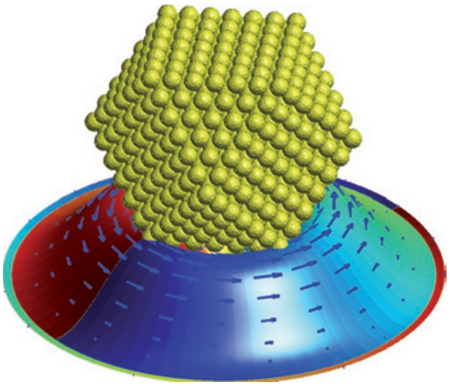
NANOPARTICLES

In a spin

Adv. Mater. http://doi.org/fz9jgd (2012)



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Light beams that have helical wavefronts were first developed and exploited in the 1990s and can be used to transfer angular momentum to particles and make them spin. Recently, twisted beams of electrons have also been created by passing electrons through a graphite film or a holographic mask. Jo Verbeeck and colleagues at the University of Antwerp have now shown that these electron vortex beams can be used to rotate gold nanoparticles.

The researchers used a holographic mask with an edge dislocation to generate a vortex beam in a transmission electron microscope. A left- or right-handed beam was then used to illuminate a single gold nanoparticle that had a diameter of 3 nm and was supported on a silicon nitride substrate. Owing to the transfer of angular momentum via elastic scattering, the nanoparticle can rotate clockwise or anticlockwise depending on the sign of the vortex beam.

Verbeeck and colleagues also show that the rotation can be used to examine the friction between the nanoparticle and the support, and were able to determine a rotational diffusion coefficient that was consistent with known theoretical values. *OV*

MAJORANA FERMIONS

Glimpsed in a nanowire

Nature Phys. **8,** 887–895 (2012)

Majorana fermions — particles that are their own antiparticle — were first predicted in the 1930s, but such elementary particles have yet to be identified. In condensed matter, experiments have recently hinted at the existence of quasiparticles with Majorana-like states, which could, for example, be used as information carriers in robust quantum computation. However, definitive proof of these fermions also remains elusive. Moty Heiblum and colleagues at the Weizmann Institute of Science have now provided further evidence for the existence of Majorana states in a semiconducting nanowire.

When in proximity to a superconductor, a nanowire can enter a topological phase that is expected to host Majorana quasiparticles at both ends. The signature of Majorana states in the transport characteristics of the nanowire is a conductance peak of $2e^2/h$ at zero applied bias, where e is the elementary charge and h is Planck's constant. Heiblum and colleagues observed the emergence of zero-bias peaks in an indium arsenide nanowire in contact with an aluminium superconductor as a function of applied magnetic field, chemical potential and temperature. The zero-bias peaks disappear when the magnetic field causes the superconducting gap to collapse, as expected for a Majorana state.

Although the measured zero-energy conductance has a smaller amplitude than the predicted value, and other mechanisms could give rise to similar transport features, the agreement between the experiments and numerical simulations strongly suggests the formation of Majorana states in the nanowire. *EDR*

DYE-SENSITIZED SOLAR CELLS

Suitably symmetric

Angew. Chem. Int. Ed. http://doi.org/fz9jpn (2012)

In a dye-sensitized solar cell, a dye molecule is adsorbed on a semiconductor nanoparticle and injects an electron into the nanoparticle when exposed to sunlight. To improve the efficiency of such solar cells, researchers have tried to increase the rate of the charge-injection process while minimizing charge recombination, and it is known that both events are determined by energetic and kinetic factors. Alessandro Troisi and colleagues at the University of Warwick have now suggested that molecular symmetry should also be taken into account.

In an ideal system, charge injection would be allowed by symmetry and charge recombination forbidden by it. However, this is almost impossible when either the charge donor or acceptor is a semiconductor because there will always be a state in the semiconductor that matches the symmetry of the dye orbital involved in the process. The trick then is to use a bridging group that physically separates the dye from the semiconductor so that the through-bond channel is open only in one direction. Using simple quantum-mechanical calculations, Troisi and colleagues show that this is possible for molecules possessing a certain type of symmetry. In such systems, the dye localizes a high molecular-orbital density on the bridge and promotes charge injection, but when oxidized the dye molecule remains almost completely isolated from the bridge and prevents charge recombination.

With this approach, charge recombination rates could be reduced by two to three orders of magnitude. *AM*

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Nano Lett. **12,** 6212–6217 (2012)

Human hair is a long cylinder with a diameter of 30–100 μm, and the hair shaft — the part seen above the skin — consists of three layers. The outermost region, called the cuticle, contains many layers of cells and protects the middle layer called the cortex. The cortex, which contains lipids, keratins (structural proteins) and melanin (colour pigment), provides strength, texture and colour. The medulla, which is the innermost layer, is often absent but may be seen in thick hairs. In ancient times, lead minerals were used to dye human hair. Now, Philippe Walter and colleagues have shown that gold nanoparticles can be grown inside them.

The researchers — who are based at various institutes in France — treated white human hair with an alkaline solution of chloroauric acid ($HAuCl_4$). The treated hair changed from pale yellow after 1 day to deep brown after 16 days. High-resolution imaging and spectroscopy showed that gold had been taken up by the cuticle and cortex, and that gold nanoparticles had formed on the surface of the hair shaft on each cuticle cell. Closer examination of the cuticle revealed that many of the nanoparticles were formed in areas with keratins, which contain cysteine-rich amino acids.

Multiple washings did not affect the colour of the hair because the gold nanoparticles were buried and stabilized inside the keratin structure, and the researchers suggest that this approach might be of use in the hair colouring industry. *ALC*

Written by Ai Lin Chun, Elisa De Ranieri, Alberto Moscatelli and Owain Vaughan.