

# ADVANCED FUNCTIONAL MATERIALS

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## Lithography

Nanosphere lithography with nanosphere–protein conjugates is proposed by R. E. Gyurcsányi and co-workers as a generic method to create surface molecularly imprinted polymer films for selective protein recognition. On page 4703, electrosynthesis of a polymer film in the voids of the nanosphere array followed by removal of the nanospheres generates complementary cavities bearing the imprints of the proteins.

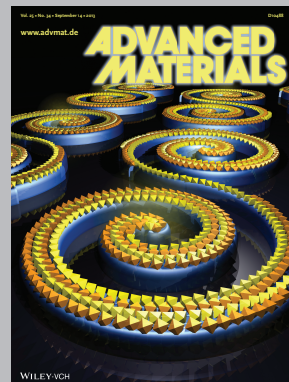
## Microcapsules

A. R. Patel, K. P. Velikov, and co-workers report novel all-natural microcapsules fabricated by utilisation of the spontaneous non-covalent interactions between a biopolymer gelatin and a natural resin-shellac. On page 4710, versatile applications of these novel microcapsules for pharmaceuticals (encapsulation and release of bioactive molecules), foods (loading of colorants and flavors), sensors (encapsulation of pH sensitive dye), and biotechnology (enzyme immobilization) fields are successfully demonstrated.



## Graphene

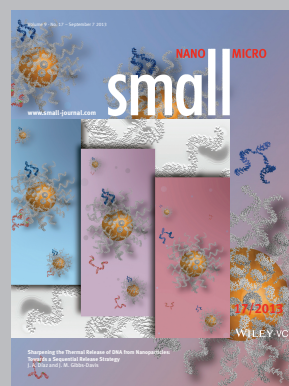
A graphite ‘flower’ is produced by V. Palermo and co-workers in order to study the production and exfoliation mechanism of soluble of graphene and graphene oxide nanosheets due to chemical etching, electrochemical treatment, or sonication in organic solvents of bulk graphite. In the background of the back cover image, the same material is visualized by electron microscopy. The exfoliation process and roughening of the flat graphite substrate upon exfoliation is directly visualized at the nanoscale on page 4684.



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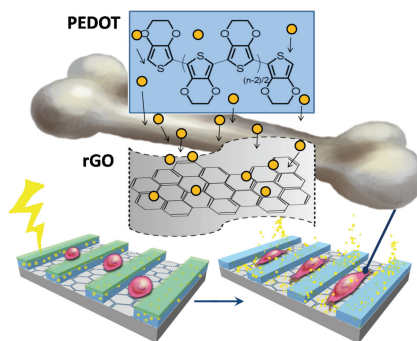
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# FULL PAPERS

## Electrodes

Y.-S. Hsiao, C.-W. Kuo,  
P. Chen\* .....4649–4656

**Multifunctional Graphene–PEDOT  
Microelectrodes for On-Chip  
Manipulation of Human Mesenchymal  
Stem Cells**



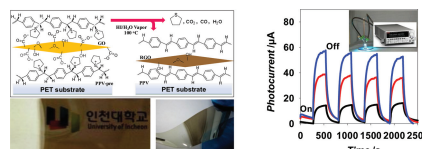
The **multifunctional organic bioelec-  
tronic interfaces** composed of integrated  
reduced graphene oxide (rGO) and drug  
dexamethasone 21-phosphate disodium  
salt (DEX)-loaded poly(3,4-ethylenedi-  
oxythiophene) (PEDOT) microelectrode  
arrays are reported. They can be used  
to manipulate the attachment, orien-  
tation, and differentiation of human  
mesenchymal stem cells (hMSCs) for  
long-term cell culturing through electrical  
stimulation.

## Flexible Electronics

B.-H. Wee, J.-D. Hong\* .....4657–4666

**A Method for Fabricating an Ultrathin  
Multilayer Film Composed of Poly(*p*-  
phenylenevinylene) and Reduced  
Graphene Oxide on a Plastic Substrate  
for Flexible Optoelectronic Applications**

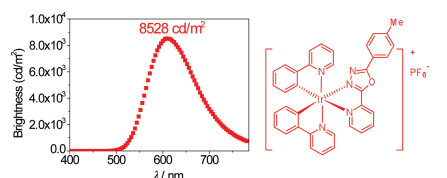
A **novel method for the fabrication of a uniform ultrathin multilayer film** composed of  
alternating poly(*p*-phenylene vinylene) and reduced graphene oxide layers on a plastic  
substrate is reported for flexible optoelectronic applications. The ultrathin photodiode  
exhibits extraordinary optoelectric characteristics, including photocurrent and photo-  
responsivity; these are among the best values achieved in carbon-based materials.



## Light-Emitting Diodes

J. Zhang, L. Zhou, H. A. Al-Attar,  
K. Shao, L. Wang, D. Zhu,\*  
Z. Su,\* M. R. Bryce,\*  
A. P. Monkman .....4667–4677

**Efficient Light-Emitting Electrochemical  
Cells (LECs) Based on Ionic Iridium(III)  
Complexes with 1,3,4-Oxadiazole  
Ligands**

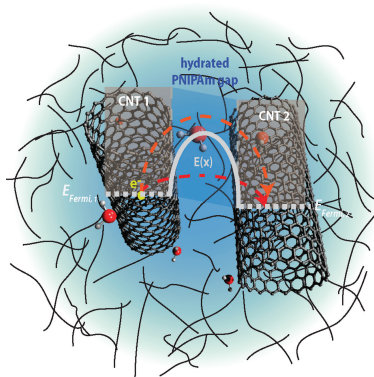


**2,5-Diaryl-1,3,4-oxadiazole derivatives** are  
shown to be versatile cyclometalating  
C^N and coordinating N^N ligands for  
ionic iridium complexes that are fabri-  
cated into light-emitting electrochemical  
cells (LECs). High brightness red emis-  
sion from a LEC at a driving voltage of 10 V  
is observed.

## Carbon Nanotubes

G. E. Fernandes,\* J. H. Kim,  
A. K. Sood, J. Xu .....4678–4683

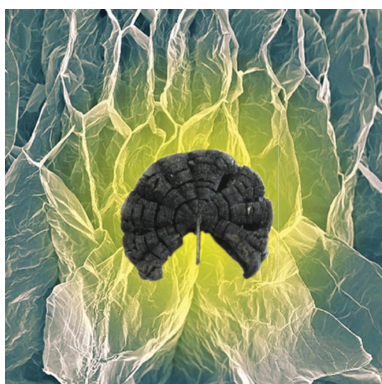
**Giant Temperature Coefficient of  
Resistance in Carbon Nanotube/Phase-  
Change Polymer Nanocomposites**



A **carbon nanotube phase-change nano-  
composite with a hydrogel achieves giant  
temperature coefficients of resistance**  
resulting from a phase-transition that  
directly changes the tunneling poten-  
tial that electrons experience in moving  
between nearby nanotubes. The bolo-  
metric photoresponses of this material  
are studied and its giant responses to  
temperature and humidity give it great  
potential for sensor applications and  
uncooled infrared detection.

## FULL PAPERS

The different exfoliation routes of graphite to produce graphene by sonication in solvent, chemical oxidation, and electrochemical oxidation are compared. The results obtained show the trade-off between exfoliation speed and preservation of graphene quality. A key step to achieve efficient exfoliation is to couple gas production and mechanical exfoliation on a macroscale with non-covalent exfoliation and preservation of graphene properties on a molecular scale.

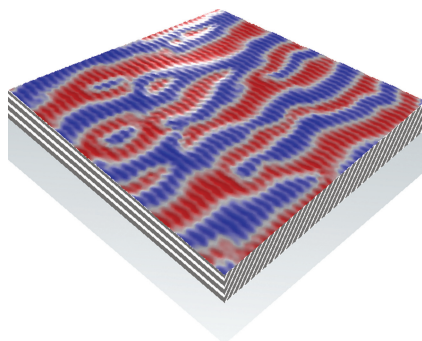


## Graphene

Z. Y. Xia, S. Pezzini, E. Treossi,  
G. Giambastiani, F. Corticelli,  
V. Morandi, A. Zanelli, V. Bellani,  
V. Palermo\* .....4684–4693

### The Exfoliation of Graphene in Liquids by Electrochemical, Chemical, and Sonication-Assisted Techniques: A Nanoscale Study

Coupling of structural and micromagnetic properties of ferromagnetic Ni-Mn-Ga shape memory thin films is investigated by means of three dimensional numerical simulations and temperature dependent magnetic force microscopy measurements across the martensite and Curie temperatures. A stress-induced magneto-crystalline anisotropy is detected within the austenite phase, which is quantified based on a model of partial flux closure.

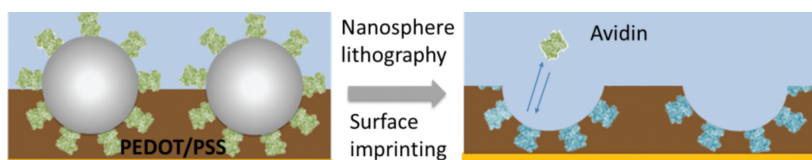


## Nanostructures

A. M. Jakob, M. Hennes, M. Müller,  
D. Spemann, S. G. Mayr\* .....4694–4702

### Coupling of Micromagnetic and Structural Properties Across the Martensite and Curie Temperatures in Miniaturized Ni-Mn-Ga Ferromagnetic Shape Memory Alloys

A versatile approach based on nanosphere lithography is proposed to generate surface-imprinted polymers for selective protein recognition. Nanogravimetric measurements demonstrate that the protein (avidin) coating of the nanospheres generates selective recognition sites for avidin on the surface of the PEDOT/PSS film. This methodology coupled with oriented conjugation of the macromolecular template to the nanospheres offers the possibility of site-directed imprinting.



## Lithography

J. Bognár, J. Szűcs, Z. Dorkó, V. Horváth,  
R. E. Gyurcsányi\* .....4703–4709

### Nanosphere Lithography as a Versatile Method to Generate Surface-Imprinted Polymer Films for Selective Protein Recognition

Novel all-natural microcapsules fabricated from biopolymers, protein (gelatin) and resin (shellac), using a simple extrusion method. Furthermore, a range of biorelated applications including encapsulation and release of bioactives, loading of colorants and pH sensitive dye, temperature-triggered flavor release, and enzyme immobilization are successfully demonstrated.



## Microcapsules

A. R. Patel,\* C. Remijn, A. M. Cabero,  
P. C. M. Heussen, J. M. S. ten Hoorn,  
K. P. Velikov\* .....4710–4718

### Novel All-Natural Microcapsules from Gelatin and Shellac for Biorelated Applications



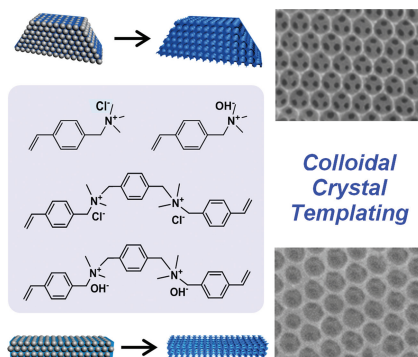


## FULL PAPERS

## Colloidal Crystals

H. He, M. Zhong, D. Konkolewicz,  
K. Yacatto, T. Rappold, G. Sugar,  
N. E. David, J. Gelb, N. Kotwal, A. Merkle,  
K. Matyjaszewski\* .....4720–4728

### Three-Dimensionally Ordered Macroporous Polymeric Materials by Colloidal Crystal Templating for Reversible CO<sub>2</sub> Capture



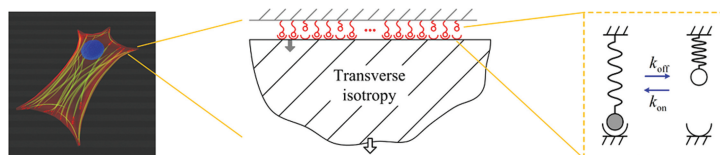
Novel functionalized three-dimensionally ordered macroporous (3DOM) polymeric materials with well-interconnected and chemically stable structures are created through templating with latex colloidal crystals. These materials display improved CO<sub>2</sub> air capture performance compared to a commercially available resin. A versatile strategy is developed to prepare functional porous polymers by colloidal crystal templating, which opens up the use of 3DOM materials for CO<sub>2</sub> capture.

## Anisotropic Materials

W. Zhang, Y. Lin, J. Qian,\* W. Chen,\*  
H. Gao .....4729–4738

### Tuning Molecular Adhesion via Material Anisotropy

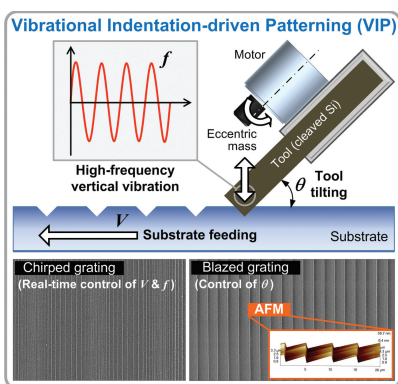
The collective behaviors of multiple receptor-ligand bonds between a cell and a transversely isotropic matrix are investigated using a two-level model in which the reversible processes of stochastic bond rupture and rebinding at molecular scale and the elastic response of transversely isotropic materials to bond force distributions at continuum scale are integrated.



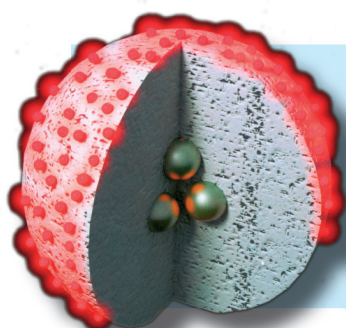
## Lithography

S. H. Ahn, J. G. Ok, M. K. Kwak,  
K.-T. Lee, J. Y. Lee,  
L. J. Guo\* .....4739–4744

### Template-Free Vibrational Indentation Patterning (VIP) of Micro/Nanometer-Scale Grating Structures with Real-Time Pitch and Angle Tunability



A template-free, high-throughput patterning technique—vibrational indentation-driven patterning (VIP)—realizes continuous, period-tunable fabrication of micro/nanometer-scale gratings by vertical indentations of a vibrating flat tool edge on a moving substrate. By modulating the tool vibration, substrate feeding rate, and the tool tilting angle, the period-variable chirped gratings and angle-tunable blazed gratings can be easily achieved.



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The basic microstructure-dependent energy storage mechanisms of nanostructured  $\text{MnO}_2$  are investigated via dynamic observation of the growth and in situ probing the mechanical properties by using in situ AFM. A series of dramatic evolutions of nanostructured  $\text{MnO}_2$  involving progressive nucleation, three-dimensional growth, reversible expansion, proton intercalation induced softening, and self-accommodation phenomena can be correlated to its remarkable energy storage performance.

### Energy Storage

X. Y. Tao,\* J. Du, Y. Sun, S. L. Zhou,  
Y. Xia, H. Huang, Y. P. Gan,  
W. K. Zhang,\* X. D. Li\* .....4745–4751

**Exploring the Energy Storage  
Mechanism of High Performance  $\text{MnO}_2$   
Electrochemical Capacitor Electrodes:  
An In Situ Atomic Force Microscopy  
Study in Aqueous Electrolyte**

