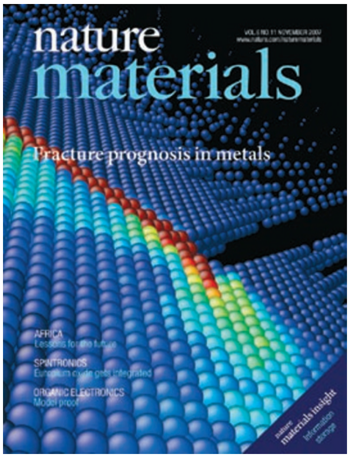


Cover story

Vol.6 No.11 November 2007

The propagation of cracks is one of the most important aspects of the mechanical properties of metals. Curiously, the fundamental processes occurring in the crack propagation front remain little understood; for example, theories have suggested the formation of twin boundaries in aluminium, whereas this has never been observed in experiments. Derek Warner and colleagues now solve this discrepancy by using a multiscale computer algorithm that is able to model the crack-tip behaviour in f.c.c. metals such as aluminium across multiple length- and timescales. The authors are able to study nanoscale fracture for more realistic loading conditions than in previous models. Indeed, the predicted trends in crack propagation confirm experimental observations, and highlight the significant influence of loading rates on the fracture process.
[Article p876; News & Views p795]

THE CHOSEN ONE

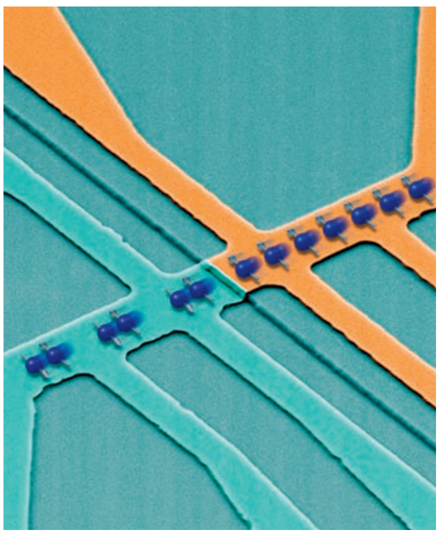
Light-emitting electrochemical cells (LEECs) are organic electronic devices that use mobile ions as charge carriers in the active layer. This circumvents the need for reactive metal electrodes, which is one of the disadvantages of the LEEC's cousins, light-emitting diodes (LEDs). However, there is controversy over the operating mechanism of LEECs; two models exist, with neither one universally accepted. Malliaras and colleagues elucidate the operating mechanism for one type of LEEC. On model, planar devices, they use atomic force microscopy to directly measure the electric field distribution between the device's electrodes, providing evidence for the 'electrohydrodynamic' model of operation.
[Article p894; News & Views p796]

COOPERATIVE CONDUCTION

A crucial requirement for solid-oxide fuel cell devices is fast-ion conduction in electrolyte materials. Particular attention has recently been devoted to proton-conducting ceramics containing tetrahedral moieties, but an atomistic–scale understanding of the conduction mechanism in these systems is still lacking. Peter Slater and colleagues now demonstrate that in gallium-based oxides oxide-ion conduction proceeds via a cooperative process involving the breaking and re-formating of Ga_2O_7 units, whereas proton conduction arises around gallate tetrahedrons. Similar transport mechanisms should also explain ionic conduction characteristics in related oxide systems containing tetrahedral moieties.
[Letter p871]

A GOOD MATCH FOR SPINTRONICS

The integration of spintronics devices with present electronic systems requires materials with high spin-polarization and structural compatibility with silicon. Andreas Schmehl and colleagues demonstrate that europium oxide could be a good candidate. Although previous studies have suggested the existence of high spin-polarization in EuO, this study shows for the first time that stable thin films of lanthanum-doped EuO can be grown epitaxially on silicon and on gallium nitride, and that the spin population is almost fully polarized. These results could enable the realization of practical and efficient devices that work through spin manipulation.
[Article p882; News & Views p798]



Epitaxial integration of highly spin-polarized europium oxide on silicon and gallium nitride.

p882

THE RIPPLE EFFECT

The experimental observation of ripples in graphene, an example of a two-dimensional crystal, poses questions about the existence of these undulations and their role in the stability and electronic properties of the material. Annalisa Fasolino and colleagues now have theoretical results showing that a graphene sheet forms spontaneous ripples, with wavelengths of around 50 carbon–carbon bond lengths, in order to balance oscillations due to thermal fluctuations. Monte-Carlo simulations illustrate how this buckling mechanism, which occurs via variations in the carbon–carbon bond lengths, is an intrinsic property rather than an experimental artefact, and is responsible for stabilising the graphene sheet.
[Letter p858; News & Views p801]

DYNAMIC PHOTONIC CRYSTALS

Two-dimensional photonic crystals have recently had remarkable success. Owing to advanced fabrication techniques and optimized design of these crystals, microresonators have been fabricated within them that can store light up to two million times the oscillation period of a photon. However, to use such microresonators in, for example, quantum information processing, non-destructive control over the stored photons is required. Susumu Noda and colleagues now report on a scheme that achieves precisely this. Short laser pulses induce variations in the coupling between the microresonator and a nearby waveguide, and thus enable the controlled storage and release of photons.
[Letter p862; News & Views p799]

FULL OF HOLES

Highly regular arrays of toroidal holes can form in smectic liquid crystals when they are confined in micrometre-sized channels. Jung and colleagues explore this phenomenon, and use direct visualization of the inside of the toroids to show that the smectic layers of the liquid crystals are aligned normal to the side walls. The authors go on to demonstrate the concept of 'smectic liquid crystal lithography' by confining fluorescent particles in the holes. When the liquid crystal template is removed, ordered arrays of particles are left. Given the inherent regularity of the arrays of toroidal holes, this method could have advantages over existing approaches for lithographic applications.
[Letter p866]

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