catalysts in many industrial reactions. However, the molecular dimensions of the pores can also adversely influence catalytic activity by limiting the diffusion of the reactants and products. Molecular diffusion can be enhanced by reducing the thickness of the crystals, but synthesizing zeolites with thicknesses of less than 5 nm has proved to be difficult. Now, researchers in Korea, Sweden and Japan have produced zeolite nanosheets that are only 2 nm thick — the thickness of a single unit cell.

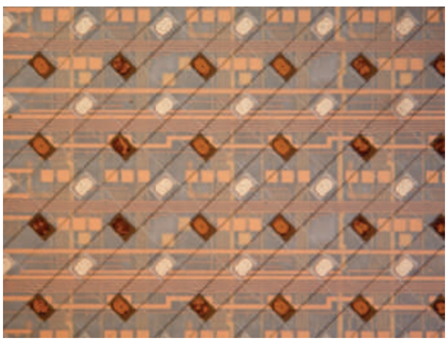
Ryong Ryoo, of KAIST, and colleagues created nanosheets of MFI zeolite — an important catalyst in the petrochemical industry — by using bifunctional surfactants that directed the formation of structures on the microporous and mesoporous length scales simultaneously. A diammonium head group controlled the structure of the MFI nanosheets, and intermolecular interaction between long-chain alkyl tails induced the formation of a lamellar structure, in which multiple nanosheets were stacked regularly or single nanosheets were randomly arranged.

Catalytic testing of the nanosheets showed that they were substantially more active and deactivated more slowly than conventional MFI zeolite.

LOGIC CIRCUITS

Memristor multiplication

Nano Lett. doi:10.1021/nl901874j (2009)



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The famous Moore's Law of computing — observing that the number of transistors on a chip, and hence processing power, approximately doubles every two years — may be limited once the smallest possible transistors are made. Even so, performance growth could continue by instead trying to get more computing power out of each transistor. Qiangfei Xia and co-workers at Hewlett-Packard have now shown how this can be achieved by building components called memristors, made from nanowires on top of standard complementary metal-oxide-semiconductor (CMOS) logic circuits.

The researchers used nanoimprint lithography to arrange two perpendicular layers of titanium dioxide nanowires with a switching material sandwiched between them, on a CMOS substrate. Memristors are formed at every junction where two nanowires cross, and are joined to the CMOS circuit by tungsten connections.

The CMOS circuitry can apply voltages to open or close the memristors. In so doing, the chip connects other CMOS components together, and can synthesize a much greater number of logic circuits.

These hybrid memristor–CMOS chips have the added advantage that the memristors remain in their open or closed states even when the power is turned off, suggesting that they could act as energy-saving memory cells. Furthermore, the fact that they were made in a commercial factory makes them a hugely promising technology for the future.

SILVER NANOSPHERES

Tiny thermometers

Adv. Mater. doi:10.1002/adma.200901313 (2009)

Many types of thermometers exist, but most function in real time and are for *in situ* detection only. In an explosion, a different type of thermometer is needed for recording temperatures during the event, which are read out only after the blast. Researchers from Boston College and MIT now show that silver nanoparticles can be used for such purposes.

Zhifeng Ren and colleagues deposited silver nanoparticles (of diameters ranging between 10 nm and 100 nm) on a carbon-coated transmission electron microscope grid and heated it to different temperatures for different durations. The size of the nanoparticles grew linearly with temperature up to about 615 °C, above which the evaporation of silver becomes significant. As more spheres evaporate at higher temperatures, the number of spheres per unit area (or areal density) decreased. The nanospheres retained their shapes and sizes after cooling down to room temperature, and so different methods could be used to estimate the temperatures of each sphere-containing region from the size and/or the areal density of the nanospheres.

Although size provided a good estimation, other parameters such as geometry and crystallinity of the nanoparticle can affect the accuracy of the temperature measurements and would require further careful investigation.

The definitive versions of these Research Highlights first appeared on the *Nature Nanotechnology* website, along with other articles that will not appear in print. If citing these articles, please refer to the web version.

Top down
Bottom up

Search and destroy

A multifunctional nanoparticle that can help doctors find and treat cancer and atherosclerosis has been synthesized.

Designing a nanoparticle for real-world cellular imaging and therapy requires the expertise of many collaborators: in the case of a recent paper by a collaboration from Texas the number was 18 (*ACS Nano* doi:10.1021/nn900440e; 2009). How did such a large collaboration come together? In short, one person at a time. Thomas Milner, an expert in biomedical optics, had been working with Marc Feldman, a cardiologist, for several years on imaging atherosclerosis with nanoparticles and optical coherence tomography. In 2006, they contacted Keith Johnston to design advanced nanoparticles to improve imaging and therapy. Kostia Sokolov added expertise on cellular studies, and Stanislav Emelianov on photoacoustic and ultrasonic imaging.

The team fabricated and characterized a nanoparticle that ticks many boxes. It is small enough (30 nm) to demonstrate uptake by macrophages, aided by a biomimetic coating. It is stable in deionized water over a period of 8 months. It absorbs light in the near infrared, where soft tissue, haemoglobin and water absorb only weakly, and shines brightly as a result. Finally, the particle is magnetically active, allowing MRI contrast imaging. It can also be used for therapy: a single laser pulse will heat a nanoparticle-laden macrophage enough to destroy it.

Such a large collaboration required a well-defined flow of ideas — what Johnston calls an event sequence: "For medical applications of nanoparticles, the clinical and biomedical constraints drive the optical and magnetic interrogation that drives the chemical engineering." The biggest challenge was "keeping the scope from growing too large, as various groups favoured certain aspects, each of which could be a full study in itself". The students, as well as the principal investigators, helped set the tone: "Most of the students need to be extroverted and educated in researching in teams, as their interactions drive the collaboration as much as those of the faculty."