More than invisibility

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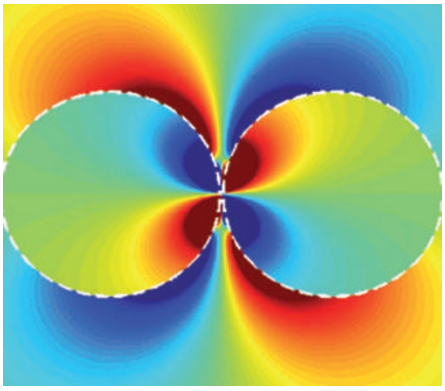

One of the most spectacular applications of transformation optics is metamaterial cloaking devices that can render an object invisible to the eye. Their complex structure can be derived by an approach based on a coordinate transformation that calculates a set of materials parameters that converts the actual path of a beam of light into an artificial path that simulates the desired behaviour. For example, in an invisibility cloaking device the light path disturbed by the cloaked object is made to appear as a straight line so that it seems as if no object is there. In this and earlier studies, Alexandre Aubry and colleagues from Imperial College, London, apply transformation optics to an entirely different system that describes the optical resonances between two metallic cylinders in close vicinity. The intense optical fields in the gap between the two cylinders can be calculated elegantly through a coordinate transformation that takes the electric fields of two straight slabs of metal and transforms them into the field of a pair of cylinders. These results show impressively the potential of transformation optics not only for metamaterials but also for other nanophotonic structures.

Fishing for proteins

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The analysis of membrane proteins relies on the efficient extraction and isolation of specific proteins. A commonly used technique involves the labelling of proteins with biotin followed by extraction using streptavidin as a receptor. This technique has several drawbacks, however, including potential contamination resulting from degradation of streptavidin or from naturally occurring biotin-containing proteins. Now, Song Ho Ryu, Kimoon Kim and colleagues have developed a synthetic, biocompatible host–guest system that can be used to extract and isolate model proteins from a heterogeneous protein mixture more efficiently than the biotin–streptavidin system. They also show that the extraction of plasma membrane proteins using the synthetic system is comparable, or better in some cases, than the biotin–streptavidin system. The synthetic receptor–ligand pair is composed of cucurbit[7]uril and a ferrocene compound. Cucurbit[7]uril conjugated beads are shown to selectively capture ferrocene-labelled proteins within a protein mixture, and subsequently the labelled proteins can be recovered, at room temperature, using a ferrocene-based compound that acts as a stronger binding agent.

Dot spotting

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Their quantized, atomic-like electron energy spectrum makes semiconductor quantum dots (QDs) ideal candidates for quantum information applications. For example, the recombination of electrons and holes electrically injected in a dot can give rise to single-photon emission. Isolating the light emitted by a single dot in a population of typically a few hundred to a few thousand per square micrometre is quite difficult. Andreas Baumgartner and colleagues have now shown how this is possible by using appropriate electrical injection conditions. Their InAs QDs were embedded in a p-i-n structure. For relatively low applied bias, the electrons and holes can be injected in the QDs resonantly, giving rise to sharp, atom-like electroluminescence lines. Moreover, the emission can be mapped out in space, resulting in very defined spots, which are attributed to the creation of preferential tunnelling paths between the p and n electrodes and some of the QDs. The results may have important implications for the realization of solid-state single-photon emitters.

Active ferrogels

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Porous gels are widely used as scaffolds for tissue regeneration, and as carriers and deliverers of drugs for the treatment of various diseases. Drug delivery in most porous scaffolds occurs through passive mechanisms — molecular diffusion, cell migration or material degradation. This and current limitations in the amount of deformation, volume change and pore size of polymer–gel scaffolds impair the transport of large molecules and cells through the gels, which severely restricts their effectiveness in cell therapy and tissue engineering. Now, Mooney and co-workers report the fabrication of an active macroporous ferrogel — a polymer gel with embedded magnetic nanoparticles — which undergoes large deformation and volume changes (over 70%) when a magnetic field is applied. They showed that the ferrogel can release drugs and cells on demand both *in vitro* and *in vivo*, and that cell delivery is enhanced as a result of the deformation-triggered convection of water flowing through the large, interconnected pores. These magnetically responsive ferrogels may also find applications as biomedical actuators and sensors.

See-through electrodes

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Transparent electrodes, which are crucial for the extraction or injection of charge carriers in organic electronic devices such as thin-film solar cells and light-emitting diodes, are generally based on indium tin oxide (ITO). Researchers have been looking for alternatives to this material, however, because the flexibility of ITO films is limited and indium is scarce. A number of materials have been investigated, including metal meshes and conducting polymers. William Kylberg and colleagues have now combined these two approaches in a scalable architecture. They soaked a fabric of molybdenum wires and polymer fibres in a solution of poly(3,4-ethylenedioxythiophene):poly(styrene sulphonic acid), resulting in a smooth, flexible conductor with a light transmission comparable to that of ITO. Using their new electrode material, the researchers fabricated bulk heterojunction solar cells with respectable efficiencies. Although ohmic losses in the conducting polymer layer still limit the performance of small devices compared with ITO-based cells, the researchers suggest that large-area devices may benefit from the high in-plane conductance of the woven electrodes, which can already be fabricated in a roll-to-roll process.