At the interface

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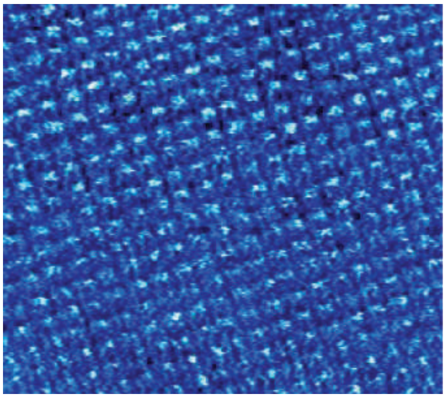


Understanding the structure of liquid/solid interfaces is important for applications such as catalysis and electrochemistry. Now, Voïtchovsky *et al.* report the probing of various liquid/solid interfaces, on an atomic and molecular scale, using small-amplitude modulation atomic force microscopy (AFM). The solid and the dynamically operated AFM cantilever are both immersed in the liquid during the imaging process. The method can be used to image a range of hard or soft materials, including mica, calcium carbonate (pictured), silicon carbide or a lipid bilayer, with water or dimethylsulphoxide as the solvent. The method produces high-resolution topographical images that resemble the known crystallographic forms of the analysed materials. In addition, Voïtchovsky *et al.* propose a model that explains the forces involved in image formation and then, by establishing a calibration curve using contact-angle-derived data, can precisely map the interfacial energy with nanoscopic resolution. The researchers predict that the technique could be widely adopted because it requires no modification of a standard AFM instrument.

Nonlinear metamaterials

Phys. Rev. Lett. **104,** 153902 (2010)

The subwavelength design of metamaterials enables unprecedented control over the propagation of light. Many metamaterials achieve their function through electromagnetic resonances, which suggest that their behaviour can be actively controlled through a tuning of these resonances. In a strategy to realize active metamaterials with ultrafast switching times, Andrey Nikolaenko and colleagues from Southampton University have now studied the influence of carbon nanotubes on the properties of metamaterials resonators. For this, a thin layer of carbon nanotubes was deposited onto an array of conventional split-ring resonator structures. The presence of the electrically highly polarizable carbon nanotubes considerably alters the response of the system as a result of the coupling between carbon nanotube exciton resonances and the plasmonic resonance of the metallic metamaterials resonators. The response time of this nonlinear system is expected to be similar to those of pure carbon-nanotube films (less than 600 fs). These fast switching times suggest the use of such metamaterials composites as candidates for compact, thin-film components in nonlinear optical devices such as optical switches and other ultrafast photonic media.

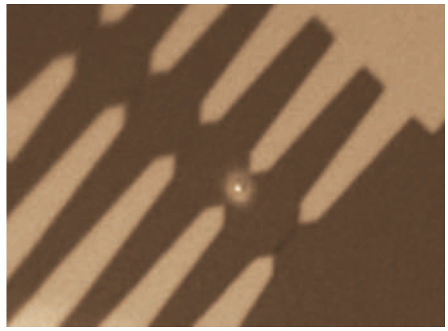
Shooting nanoparticles

Soft Matter doi:10.1039/c002231d (2010)

At present, a huge amount of research is being carried out on delivery vehicles that protect then release therapeutic nanoparticles. Li Liu and co-workers have now fabricated a hydrogel capsule that releases nanoparticles based on the principles of the squirting cucumber. The team used a microfluidic device to produce emulsions that convert into microcapsules when exposed to ultraviolet light. The capsules are composed of a poly(*N*-isopropylacrylamide) hydrogel shell and an oil-phase core; the carboxylate-modified yellow–green fluorescent beads used as model nanoparticles are in the aqueous phase and dispersed into this core. At 20 °C the hydrogel is swollen (like those of a ripe fruit), but when it is heated to 50 °C it undergoes a phase change and shrinks, thereby increasing the pressure inside the microcapsule. Eventually the shell ruptures and all of the cargo is squirted out in a vortex with high momentum. Site-specific thermotherapy can be used as the heat source for medical applications, and although the capsules are too large at the moment, their size could be reduced using a smaller fluidic device.

Metallic shine

Nano Lett. doi:10.1021/nl9039795 (2010)



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Electroluminescence in the visible light range is usually a result of the recombination of electrons and holes that have been electrically injected, and is known as an interband transition. To recombine, the two charges have to be at the so-called K point of the electronic band structures, so that their momentum is negligible. Otherwise, the emission of a photon would violate energy and momentum conservation laws. However, the two-peak electroluminescence observed by Stephanie Essig and colleagues in single-walled carbon nanotube devices cannot be due to such a process. In that case, the energies of the peaks should depend on the nanotube diameters, and they are not. The researchers propose that the peaks are connected to an intraband electron transition, from high-energy high-momentum states to the K point, with the simultaneous emission of phonons that carry the electron momentum after the light has been emitted. This scenario should also have important implications for electroluminescence of graphene, which has a very similar electronic structure.

Size matters

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Practical ways of producing robust and geometrically ordered semiconductor nanocrystals with long carrier lifetimes and high mobilities are vital for the next generation of optoelectronic devices such as solar cells. To reach such an objective, a better quantitative understanding of charge transport in nanocrystal solids is necessary. Matt Law and colleagues now show how the carrier mobility in alkanedithiol-coated lead chalcogenide films depends on ligand length and nanocrystal size. Room-temperature measurements show that electron and hole mobilities increase exponentially with decreasing ligand length, thus revealing the inverse relationship between coupling energy and internanocrystal distance. Field-effect transistor measurements at constant ligand length demonstrate that mobilities depend strongly on the average nanocrystal size independently of the size distribution. The fact that the carrier mobility is independent of polydispersity is thought to result from percolation networks of small bandgap nanocrystals carrying most of the current. The authors believe that higher mobilities and long-range coherent transport could be obtained if positional and energetic disorder can be removed using high-quality superlattices of monodisperse nanocrystals.