

Nanoscale patterning using photochemistry

In semiconductor device fabrication, electron beam lithography has become established as the technique of choice for the fabrication of small (<100 nm) structures. However, this technique requires complex processing and is very slow, which has led researchers to investigate alternative optical techniques. Now, Shuqing Sun and Graham Leggett at the University of Sheffield (*Nanoletters* <http://dx.doi.org/10.1021/nl049540a>) have

developed a photochemical technique that allows the fabrication of structures with dimensions as small as 20 nm. The researchers use a near-field scanning optical microscope coupled to an ultraviolet laser to selectively oxidize a strongly bound monolayer adsorbed on a gold surface. The researchers were able to write lines as narrow as 20 nm on the gold film, and the resolution was found to increase as the gold grain size

was reduced. The authors propose that the higher-than-expected resolution may be due to the role played by the morphology of the gold substrate in regulating the near-field optical processes leading to photooxidation. The resolution achieved by this technique is significantly beyond the diffraction limit of light, and rivals the performance of electron beam lithography, while having the advantages of being suited to ambient and fluid environments.

Electric field effect in colloids



Centrifugation and sedimentation techniques are indispensable tools for separating and analysing macromolecules, organelles, cells and colloids. Recently, there have been several indications reporting the existence of a surprising phenomenon involving an internal macroscopic electrical field generated in the sedimentation of suspensions of charged colloidal particles. Writing in *Nature* (429, 857–860; 2004), Mircea Rasa and Albert Philipse report ultracentrifugation experiments on charged colloidal silica spheres that confirm the existence of such an electric field, and describe its drastic effects on the sedimentation profile of very dilute dispersions at low ionic strength. Their findings demonstrate that the careful analysis of the density profile for a dilute suspension of charged colloids can allow the determination of both the molecular mass and the charge of the sedimenting species. And, although it remains to be demonstrated that the phenomenon can also be measured for macromolecules, this approach is promising as a potential alternative to electrophoretic methods for characterizing globular proteins.

GLASS WITH METTLE

When asked to name a substance that is both strong and elastic, most people probably would not think of glass. And yet metallic glasses — amorphous metals with no underlying crystal structure — can be stronger than steel and less brittle. The trouble is, they are difficult to make in bulk quantities. In general, cooling a molten metal slowly leads to crystallization as it solidifies. For a truly random distribution of atoms, several different elements are melted together and cooled rapidly, although separation can happen with temperature changes. But now, Jianzhong Zhang and Yushen Zhao (*Nature* 430, 332–335; 2004) have made glassy zirconium, the first pure amorphous metal, at high pressure and temperature (above 5 GPa and 625 °C). Moreover, this amorphous phase is formed from a solid phase — bypassing any liquid phases — and demonstrates good thermal stability. On cooling to room temperature, the zirconium remains amorphous. The authors conclude that this metallic glass is both scientifically intriguing and technologically important.

Blowing bubbles



The field of microfluidics offers the possibility of miniaturizing entire chemistry laboratories down to the size of a credit card. Typically, this involves driving minuscule volumes of fluid through a network of micrometre-scale channels that connect the myriad devices such as valves, mixers, heating elements and sensors that perform the tasks of more conventional lab equipment. However, finding effective means for both constructing and driving fluids through such tiny channels is challenging. In a recent report in the *Proceedings of the National Academy of Sciences* (101, 9523–9527; 2004), Phillipe Marmottant and Sascha Hilgenfeldt suggest that by using air bubbles to focus high-frequency sound waves to direct and drive the flow of liquid in an open microfluidic system, the difficulties associated with such channels could be avoided altogether. They find that by placing a solid microparticle (in this case a quartz particle of 20 μm radius) near a larger air bubble (radius, 80 μm) in a

liquid subjected to low-intensity ultrasonic radiation, they can perturb the acoustic field around the bubble to generate a steady unidirectional flow and control the path of smaller (radius, 10 μm) tracer particles.

Suzuki in a nanoreactor

Since it was developed in the 1980s, the Suzuki reaction (the direct joining of two benzene rings) has made chemists' lives a lot simpler. By consequence, it has had a strong impact in the pharmaceutical, agrochemical and manufacturing sectors, allowing the synthesis of many different products, including herbicides, polymers and drugs for treating blood pressure. Useful though it is, the Suzuki reaction has to be carried out in organic solvents. Researchers in Korea have now found a way to make the Suzuki reaction happen in a water solution at room temperature (M. Lee, C.-J. Jang and J.-H. Ryu, *Journal of the American Chemical Society* 126,

8082–8083; 2004). They achieved this by hosting the hydrophobic reactants in the core of a micelle that functions as a nanoreactor. The micelle consists of block-copolymer molecules having a rigid hydrophobic rod-like block between two external flexible hydrophilic segments. In water these molecules self-assemble to form a nanoscale micellar structure with a hydrophobic core in which the reaction takes place. The authors speculate that this micellar system might host several types of coupling reactions similar to the Suzuki one, providing more environmentally friendly chemical processes.