

## Invasive liquid metals



When liquid metals are brought into contact with polycrystalline materials the consequences can be catastrophic — leading to embrittlement and even structural failure. The precise mechanism governing this fascinating process remains little understood, partly due to the high speed of the liquid penetration

into the bulk, reaching several micrometres per second. Wilfried Sigle and co-workers have now invented an intriguing microscopy technique for studying Al embrittlement by liquid Ga: implantation of Ga ions into the area of a grain boundary, which provides a controlled amount of Ga atoms

such that their initial propagation along grain boundaries can be observed (*Appl. Phys. Lett.* **89**, 121911; 2006). As predicted by previous theoretical models, the propagating Ga atoms are forced onto certain Al lattice places. A strong bond between Ga and Al atoms could then explain the shearing of the grains along the grain boundary that Sigle *et al.* observe. The resulting forces lead to an opening of the grain boundaries and to a further penetration of Ga. The innovative method used here could lead to additional insights into the initial processes governing liquid-metal embrittlement.

### HYBRID AlGaInAs–Si LASER

A room-temperature, electrically pumped hybrid III–V semiconductor–silicon laser has been developed by Alexander Fang and colleagues in the USA and Israel (*Opt. Express* **14**, 9203–9210; 2006). Until now such a device has evaded researchers owing to the difficulty and cost of aligning the semiconductor lasers and silicon waveguides, outweighing the savings of using low-cost silicon. Fang *et al.* overcame this by placing a AlGaInAs III–V quantum-well structure onto a patterned silicon wafer using low-temperature bonding. The resulting surface was then ion-etched, followed by annealing at high temperature. The optical mode of the laser was calculated to overlap by 75% with the silicon waveguide. The fact that both the laser and the silicon waveguide were etched at the same time, means that no alignment was needed between that and the waveguide before bonding. This bodes well for large-scale optical integration onto a silicon platform, forming low-cost lasers. The method could also be adapted to make other devices, such as optical amplifiers, by altering the waveguide dimensions and composition of the III–V layer.

## Do away with platinum

The costly platinum anode is one main reason why large-scale biological fuel cells have not yet been developed. Researchers in Germany have resorted to a tungsten carbide electrocatalytic anode and found that the performance of their biological fuel cell (comprising also a pyrolysed iron(III) phthalocyanine catode and hydrogen-producing bacteria

from soil) is remarkable with current densities up to  $3 \text{ mA cm}^{-1}$  (*Angew. Chem. Intl Edn* **45**, 6658–6661; 2006). Tungsten carbide was proposed as anode material as early as the 1970s, but its modest oxidative performance could not fulfill the requirements of chemical fuel cells. It seems to have gone virtually unnoticed in biocatalytic settings until now. However,

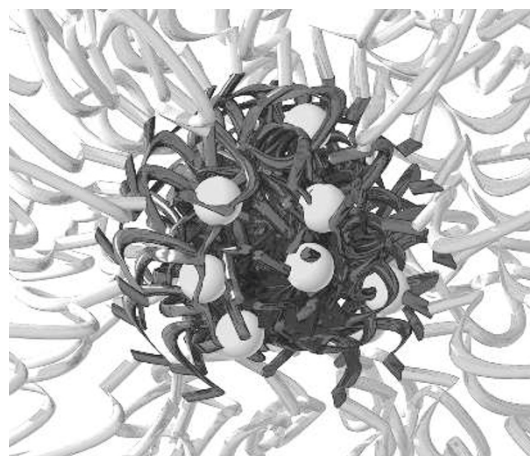
as the authors of this report note, the rate of power generation in biological fuel cells is limited by the cell metabolism so that constraint does not apply here. Other properties of tungsten carbide, such as robustness, biocompatibility and low cost, all point to its usefulness in the future development of biological fuel cells for large-scale plants.

## Smart bioreactors

Injectable nanometre-scale vesicles and particles are currently being widely investigated for targeted delivery of drugs and contrast agents in biological systems. A promising methodology is the combination of target-specific nanoscale polymer vesicles with multifunctional biological components such as enzymes and transmembrane pore proteins. Patrick Hunziker and colleagues now report the loading of a known cell-targeting polymer vesicle with a pH-sensitive enzyme, by integrating bacterial pore proteins into the otherwise impenetrable triblock-copolymer membrane

of the vesicle (*Nano Lett.* **6**, 2349–2353; 2006). This approach shows that it is possible to design a nanoscale bioreactor that has size-selective diffusion governed by a specific trigger mechanism — in this case pH — that enables external control of its activity. The authors believe that the principle of this nanoscale reactor will prove crucial for equipping artificial systems with an increasingly complex range of biological functionalities, and should prove directly applicable as a stable carrier with complex and automated diagnostic and therapeutic properties.

## Polymers pull together



The morphology of block-copolymer blends can be controlled using charge-transfer interactions, report Ikkala and colleagues (*Macromolecules* doi:10.1021/ma061165g; 2006). They use blends of a pyridine-containing block copolymer and fullerene molecules. Fullerenes are electron deficient, and are known to form charge-transfer complexes with pyridine, which is electron-donating. Ikkala and colleagues therefore use a block copolymer formed from polystyrene (PS) and poly(4-vinylpyridine) (P4VP). This polymer's usual morphology in films cast from xylene consists of tightly bound cylinders of P4VP chains surrounded by coronas of PS blocks, resulting from the fact that xylene is a good solvent for PS and a poor solvent for P4VP. When  $C_{60}$  is added, it initially swells the PS blocks, as xylene is also a good solvent for  $C_{60}$ . After ageing the solutions, however, a charge-transfer complex between the P4VP and  $C_{60}$  forms, swelling the P4VP cores instead. This should be expected to result in a lamellar morphology in films, but the authors observe spheres. They postulate that as  $C_{60}$  forms complexes with up to six P4VP sections, the tighter sphere morphology is favoured.