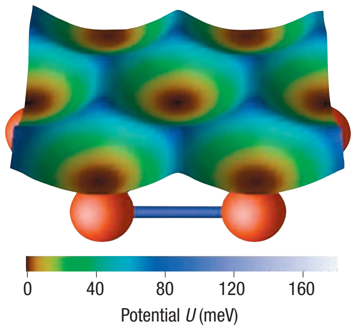
Forced to move



Science **319,** 1066–1069 (2008)

The tips of scanning probe microscopes have been used to move atoms on surfaces, producing exciting scientific results as well as stunning images, including so-called quantum corals. But the details of the dynamics by which adsorbed atoms move on different surfaces have so far not been known. Now, Markus Ternes and colleagues have used an atomic force microscope (AFM) to measure the forces exerted by the probe tips when moving atoms and molecules on surfaces. Through repeated scans of the AFM tip at various heights from the sample surface they mapped out the vertical stiffness of the tip–sample junction, observing a clear jump in the curves when the adsorbed atom or molecule hopped to the nearest available site. From the stiffness they could reconstruct the tip–adsorbate energy landscape, and, by differentiation, the force in lateral and vertical directions. Besides providing a means of designing specific atomic arrangements, this method might be extremely useful for the investigation of atomic-scale friction, atomic diffusion on surfaces and bottom-up assembly mechanisms.

Glassy interiors

Lab Chip doi:10.1039/b800001h (2008)

It is well-established that low-cost and precisely controlled microfluidic devices can be made by soft lithography techniques, using polydimethylsiloxane (PDMS) as a starting material. However, swelling of PDMS in response to organic solvents and its permeability to liquids and gases can affect the performance of devices made from it – organic solvents alter the channel dimensions and liquid/gas permeability creates problems for reactions inside the channels. Now, David Weitz and colleagues have devised a method that overcomes these disadvantages by depositing a glass-like coating on the inside of the channels, forming a chemically resistant interior. Sol–gel chemistry is used to form the protective layer from alkoxy silanes and gelation is initiated by heating the device. The thickness of the coating increases, and hence the channel dimensions decrease, by heating the device for longer. Also, the layer can be functionalized and hence used to tune the interfacial properties of the channel. This protective coating should increase the opportunities for PDMS-based microfluidic devices and extend the range of compatible chemicals.

Different on the inside

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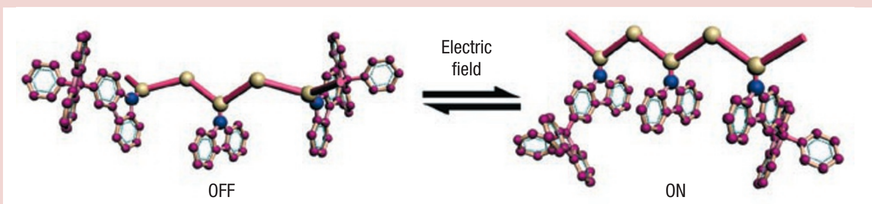
The number of applications of mesoporous materials could be greatly increased by a universal method to functionalize the inner and outer surfaces differently. For instance, it would make them ideal for applications such as drug delivery, where the outer surface of the material could be functionalized with antibodies for cell targeting, with the inner pore surface chemistry being tailored for the controlled release of medication. Gooding and colleagues manipulate surface tension and capillarity to achieve this differential functionalization, demonstrating the effect on porous silicon photonic crystals. They start by forming a monolayer of succinimide-terminated alkyl chains to provide reactive functional groups on both the outer surface of the crystal and inside the pores. The hydrophobicity of this monolayer prevents water from entering the pores, so incubation in an aqueous peptide solution results in only the outer surface being derivatized. By then using an organic solution of reactant, which in contrast to aqueous solutions can infiltrate the pores by capillary action, the internal pore surfaces are functionalized with amines. The authors show that the derivatization of the outer surface results in selective adhesion of cells: a step towards biophotonic devices.

Build one, get one free

Appl. Phys. Lett. **92,** 041102 (2008)

Quantum cascade lasers, where lasing occurs by transitions between energy states within the conduction band of a semiconductor, are attractive as they offer design flexibility of the lasing transition that is largely independent of the actual material used. On the other hand, conventional lasers that function by the interband transition of electrons recombining with holes offer less design flexibility, but generally show much lower lasing thresholds. This propensity to lase has now been used by Ohtani and colleagues to fabricate a structure that shows simultaneous lasing from interband and intersubband transitions. The design of the structure is that of a regular quantum cascade laser, where the number of electrons placed into the conduction band is controlled through doping. At high doping concentrations, the structure shows intersubband lasing, at low doping levels interband lasing, and both types of lasing simultaneously at intermediate doping levels. Such lasers might find application in gas sensing, where the two laser signals could be used in optical differentiation techniques to stabilize the detection system.

Memorable polymers



J. Am. Chem. Soc. **130,** 2120–2121 (2008)

Organic semiconductor polymers transport charge via their π orbitals, the orientation of which depends on the conformation of the polymer, and affects the charge mobility. So far there has been little work on tuning these properties. But Ling-Hai Xie and colleagues have now demonstrated the first organic non-volatile flash-memory device based on alterations of the polymer's conformation. They took poly(*N*-vinylcarbazole) (PVK) — commonly used in organic devices — which transports charge via the intrachain stacked π orbitals that result from face-to-face conformations of the carbazole (Cz) group. The researchers added the bulky phenylfluorene (PF) as a side group, with the aim of using its steric effects to tune the conformation of the polymer. On sweeping a voltage from 0 to +3 V across a sandwich device made from PVK–PF, they measured a sharp increase of current at 2.2 V — the ON state, where Cz is stacked face to face. On applying a reverse voltage sweep, the field effects induced conformational changes of the PF groups, which blocked the face-to-face orientation of Cz — the OFF state (see figure). This ON/OFF process occurred with no degradation of the conductivity, even after 10^8 cycles.