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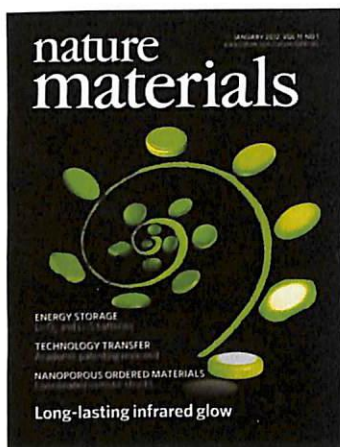


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Li-O<sub>2</sub> and Li-S batteries

**TECHNOLOGY TRANSFER**  
Academic patenting reviewed

**NANOPOROUS ORDERED MATERIALS**  
Coordinated osmotic shocks

**Long-lasting infrared glow**



**COVER IMAGE**

Persistent phosphors are known from applications such as night-vision goggles where they produce a characteristic green afterglow.

The discovery of persistent phosphors that instead operate at near-infrared wavelengths with much longer afterglows may now enable new applications in night-vision surveillance and in bio-imaging.

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IMAGE: ZHENGWEI PAN AND FENG LIU

COVER DESIGN: DAVID SHAND

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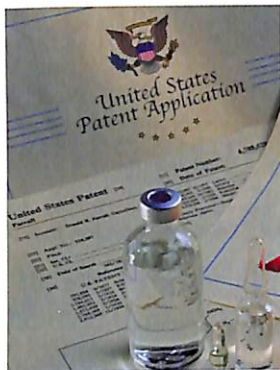
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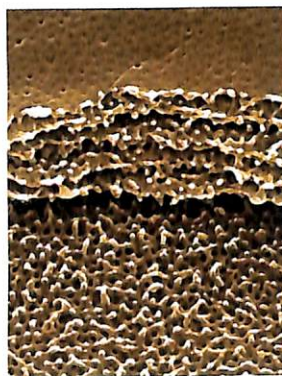




Technology-transfer activities are on the rise, but only a few academic patents are bound to become a commercial success. This issue explores the challenges of protecting early-stage technology, and highlights successful academic patenting strategies in the case of graphene-related inventions.

(Image: © Getty Images)

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Vesicles can rupture as a result of an imbalance in osmotic pressure between their inside and the exterior.

Such an 'osmotic shock' has now been multiplexed in a coordinated fashion within an ordered material in which a minor component swells and ruptures, thus leading to a porous bicontinuous structure.

Such perforated ordered materials may find applications in photonics, optoelectronics and nanofiltration.

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**COVER IMAGE**

Highly monodisperse silver polyhedral nanocrystals passivated with polymers are shown to behave as quasi-hard particles that self-assemble by sedimentation into millimetre-sized, three-dimensional supercrystals, which correspond to the particles' three-dimensional densest packings. Monte Carlo simulations confirm the observed self-assembled structures, including an exotic structure for octahedra that is stabilized by depletion forces induced by an excess of polymer in solution.

Letter p131

IMAGE: JOEL HENZIE AND PEIDONG YANG

COVER DESIGN: DAVID SHAND

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Kinks show up

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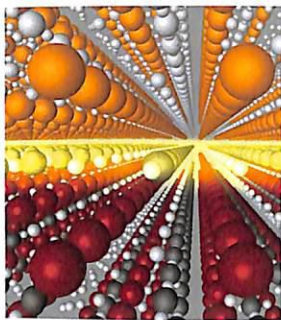
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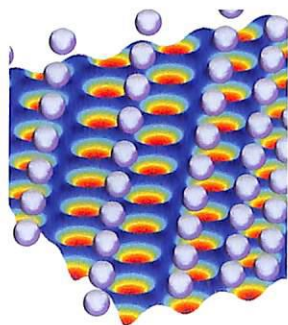
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Oxide materials show an amazing variety of electronic and ionic phenomena. In this focus issue we review the progress in oxide thin-film technology and highlight the outstanding challenges for the fundamental understanding and practical implementation of complex oxides in devices. (Image: J. Mannhart & A. Herrnberger) Editorial p91; Commentary p92; Review Article p103



The frictional properties of a two-dimensional colloidal crystal reveal that excitations known as kinks and antikinks form when the crystal is dragged along a solid surface. This phenomenon, which was predicted previously but never observed, demonstrates the potential of using colloidal crystals to study frictional properties that are otherwise difficult to characterize. Letter p126; News & Views p97

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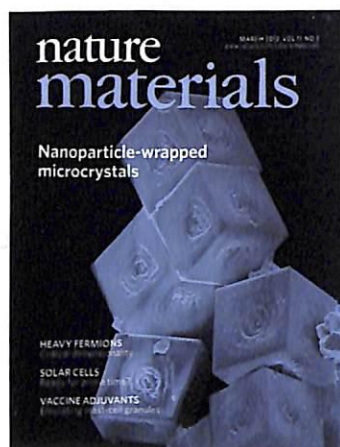
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**COVER IMAGE**

The growth of microcrystals can be controlled by various agents such as ions, small charged molecules and polyelectrolytes. However, their use is specific to the crystallizing material. It is now shown that oppositely charged nanoparticles can act as 'universal' surfactants for controlling the growth and stability of microcrystals of inorganic salts and of charged organic molecules.

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IMAGE: DAVID A. WALKER AND  
BARTLOMIEJ KOWALCZYK

COVER DESIGN: DAVID SHAND

**ON THE COVER****Heavy fermions**

Critical dimensionality

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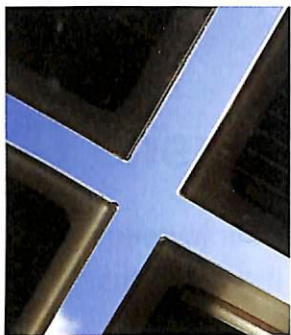
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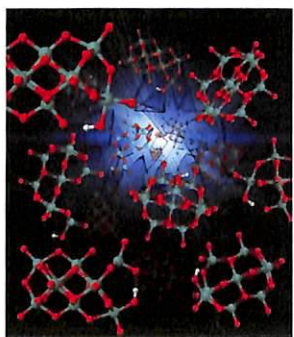
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Progress in photovoltaic technology could soon mean grid parity for solar electricity. In this focus issue we highlight the scientific as well as science-policy strategies aimed towards achieving this goal. (Image: © Getty Images) Editorial p173; Commentary p174; Interview p178



Dissolution processes affect the performance of oxides in applications ranging from power generation to catalysis. A study on polyoxometalate ions, which are thought to model oxide surfaces, now suggests that dissolution is controlled by the stability of transient oxygen-stuffed structures. Letter p223; News & Views p183

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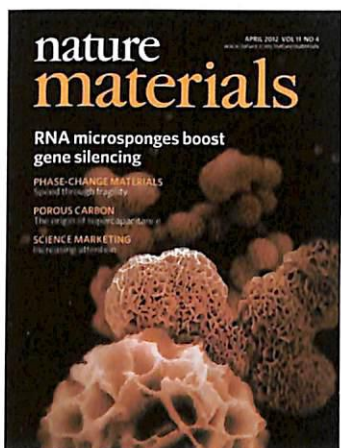
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**COVER IMAGE**

siRNA delivery has so far been hampered by carriers that inefficiently encapsulate RNA, and by its degradation prior to cellular uptake. Now, self-assembled crystalline microsponges consisting solely of cleavable RNA strands — which are converted to siRNA only after cellular uptake — achieve, with three orders of magnitude lower concentration, the same degree of gene silencing as conventional siRNA nanocarriers. Letter p316; News & Views p268

IMAGE: JONG BUM LEE

COVER DESIGN: DAVID SHAND

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Phase-change materials

Speed through fragility

Letter p279; News &amp; Views p270

Porous carbon

The origin of supercapacitance

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Science marketing

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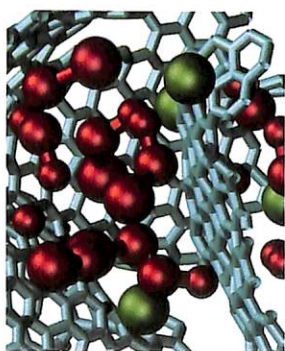


To ensure that their work gets the attention it deserves, scientists need to engage with different stakeholders ranging from colleagues to funding agencies and the general public. In this focus issue we explore concepts from marketing that could help scientists in this effort, and highlight the latest online tools and services for successful science communication.

(Image: © Getty Images)

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Although the superior electrochemical performance of supercapacitors capable of rapidly storing electrical energy is due to reversible ion adsorption in porous carbon electrodes, the molecular origin of this phenomenon is still poorly understood. A quantitative picture of the structure of an ionic liquid adsorbed inside realistically modelled microporous carbon electrodes is now proposed.

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### COVER IMAGE

The maximum imaging resolution in classical optics is limited to approximately the wavelength of light used, and subwavelength resolution can only be achieved by advanced imaging schemes. The appeal of the super-oscillatory lens optical microscope described here is that it enables subwavelength imaging with, in principle, unlimited resolution using a modified conventional microscope.

Letter p432

IMAGE: PHIL SAUNDERS, SPACE CHANNEL UNIV. SOUTHAMPTON

COVER DESIGN: DAVID SHAND

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Advanced hologram designs  
Article p450

#### Dendritic polymers

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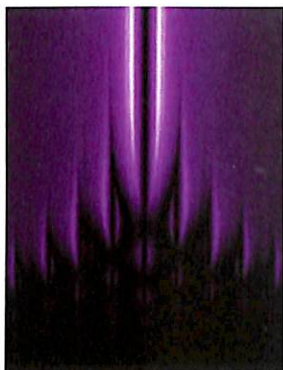
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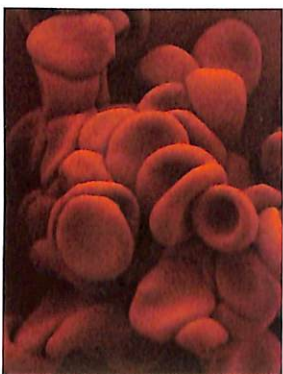






The observation of a superconductive current flowing through a topological insulator is considered the first step towards the observation of the elusive Majorana fermions. This is now achieved in a superconductor/topological insulator/superconductor junction in which direct evidence of Josephson supercurrents is reported.

Letter p417



The headgroup of phospholipids in eukaryotic cell membranes contains phosphatidyl choline (PC). Now, branched polyglycerols decorated with the 'PC-inverse' choline phosphate (CP) are shown to behave as 'universal' biomembrane adhesives, binding electrostatically to cell membranes and to PC-containing liposomes. Binding can be reversed by exposure to PC-containing polymers. These adhesives may find use as tissue sealants and as drug-delivery vehicles.

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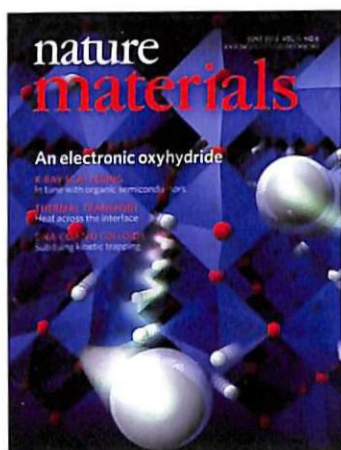
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**COVER IMAGE**

The substitution of oxygen by hydride anions in oxide materials to form oxyhydrides has been difficult to achieve because it requires highly reducing conditions without transferring an electron from the hydride. An oxyhydride of  $\text{BaTiO}_3$  that is electronically conducting, stable in air and water at ambient conditions, and exchangeable with hydrogen gas at 400 °C, has now been prepared.  
Letter p507

IMAGE: SCIENCE GRAPHICS

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**X-ray scattering**  
In tune with organic semiconductors  
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**Thermal transport**  
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Letter p502

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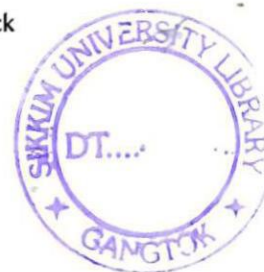
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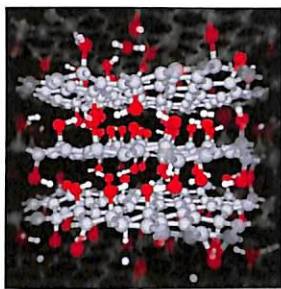
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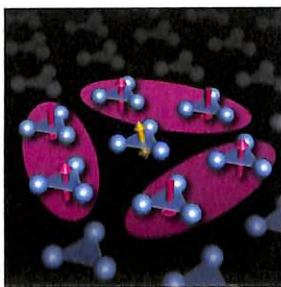






Graphene oxide could potentially be used for numerous applications, particularly in electronics. Understanding its structural stability in an ambient atmosphere is essential for the realization of devices. A study now shows that multilayer graphene oxide is in fact metastable at room temperature.

Article p544



Geometrically frustrated magnets are systems where it is impossible for all magnetic interactions to occur simultaneously. The discovery of frustrated magnetism in a system where the magnetic moments are situated across clusters of transition metal elements instead of individual ions promises a new approach for controlling such magnetic states.

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**544** Room-temperature metastability of multilayer epitaxial graphene oxide

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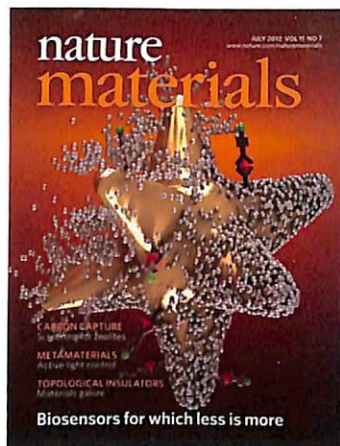
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### COVER IMAGE

Conventional sensors generate a signal that is directly proportional to the concentration of the target molecule. Now, by means of an enzyme that controls the growth of silver nanocrystals on plasmonic transducers, a nanosensor with sensitivity that is inversely proportional to concentration, and can detect ultralow concentrations of the cancer biomarker prostate-specific antigen in whole serum, is demonstrated. Letter p604; News & Views p570

IMAGE CREDIT: MIGUEL SPUCH CALVAR

COVER DESIGN: DAVID SHAND

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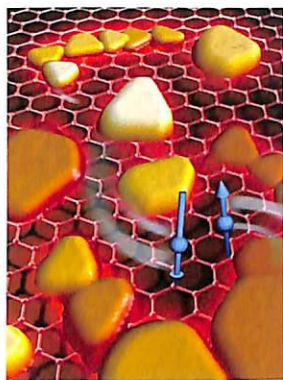
590 **Electrical control of the superconducting-to-insulating transition in graphene-metal hybrids**  
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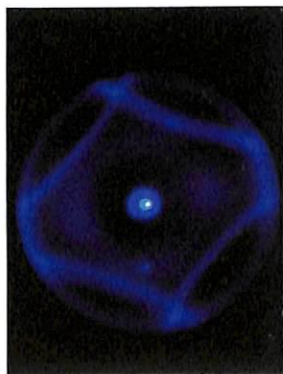
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Although intrinsic superconductivity in graphene has not been demonstrated yet, superconductivity in this material can be induced by the proximity effect. The deposition of metallic nanoparticles on a graphene layer allows the status of graphene to be tuned from insulating to superconducting. This metal-graphene hybrid material can therefore be seen as a model system for elucidating the properties of inhomogeneous superconductors. (Image: Z. Han and V. Bouchiat, CNRS-Grenoble.) Letter p590; News & Views p567



Liquid-crystalline order can be templated in a material by refilling a photopolymerized liquid-crystal cast with the material after the non-polymerized portion has been washed out. This approach has now been used to template, in achiral liquid crystals, chiral three-dimensional blue phases with unprecedented thermal stability that are suitable for narrowband mirrorless lasing and switchable electro-optic devices. Letter p599

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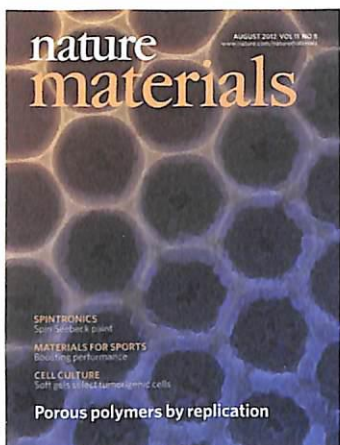
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**COVER IMAGE**

The spatial organization of porous coordination-polymer crystals into higher-order structures is critical for their integration in heterogeneous catalysts, separation systems and electrochemical devices. A method for spatially controlling the nucleation site leading to the formation of mesoscopic architecture in porous coordination polymers, in both two and three dimensions, is now demonstrated.

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COVER IMAGE: SHUHEI FURUKAWA

COVER DESIGN: DAVID SHAND

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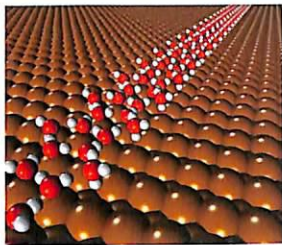
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When water binds to solid surfaces it forms a large variety of structures, which leads to behaviour relevant to many technological processes and phenomena such as lubrication, heterogeneous catalysis and electrochemistry. A Review in this issue discusses current understanding of the interface between water and flat metal surfaces at the atomic and molecular levels, as well as open questions in this field.  
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The history of the Olympic and Paralympic Games has shown that new materials can play a pivotal role in boosting athletes' performance. In this Focus issue we highlight the origins of sports technology, the latest developments in high-performance materials from academic and industrial viewpoints, and recent progress in bone, cartilage and spinal cord repair.  
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**COVER IMAGE**

*Nature Materials* is ten years old. The word cloud on the cover shows the 222 words that appeared at least ten times in all the titles published in the journal (including news items). The size and colour intensity of each word are proportional to its frequency, counts for word derivations were aggregated into one form, and common English words, names of disciplines and the word 'materials' were not included.  
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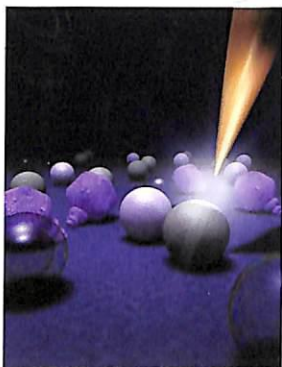
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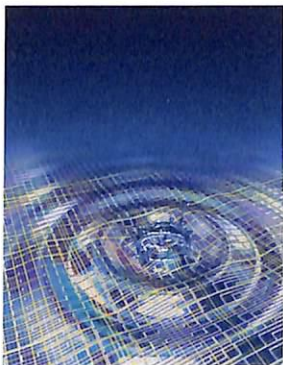
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Electrostatic force microscopy with sub-piconewton resolution can now be used for the label-free identification of materials of single dielectric nanoparticles of similar morphology but distinct low-polarizable materials. The technique can also distinguish between empty and DNA-containing virus capsids, and should be extensible to the characterization of surface and subsurface dielectric properties of nanoscale dielectrics and biological macromolecules in general.

Article p808; News & Views p748



Flexible strain-gauge sensors, which could eventually be used in electronic skin, generally require complex device architectures. A simple and highly sensitive resistive sensor for the detection of pressure, shear and torsion with discernible strain-gauge factors has now been fabricated using two interlocked arrays of platinum-coated polymer nanofibres.

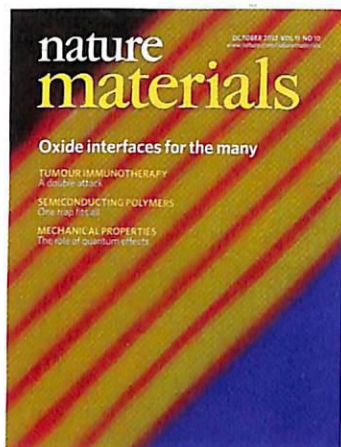
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## COVER IMAGE

The electronic interactions at the interface of oxide materials promise properties that can be very different from those of the parent compounds. The finding that many-body interactions in oxide superlattices can be used to engineer electronic properties offers a new strategy for designing oxide heterostructures. Letter p855; News & Views p833

COVER IMAGE: JULIA A. MUNDY

COVER DESIGN: DAVID SHAND

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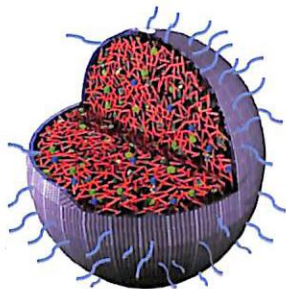
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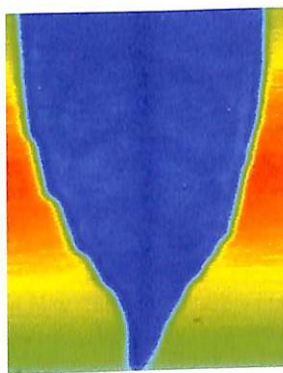
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The sustained release of both hydrophilic and hydrophobic immunomodulators for metastatic melanoma by nanoscale liposomal polymeric gels administered intratumorally or systemically is demonstrated. It is also shown that such a co-delivery approach delays tumour growth and increases the survival of tumour-bearing mice, and that its efficacy results from the activation of both innate and adaptative immune responses. Article p895; News & Views p831



Its high carrier mobility is one of the factors that makes graphene interesting for electronic and photonic applications at terahertz frequencies. Such possibilities are now further supported by the demonstration of an efficient room-temperature graphene detector for terahertz radiation that promises to be considerably faster than competing techniques. Letter p865

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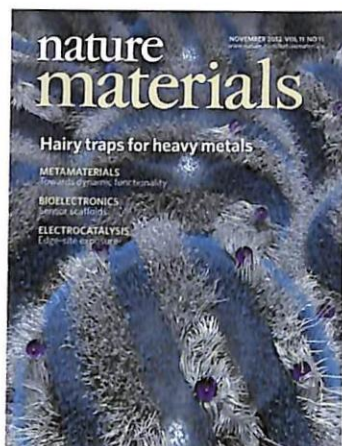
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**COVER IMAGE**

Solid-state sensors for the detection of heavy-metal cations require for the most part sophisticated chemistry and equipment. It is now shown that toxic cations in environmental samples can be detected with ultrahigh sensitivity and over a broad range of cation concentrations by measuring the tunnelling current across films of nanoparticles decorated with striped monolayers of organic ligands.

Article p978; News & Views p913

COVER IMAGE: THOMAS M. HERMANS,  
NORTHWESTERN UNIV.

COVER DESIGN: DAVID SHAND

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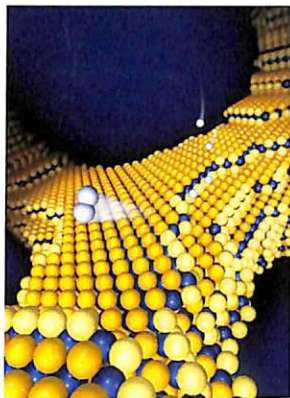
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- 948 **Fractionalization of interstitials in curved colloidal crystals**  
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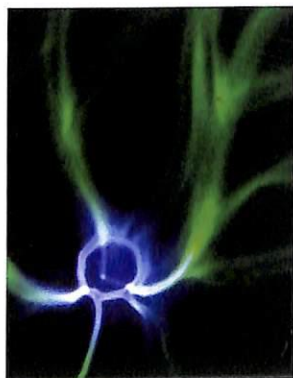




Controlling surface structure at the atomic scale is paramount to developing effective catalysts. The surface structure of MoS<sub>2</sub> is now engineered to preferentially expose edge sites by successfully synthesizing contiguous large-area thin films of a highly ordered double-gyroid MoS<sub>2</sub> bicontinuous network with nanoscale pores.

(Image: © Jakob Kibsgaard, Zhebo Chen and Thomas F. Jaramillo)

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Three-dimensional bioactive scaffolds can support tissue growth for studies in cellular biophysics and regenerative medicine. Such scaffolds have now been integrated with semiconductor nanowires to probe their porous interior, allowing for real-time monitoring of signals such as the response of neural and cardiac tissue models to drugs.

(Image: © Tian, Lieber and Kohane Groups, Harvard University and Boston Children's Hospital)

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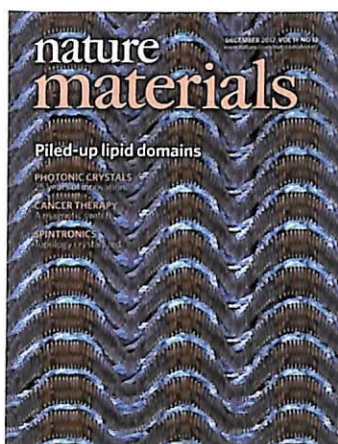
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**COVER IMAGE**

Stacked lipid bilayers usually display smectic order. It is now found that multicomponent stacked bilayers can also exhibit columnar order, which arises from the coupling of interlayer smectic order and intralayer phase-separated domains, and propagates across hundreds of layers. It is postulated that such long-range alignment of lipid domains is assisted by the surface tension associated with the differences in hydrogen bonding of the water molecules between coexisting phases.

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COVER IMAGE: ATUL N. PARIKH,  
JIGISHA B. PARIKH AND STEVEN OERDING  
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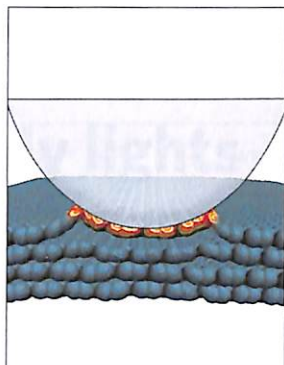
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Classically, friction is known to increase with increasing normal load. Scanning probe experiments now show that reversible local delamination of chemically modified graphite can lead to an enhancement in friction as the applied load decreases, resulting in an effectively negative friction coefficient.

Letter p1032; News & Views p1004



Implantable neural microelectrodes are critical to neuroscience research and emerging clinical applications including brain-controlled prostheses.

A composite electrode consisting of a carbon fibre core, an insulating polymer coating and a polythiophene-based recording pad has now been developed that shows reduced chronic reactive tissue response in rats compared with existing architectures, owing to its smaller size and improved mechanical compliance with brain tissue.

(Image: © Huanan Zhang and Takashi D. Y. Kozai)

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