Plasmonics with a twist

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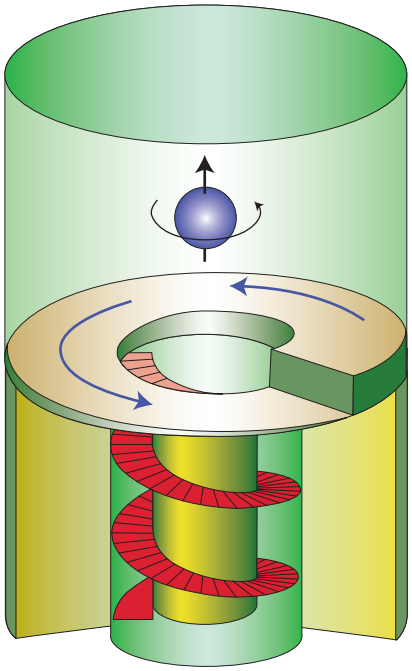

Chiral plasmonic structures are known to be able to selectively filter light of different circular polarization. The role of the different components in the angular momentum of a light beam in nanophotonic devices has now been studied by Yuri Gorodetski and colleagues from the Israel Institute of Technology in Haifa. The angular momentum of a spiral structure consists of the spin associated with its handedness, as well as the orbital angular momentum, which relates to the pitch of the spiral. The researchers now demonstrate the selective transmission of light based on the conservation of angular momentum in structures that consist of a spiral structure at the surface and a nanoaperture at the centre. Light only propagates through the hole if the circular polarization of the light beam, plus the pitch of the spiral at the surface that is used to couple to the light, exactly add up to match the total angular momentum of the surface plasmon that guides the light through the aperture. These results demonstrate how complex considerations of spin and angular momentum in the design of nanophotonic structures can lead to new applications.

Hole that matters

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The spin of an electron confined in a semiconductor quantum dot (QD) is often considered to be an excellent candidate for quantum information processing. Unfortunately, its coherence is limited by the interaction with the thousands of nuclear spins in the dot, which limits the time available for any operation to be performed to only about 10 ns — too short for practical applications. Daniel Brunner and colleagues have demonstrated that a way to overcome this obstacle is to use the hole's spin instead of the electron's spin. They performed a so-called two-colour absorption experiment on an InGaAs QD. The QD was contained by a single hole, and a magnetic field induced an energy splitting (Zeeman) between the spin states. Two lasers with an energy difference matching the Zeeman splitting were used to create equivalent excitons from the two holes. The team observed a dip in the absorption spectrum, with a size that depends on the hole's spin-coherence time, which the team estimated to be at least 100 ns. The result is very promising for applications in quantum information processing.

Nano connections

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The structure of conventional electrical connectors used in macroscale devices affords different mechanisms for electrical contact and physical engagement or connector geometries. However, this causes difficulties, such as lack of adhesion or contact selectivity, when trying to produce connectors at the micro and nanoscales. Ali Javey *et al.* have now overcome these problems by fabricating electrical connectors that use the same active area for both physical adhesion and electrical contact. The connectors are based on core–multishell nanowire forests on silicon substrates; Ge nanowire forests are produced using the vapour–liquid–solid method, a parylene shell is then added by gas-phase deposition and a silver layer is deposited via sputtering. The array structure and parylene layer allows interpenetration of the forests producing a large contact area between the outer shells. This not only provides electrical connectivity but also ensures large van der Waals interactions for high adhesion strength. The team used the connectors to connect a battery to a light-emitting diode, but the multicomponent structure of the connectors should facilitate their use in numerous applications.

Mesoporous carbons

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Mesoporous materials with large and ordered pore structure and high surface area are attractive for energy storage and conversion-device applications, such as electrochemical capacitors and lithium batteries. Although many synthetic routes to graphitic ordered mesoporous materials have been reported , they are all complex and have a high operation temperature. Linda Nazar and colleagues now propose a one-step approach to the fabrication of highly graphitic ordered porous carbon materials with high pore volume and surface area using a solid-state method that involves a silica template and metal phthalocyanines. The materials maintain a highly ordered nanoscale pore structure on heat treatment, and the graphitization is enhanced by the combined deposition from chemical vapour and catalysis. These materials also show good oxidative capacitance and stability, which make them attractive as catalysts for both direct formic acid and proton exchange membrane fuel cells.

Vaccine carriers

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Straightforward distribution of vaccines for influenza infections is of mounting importance when facing pandemic threats, such as swine and avian flu. Distribution is simplified, scarce vaccine resources stretched further, efficacy increased and dosing made easier if the vaccine can be immobilized in an appropriate adjuvant: a carrier that preserves the bioactivity of the vaccine. Only one type of adjuvant — particulate aluminium compounds — is currently approved for *in vivo* use, but Eduardo Ruiz-Hitzky and colleagues show that a hybrid bionanocomposite can also be used for the delivery of influenza vaccines. The bionanocomposite consists of the biopolymer xanthan gum and a microfibrous silicate, sepiolite. This combination allows easy association of the positively charged vaccine particles with the negative charges on the xanthan gum, and also provides a physico-chemical environment that preserves the macromolecular configuration of the vaccine. The bionanocomposite is easy to handle, and when loaded with vaccine, increases immune responses within mice. This works whether the vaccine is delivered intranasally or intramuscularly, potentially providing new inoculation strategies. Uses in biosensors, bioreactors and drug-delivery systems are also anticipated.