Janus catalysts

Science **327,** 68–72 (2010)

© GETTY

Hybrid nanoparticles consisting of carbon nanotubes fused with silica are known to produce water-in-oil and oil-in-water emulsions because of the hydrophilic and hydrophobic nature of the silica and nanotubes respectively. Steven Crossley and colleagues have now added Pd metal particles to these Janus composites for use in biphasic hydrogenation and condensation reactions that are important in biomass refining. In contrast to surfactants often used to create emulsions for phase-transfer processes, the solid catalyst is easily recovered and reaction rates are improved owing to the high concentration of Pd catalyst at the interface. The Pd particles are shown to preferentially bind to the hydrophilic silica, enhancing reactions involving water-soluble species in the emulsion. Simultaneously, the yield of reactions taking place purely in the organic phase increases relative to the emulsion. The system also has the potential to allow the numerous steps required for drug syntheses to take place in one pot, negating the need for multiple reaction, separation and purification steps. For instance, an organic soluble species produced in the aqueous phase would then transfer to the organic phase for the next step.

A perfect match

Appl. Phys. Lett. **95,** 261908 (2009)

Quantum dots are often considered ideal systems for quantum information applications, particularly as they can be efficient single photon emitters. It would be desirable to obtain indistinguishable photons from different quantum dots, as this is necessary for several types of quantum algorithms. Unfortunately this is rather difficult, as usually all quantum dots emit at different wavelengths. Mohamed Benyoucef and colleagues have now demonstrated a suitable strategy to improve matters. They have first embedded a sample with GaAs quantum dots in a micropillar cavity to improve light-collection efficiency. They then considered two dots located 30 µm apart and tuned the emission wavelength of one of them by heating it with a high-power focused laser beam. As a result, both quantum dots emit single photons and at the same wavelength. Interference experiments show that such photons are still distinguishable, which the authors think is a consequence of a very short dephasing time for photons emitted by GaAs quantum dots. However, the strategy seems promising and could find indistinguishable photons if quantum dots with longer dephasing times were used.

Plasmons taking off

Phys. Rev. Lett. **103,** 266802 (2009).

Surface plasmon polaritons (SPPs) on the surface of metals have the capability to process light on a scale much smaller than their resonance wavelength. Plasmonic structures are therefore widely investigated for applications in nanophotonic devices. However, one of the problems in the field has been to efficiently launch SPPs by the use of optical sources. This usually has been done by evanescent optical fields close to the metal surface. Jan Renger and colleagues now demonstrate that SPPs can also be excited from free space, with an optical source away from the surface. They achieve this by using nonlinear four-wave mixing, where the combination of three incident photons with individually tunable properties makes it possible to satisfy the conservation of energy and momentum when exciting an SPP. In comparison with near-field approaches, much higher conversion efficiencies could be achieved this way. In addition, the free-space approach has the benefit of a precise control of SPP energy and momentum through the appropriate choice of photon properties in the four-wave-mixing process.

Nanoparticles see the light

Nano Lett. doi:10.1021/nl903411s (2009)

© ISTOCKPHOTO / EVGENY KUKLEV

The concept of using nanoparticles as drug-delivery vehicles is gaining momentum, but the particles often need to be functionalized with ligands on the outside so they can be directed to specific tissues. This requires a specific cell–ligand interaction to be identified for each clinical target, resulting in the need for complex synthetic routes and limiting the targets that can be approached. Daniel Kohane and co-workers circumvent these problems by functionalizing their nanoparticles with ligands that are protected with groups that can be removed by irradiating them with light. This means that they don't need to use ligands that target specific types of cell, instead simply using ligands that target molecules on all cell membranes and irradiating them when the particles reach the target cells. The researchers show that the nanoparticles bind to cells on illumination, enabling the deposition of a sustained release system at the target site. In the future they aim to modify the wavelengths of light that can trigger the system, expanding the range of tissues on which the approach can be used.

Silicon for storage

Chem. Mater. doi:10.1021/cm903054s (2009)

Hydrogen is widely considered to be an ideal fuel because it has a high chemical energy per mass and because it does not produce carbon dioxide emissions. One significant problem in terms of its use remains the discovery of suitable materials for hydrogen gas storage. Recently, silicon nanostructures used as chemical hydrides have attracted much attention as they are expected to show great potential for uptake and release of hydrogen without the use of hydrogen gas. Susan Kauzlarich and colleagues have now prepared hydrogen-capped silicon nanoparticles through a low-temperature chemical method to study the release of hydrogen from the surface as a function of particle size. Regardless of size and crystallinity, these materials have similar SiH and SiH_2 entities on their surface, and hydrogen evolution is observed above 300 °C. An increase in the amount of hydrogen with surface area is also shown. In spite of the high operation temperature, the authors believe that reversibility through chemical hydrogenation is possible and that the surface of these nanoparticles could prove to be an interesting platform as a possible hydrogen storage system.