Assembled fullerenes

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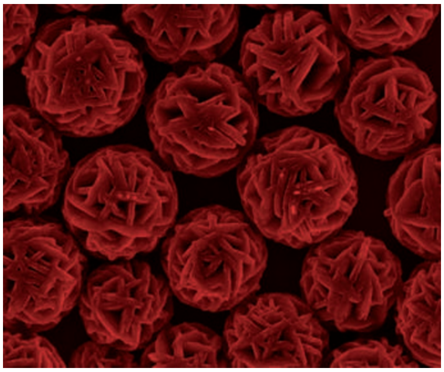

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Assembling fullerenes into larger superstructures is attractive as a route to functional materials and as a potential approach for controlling their morphology when used in devices such as organic solar cells. However, fullerenes usually need to be functionalized with additional molecules to be made to assemble into larger forms. Now, Xuan Zhang and Masayuki Takeuchi make microspheres consisting of nanoplates of unfunctionalized fullerenes, using a porphyrin polymer to control the assembly through supramolecular interactions. The fullerene and porphyrin polymer are simply mixed in solutions of toluene, and the solvent is then allowed to evaporate. The size of the microspheres can be tuned by changing the ratio of the two components, while changing the concentrations of the two individual solutions before mixing produces different shapes such as rods. The researchers also show that, no matter what the mixing ratio, very little of the porphyrin polymer is present in the final spheres. They conclude that the polymer directs the fullerenes to form the spheres by initial nanoparticle growth and assembly through microdisks, a mechanism they liken to biomineralization.

Tantalum to the rescue

Chem. Mater. doi:10.1021/cm9020782 (2009)

One of the drawbacks of developing polymer electrolyte membrane fuel cells running on small-organic-molecule fuels is the lack of anode catalysts that effectively overcome the kinetic barrier for complete oxidation of these complex molecules. Typical catalysts used, such as platinum, also suffer from poisoning by carbon monoxide impurities associated with hydrogen production from hydrocarbon reformation. Bruce van Dover and colleagues now investigate the catalytic activity of platinum–tantalum systems by means of extensive electrochemical and structural characterization. A library of thin-film systems containing Pt–Ta ordered intermetallics were tested as methanol and formic acid oxidation catalysts with a fluorescence-based parallel screening method. The significant improvement in catalytic activity was attributed to interactions between Ta suboxides and surface Pt. The most active catalyst surface was a Ta suboxide and Pt composite less than 1 nm in size, and the interaction between these species led to less Pt carbon contamination during the oxidation of methanol and formic acid.

Light forces

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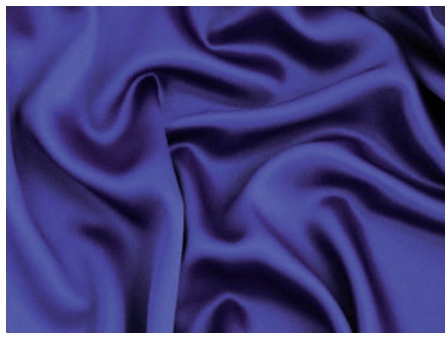
As with any other particle, the electromagnetic energy of photons can be converted into other forms of energy or used to exert small amounts of radiation pressure on surfaces. Similarly, surface plasmon polaritons (SPPs) can also be used to generate forces between closely separated metallic objects. David Woolf, Marko Loncar and Federico Capassso have now investigated the force originating from coupled SPPs between two metal plates. The force that the researchers study is an analogue of the Casimir force between two uncharged metallic plates. In the case of SPPs, the precise forces between such structures depend not only on the wavelength of light used and its power, but also on the details of the structure. Systems in which the plates are thin so that SPPs from all four faces interact with each other allow the properties to be better fine-tuned, so that, unlike in the case of thick metal plates, not only attractive but also repulsive forces can be achieved. The strength of the force between the metal plates is slightly larger than the Casimir force, suggesting the use of these plasmonic effects in controlling nanomechanical systems through light.

Covered in wrinkles

Nano Lett. doi: 10.1021/nl902729p (2009)



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Graphene has really come of age: it's full of wrinkles — at least according to a study by Ke Xu and colleagues at Caltech. Their scanning tunnelling microscopy images of exfoliated graphene on SiO_2 substrates shows the ubiquitous presence of these corrugations, typically 3 nm high, 10 nm wide and up to 1 μm long. The atomic resolution of the scanning tunnelling microscope showed that the typical hexagonal lattice of graphene transforms into a triangular lattice on the wrinkles, which the researchers ascribe to a bending force that is strong enough to break the six-fold symmetry of graphene. The electronic properties are also affected by the bending force, as shown by measurements of the differential conductance that reveal a finite density of states at the charge neutrality point — which is instead zero in flat graphene. According to recent theoretical studies, this could indeed be a consequence of large corrugations. If the wrinkles are indeed ubiquitous, their details are essential for understanding the electronic properties of graphene.

Holey nanowires

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Porous one-dimensional nanostructures show promise for use in applications such as catalysis and bioengineering. Now, highly crystalline porous nanowires of layered-hydroxide lanthanum acetate have been synthesized using a hydrothermal route. The previous syntheses of these types of material required high-temperature post treatments or a pre-existing template. However, the hydrothermal route introduced by Xun Wang and colleagues avoids this, and uses $La(NO_3)_3 \cdot 6H_2O$ and a mixture of deionized water, ethanol, oleylamine and acetic acid. They produce nanowires roughly 35 nm in diameter and up to a few micrometres in length, with a broad size distribution of pores and a positively charged surface. This, combined with the high crystallinity leads to high surface roughness such that a large area of each nanowire can interact with other species, improving their adsorption and catalysis properties. Importantly, the team demonstrate that the material can adsorb and release DNA fragments, and it can remove a common azo-dye used in the textile industry from water. These results provide positive indications that the nanowires will find use in catalysis and environmental and bio-related applications.