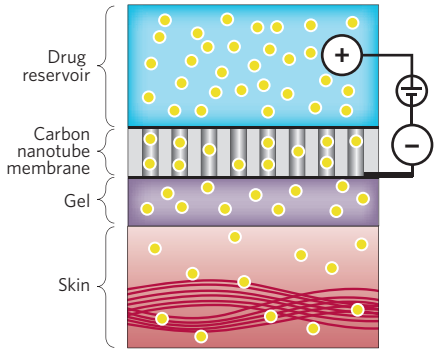
Enhanced nicotine patches

Proc. Natl Acad. Sci. USA doi:10.1073/pnas.1004714107 (2010)



The rate at which nicotine is delivered in transdermal patches is controlled by a porous membrane positioned between the nicotine-containing solution and the skin. Although the advantages of variable dosing in the treatment of drug addictions are obvious, traditional skin patches cannot provide controlled delivery rates. Recently introduced patches based on iontophoresis — electric-field-induced flow across the membrane — can provide variable dosage, but require a strong electric current across the skin, which can cause irritation. Also, the high power demand limits their applicability.

Wu *et al.*, taking advantage of the atomically smooth surface of carbon nanotubes (CNTs) and their ability to be electrochemically functionalized, were able to pump nicotine through CNT membranes faster and using much lower energy. Interestingly, the small radius of the CNTs contributes to the faster flux owing to electro-osmosis (electrically induced solvent flow). Also, the dose of nicotine switched with the voltage of the applied electric field. Long-wear patches with programmable dosage may soon become a reality.

Assembly without π

J. Am. Chem. Soc. doi:10.1021/ja1030722 (2010)

The self-assembly of porphyrins into nanostructures in organic solvents is driven by a number of different non-covalent interactions. Conversely, assembly in water has mostly been restricted to electrostatic and π–π interactions that, in water, often produce irregular aggregates and insoluble precipitates. To avoid this, Maher Fathalla *et al.* have used the host–guest interactions between β-cyclodextrin and adamantine units to assemble well-defined porphyrin nanowires in aqueous solution. The team synthesized a porphyrin with two adamantine units on each *meta* position of the *meso* phenyl rings. Adding the new porphyrin to an aqueous solution of a previously synthesized complementary porphyrin with β-cyclodextrin substituents leads to the self-assembly of nanowires made up of alternating units. Using fluorescence spectroscopy to monitor the energy transfer between porphyrin units, the team discovered that the nanowires were extremely stable, remaining intact when heated to 80 °C in the presence of disassembling agents. The approach should have important implications for new biocompatible materials.

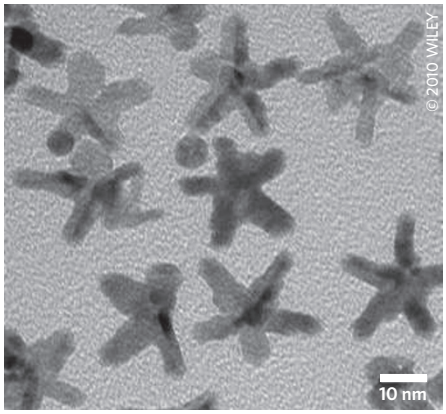
Electrical nanoswitches

Nano Lett. doi:10.1021/nl100567v (2010)

Despite the wide interest in using quantum dots and quantum rods for various device applications, one of the main obstacles to overcome is their fluorescence intermittency — or blinking — that most experts attribute to temporary charging of surface traps. Hadar Steinberg *et al.* have now demonstrated that a phenomenon similar to blinking occurs when electrical transport rather than optical emission of CdSe quantum rods is studied. The team measured the current–voltage characteristics and the current–time traces of 30-nm-long and 5-nm-wide rods through tungsten contacts. The current clearly oscillates between different values, which also in this case is a result of dynamic charging of surface traps. By studying the temperature dependence of these current instabilities the team concluded that this trapping is thermally activated. Moreover, careful analysis allowed them to establish the position of the charge traps along the rods. These measurements of current multistability can be seen as a very sensitive way to detect charge dynamics — in this case on the surface of the actual sensor.

Rhodium starfish

Angew. Chem. Int. Ed. doi:10.1002/anie.201002546 (2010)



The synthesis of Rh nanostructures of well-defined shape and size is of interest because of their potential applications in catalysis and as substrates for surface-enhanced Raman scattering (SERS). Now, Zhang *et al.* report the fabrication of fivefold-twinned Rh nanocrystals comprising five branched arms (pictured) using a polyol synthetic approach. The starfish-like crystals, which have an overall size of roughly 30 nm, grow under thermodynamic control from the corners of fivefold-twinned decahedral seeds. The reaction temperature and type of precursor are shown to influence the final product's morphology. The generation of twinned structures results from the absence of chloride ions in the precursors used, which eliminates the detrimental process of oxidative etching from the synthesis. Until now, the high-yielding formation of twinned Rh nanostructures has proven challenging because of the high susceptibility of twin defects to oxidation. Preliminary results indicate that the starfish-like crystals show improved SERS performance with respect to spherical and tripod-like Rh nanocrystals.

Antennas stretched out

Adv. Mater. doi:10.1002/adma.200904201 (2010)

In comparison with flexible electronics where devices can be bent to some degree around cylindrical structures, stretchable electronics offer far more flexibility for applications such as wearable electronics as stretchable devices can conform to almost arbitrarily shaped surfaces. With the first stretchable electronic circuits having been demonstrated, further functionality beyond electronic functions requires fresh approaches to other systems as well. To this end, M. Kubo, X. Li and colleagues from Harvard University have now realized radiofrequency antennas with unprecedented stretchability. Their approach is based on microfluidic channels made from elastic polymers that are filled with a liquid metal. As the antenna is stretched, the resonance frequency alters and can be tuned. Previously, similar antennas have shown stretchability only up to 40% strain. In the present work, a hybrid microfluidic channel was constructed, where the stiffer polymer was used for elements requiring mechanical stability, such as connectors, and a soft elastomer for the antenna parts where stretchability is necessary. The enhanced design achieves a maximum strain of 160%, and shows no sign of degradation after more than 100 stretch cycles.