburg have now shown by first-principle calculations that a major contribution to the reduced spin lifetime could be resonant scattering from local magnetic moments.

The proposed mechanism for enhanced spin relaxation can be understood as the 'spin hotspot' action of magnetic moments localized at vacancies or adatoms, which occurs when the electron energies are resonant with the energy levels of the magnetic impurity. In that case, the electron spin has an equal probability to be conserved or to flip, significantly reducing the spin lifetime. The researchers consider local magnetic moments from hydrogen adatoms, but the conclusions are also valid for the case of heavy adatoms, which would give rise to strong local spin–orbit coupling. Spin lifetime values in agreement with experiments are found for a concentration of local moments as low as 1 ppm, emphasizing the importance of achieving ultraclean graphene samples for spin-based measurements. *ED*

NANOPARTICLES

A swell block copolymer

Angew. Chem. Int. Ed. http://doi.org/f2q7gx (2014)



For inorganic nanoparticles, the relationship between morphology and properties is relatively well established. This is not the case for polymeric nanoparticles, where there is a limited ability to even control the shape of such materials. Craig Hawker and colleagues have now reported a block copolymer nanoparticle that can reversibly change its shape in response to an external stimulus.

The researchers — who are based at the University of California, Santa Barbara, the University of Melbourne and US Army Edgewood Chemical Biological Center — first synthesized spherical polymeric nanoparticles made of the block copolymer polystyrene-b-poly(2-vinlypyridine) (PS-b-P2VP). The two phases of the copolymer separate to form concentric layers and it is possible to select the outside layer by adding a surfactant that favours one phase over the other. An intermediate condition is reached when a mixture of surfactants is used: the nanoparticle becomes ellipsoidal and the phases separate in a lamellar fashion.

To introduce stimuli responsiveness to the system, Hawker and colleagues took advantage of the acid/base properties of the 2VP phase. At low pH, 2VP gets protonated and swells to more than twice its initial volume, significantly changing both the morphology and aspect ratio of the entire nanoparticle. To ensure that swelling does not break the nanoparticle, the researchers added a crosslinker. The shape change is reversible and the initial morphology is restored at higher pH values. *AM*

CRYSTAL GROWTH

Curved single crystals of gold

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Crystals produced by biological processes often exhibit complex shapes and structures, which can have curved rather than faceted surfaces. By mimicking these processes, researchers have created a range of shaped single crystals from the ceramic materials (calcium carbonate, for example) that are also used by nature. However, achieving similar shapes with functional materials like metals has remained a challenge. Boaz Pokroy and colleagues at the Technion Israel Institute of Technology, the European Synchrotron Radiation Facility in Grenoble and Ghent University have now shown that gold single crystals can be grown with curved surfaces.

The researchers first created eutectic thin films of gold–germanium by evaporating layers of gold and germanium onto oxidized silicon wafers. The samples were subsequently annealed and, through a dewetting process, droplets of gold–germanium formed. The growth process then occurs confined within these droplets, which leads to gold crystals that replicate the shape of the droplets. To prove that the curved gold crystals were in fact single crystals, thin cross-sections of the droplets were prepared using a focused ion beam and then examined with electron microscopy and different diffraction methods.

Pokroy and colleagues also show that the shape of the droplets, and thus the curvature of the single crystals, can be controlled by adjusting parameters such as the oxygen partial pressure in the environment during the annealing step. *OV*

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