# research highlights

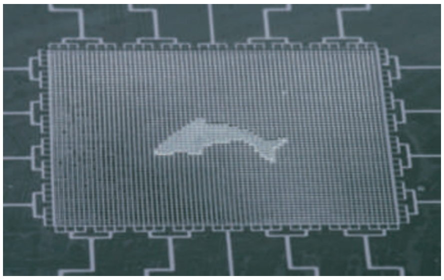
## Good on all fronts

*Supercond. Sci. Technol.* **22,** 022001 (2009)

At temperatures lower than a critical value ($T_c$), superconductors can in principle carry electrical currents without dissipation. This is only true, however, if a number of inclusions — known as pinning centres — of non-superconducting phases are inserted to stop the motion of magnetic vortices. Although many types of very efficient pinning centres have been studied in the past, they tend to create structural or chemical disorder in the material, thus reducing $T_c$. Sophie Harrington and colleagues have now identified a new type of nanoparticles, that, beside being very efficient pinning centres for the most common high-temperature superconductor, YBCO, do not seem to affect $T_c$ at all. $RE_3TaO_7$ nanoparticles — where RE is a rare earth like Er, Gd or Yb — have very similar lattice size to YBCO, and tend to be quite stable, so that structural disorder and chemical contamination of the superconductor are minimized. Indeed, introducing relatively high concentrations of $RE_3TaO_7$ yields excellent pinning properties, while keeping the $T_c$ at 92 K — as in pure YBCO.

## Polymers, actually

*Adv. Mater.* doi:10.1002/adma.200802737 (2008)



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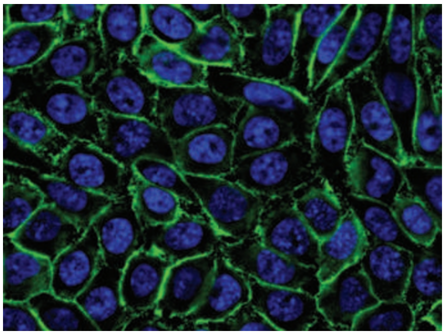
The integration of polymeric actuators into devices should see their growth from research topic to useful everyday applications. To this end, Richter and Paschew introduce an 'artificial skin', based on the reversible volume change of a stimuli-responsive hydrogel. The active layer of the device consists of a multitude of tiny individual hydrogel actuators. The pixels are patterned photolithographically on a substrate with a black underside. This ensures that light shone onto the underside from a spatially controllable source such as a liquid-crystal display is largely converted to heat. This heat is sufficient to cause a reversible volume change of more than 90% over just a 6 °C temperature difference. In the image, the depressed region within the dolphin outline is at 35 °C, while the rest of the surface is held at 29 °C using active water cooling under the substrate to ensure sharp feature edges. The image can be changed at will, as the swelling is reversible. The authors suggest a variety of applications, from microfluidic processors to communication for the visually impaired.

## Biologically compatible

*J. Am. Chem. Soc.* doi:10.1021/ja807334b (2009)



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Despite their inherent cytotoxicity, carbon nanotubes (CNTs) have been the subject of intense research for their use in biological applications. One method of overcoming the toxicity problem has been to functionalize the surface of CNTs. However, the possibility of *in vivo* desorption of the surface-bound substituents, and the likelihood of subsequent toxic effects, limits their use. As an alternative, Carolyn Bertozzi and co-workers studied boron nitride nanotubes (BNNTs); these have similar mechanical properties to CNTs but differ electrochemically and have higher structural stability. Adapting known syntheses, the team produced highly pure BNNTs that do not inhibit the growth of HEK 293 cells or induce apoptosis. Functionalizing the BNNTs with glycodendrimers increased their solubility in aqueous media and facilitated protein and cell binding. Even when the BNNTs were bound to cells no toxic effects were observed. Finally, the BNNTs were successfully used as a single-stranded DNA cell delivery transporter. Based on these findings, the development of non-toxic BNNT-based materials could lead to new biological probes and therapeutics.

## Molecular plasmonics

*Nano Lett.* doi:10.1021/nl803539 (2009)

Plasmonic systems that can manipulate and guide light at subwavelength scales should prove useful for developing nanoscale photonic integrated circuits. To realise molecular active plasmonics, a reversible shift of localized surface plasmon resonances of nanostructures by changing the interactions between molecular resonances and surface plasmon resonances is required. Tony Jun Huang and colleagues now show that a gold nanodisk array coated with rotaxane molecules and exposed to chemical reductants and oxidants exhibits reversible plasmon-based switching. This molecular plasmonic device can be operated by switching the extinction properties of a bistable rotaxane and the reversible switching correlates with the chemically driven mechanical switching observed for surface-bound rotaxane molecules. This correlation, supported by controlled experiments and a DFT microscopic model, suggest that nanoscale movement with surface-bound molecular machines can be used as the active components of plasmonic devices.

## Coupling quantum dots

*Phys. Rev. Lett.* **101,** 267404 (2008)

Quantum dots (QDs) are investigated as single-photon emitters in quantum computing schemes. However, for the realization of such scenarios, the QDs need to be embedded within microcavities of matching resonance frequency, which is made difficult by the fact that QD size and thus emission wavelength can vary considerably across a wafer. This has made the fabrication of QDs matched to microcavities an extremely challenging task. Adrien Dousse and colleagues now present an elegant solution to this problem. InAs self-assembled QDs are grown within Bragg mirrors of roughly matching resonance frequency. A photoresist is deposited on top of the structure and the wafer is then scanned with a red probe laser for QDs that match the cavity mode. A green laser beam, aligned with the red laser, then writes the pillar diameter of the microcavity into the photoresist, allowing for fine-tuning of the cavity resonance through the exact choice of pillar diameter. Even micropillars with two QDs of similar energies situated close to each other and coupled to the same cavity mode can be fabricated, facilitating much more efficient research into cavity quantum electrodynamics.