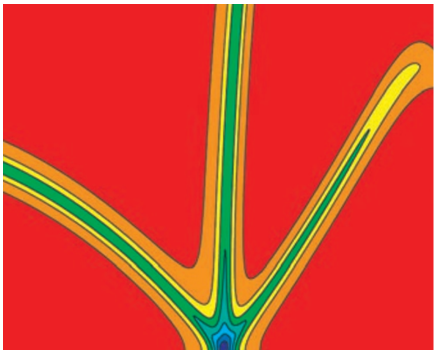
Captivating plasmons



Opt. Express **16,** 6146–6155 (2008)

Surface plasmons — collective oscillations in electron density at the surface of a metal — are known to strongly enhance local electromagnetic fields. However, rather than serving as an amplifying antenna, in the correct circumstances surface plasmons can also completely absorb light at the plasmon resonance. As Ross McPhedran and colleagues explain, this effect occurs in metal gratings with a sinusoidal variation in height, and arises from interactions, mediated by the surface plasmons, between light and the periodic structure of the grating. Furthermore, full absorption independent of polarization can be achieved by the superposition of two crossed gratings. However, the drawback of such structures is that these gratings only absorb light at normal incidence to the surface. As the researchers now demonstrate, by individually adjusting the height and periodicity of the two crossed gratings, total absorption can be tailored for angles of non-normal incidence. Such gratings might be used as optical modulators or to enhance the performance of solar cells through photothermic effects.

Memristive device

Nature **453,** 80–83 (2008)

Memristors (short for memory resistors) should in principle constitute, together with capacitors, resistors and inductors, the fourth fundamental elements for circuit building. Although this hypothetical element should present novel and valuable circuit properties, no example or useful physical model of a memristor has so far been reported. Now Stanley Williams and colleagues at Hewlett-Packard use a simple model to show that memristance arises spontaneously in a nanoscale system when ionic and electronic transport are coupled under an external bias voltage. The device, made of a layered platinum–titanium-oxide–platinum cell, can help to explain a range of hysteretic current–voltage behaviour observed in other devices that involve the transport of charged molecular species. The authors suggest that including memristors in integrated circuits should significantly extend circuit functionality for applications such as ultradense non-volatile memories.

Doubly interactive

Angew. Chem. Int. Ed. **47**, 3730–3734 (2008)

For inorganic nanocrystals to have success in biomedical applications, they must be modified to ensure they are soluble and stable in aqueous solutions. To convert them from hydrophobic to hydrophilic in nature, two methods have developed involving either coordinate bonding of hydrophilic molecules directly to their surface, or van der Waals interactions between the hydrophobic ligands of the nanocrystals and hydrophobic sections of amphiphilic molecules. Now, these strategies have been combined by H. Wu *et al.* in an approach that uses an amphiphilic polymer functionalized with coordinating groups. These 'dual-interaction' ligands, capable of both coordinate bonding and hydrophobic interactions, are used to modify a range of nanocrystals including gold particles and CdSe/ZnS quantum dots. The resultant water-soluble materials are highly stable within a wide pH range and up to temperatures of 100 °C, and have small diameters (less than 20 nm) that should not limit their use in bio-related applications. Wu *et al.* further functionalized these nanocrystals with antibodies and used them to monitor virus–protein expression in cells.

A thermal nanomotor

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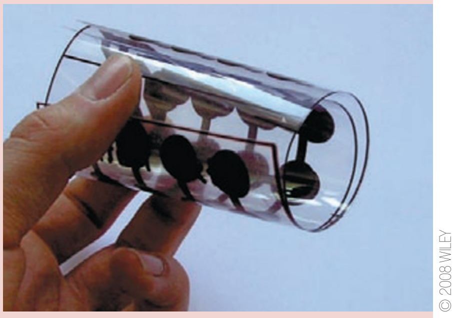
Carbon nanotubes (CNTs) are particularly promising for the fabrication of nanoelectromechanical systems (NEMS). The tubular shape restricts the motion to specific degrees of freedom, typically translation and rotation, resembling bearings in everyday machines. Amelia Barreiro and colleagues have now fabricated a motor — based on two concentric CNTs — that can carry a cargo using subnanometre steps. The inner nanotube is connected to electrodes, and the outer one is attached to a gold cargo. When an electric current flows through the inner tube, the cargo is observed to rotate and translate. Surprisingly, the direction of motion does not change if the current is reversed. The researchers concluded that the motion has a thermal origin: the current generates a thermal gradient between the centre of the tube and the extremes, and the phonons flowing because of this gradient drag the outer tube and the cargo. The thermal origin of the observed motion may provide a new range of possibilities for NEMS applications.

Printing problem

Adv. Mater. doi: 10.1002/adma.200702702 (2008)

One of the attractions of using organic compounds for displays or circuits is that they can be easily produced or patterned. A common technique for this is ink-jet printing: the material is simply printed onto a substrate to create a circuit, or into tiny wells to create pixels. Printing polymers can be problematic, however, because the long molecules have limited solubility and high viscosity. Conjugated polymers, which are extremely attractive in electronic applications because of their semiconducting properties, are even harder to pattern. To get around this problem, Stefan Mecking and colleagues from the University of Konstanz, Germany, first printed a transition metal catalyst onto standard ink-jet paper. They then synthesised the desired polymer, polyacetylene, *in situ*, by exposing the



printed substrates to acetylene for a few hours, resulting in a dark-red pattern of the polymer. They chose this as a target because it is the prototype of a conjugated conducting polymer that is not processable. To demonstrate the potential use of their technique, they created an electronic calculator on a transparency sheet. The flexible keypad could be rolled up, and worked perfectly for several weeks.