

# ADVANCED FUNCTIONAL MATERIALS

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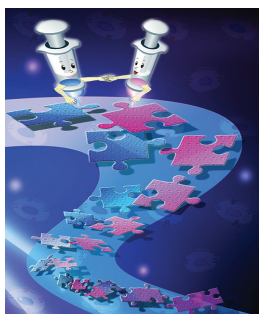
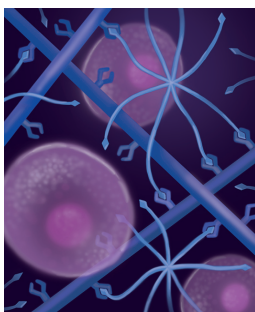


## Transient Electronics

Wirelessly controlled microfluidic systems allow programmed delivery of corrosive etchants to selected regions of microelectronic systems, to allow permanent elimination of key constituent materials. The result obtained by J. A. Rogers and team on page 1338 provides the ultimate solution for secure, unrecoverable data and/or hardware technology.

## Hydrogels

S. C. Heilshorn and co-workers design shear-thinning hydrogels for injectable encapsulation and long-term delivery (SHIELD) by combining protein-engineering and synthetic polymer technologies. On page 1344, stem cell transplantation using SHIELD results in a 400% increase in one-week cell retention compared to cell delivery in saline, the clinical standard. These materials work by providing a “shield” against cell membrane damage during injection and then stiffening in situ to create a scaffold for cell attachment.

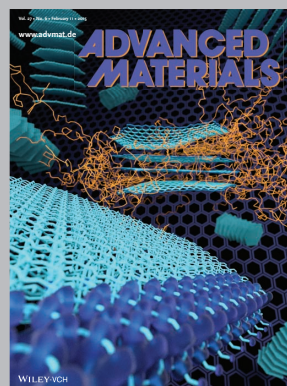
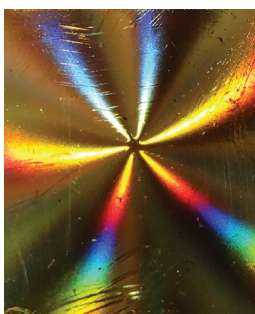


## Self-Healing Materials

On page 1352 Y. M. Chen, and colleagues develop a biocompatible polysaccharide-based self-healing hydrogel with injectability, which is prepared by the dynamic reaction of *N*-carboxyethyl chitosan, adipic acid dihydrazide with oxidized sodium alginate. The injected hydrogel fragments can be self-healed into a new integral hydrogel under physiological conditions, holding great potential for applications in biomedical field.

## Photopatterning

Unique wrinkling patterns with oscillating amplitudes in any arbitrarily complex fashion are generated by M. G. Debijs and team on page 1360 by controlling the alignment director of a liquid crystal network using photoalignment layers in combination with photomasks. The wrinkled gold surfaces are strikingly visual which is interesting for applications ranging from diffractive elements to fine jewelry.



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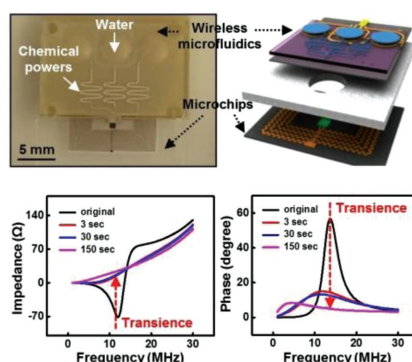
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## FULL PAPERS

**Triggerable transient electronics** are presented with the use of wireless microfluidics to enable complete dissolution of conventional microelectronic systems on demand in a controlled, programmable manner. Demonstration examples include triggered destruction of home-built metal-oxide-semiconductor field-effect transistors and commercial microchips in radio-frequency identification device.

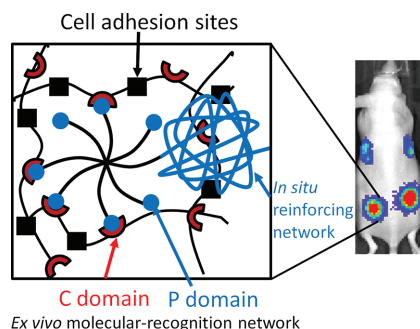


## Transient Electronics

C. H. Lee, J.-W. Jeong, Y. Liu, Y. Zhang, Y. Shi, S.-K. Kang, J. Kim, J. S. Kim, N. Y. Lee, B. H. Kim, K.-I. Jang, L. Yin, M. K. Kim, A. Banks, U. Paik, Y. Huang, J. A. Rogers\* ..... 1338–1343

## Materials and Wireless Microfluidic Systems for Electronics Capable of Chemical Dissolution on Demand

**Shear-thinning hydrogels for injectable encapsulation and long-term delivery (SHIELD)** undergo two sequential crosslinking steps: 1) peptide-based, molecular-recognition crosslinking to encapsulate cells, providing protection during injection, and 2) thermoresponsive crosslinking to form a reinforcing network in situ to reduce biodegradation rates and prolong transplanted cell retention. SHIELD is shown to provide significant cell protection using a preclinical model of human adipose-derived stem cell transplantation.

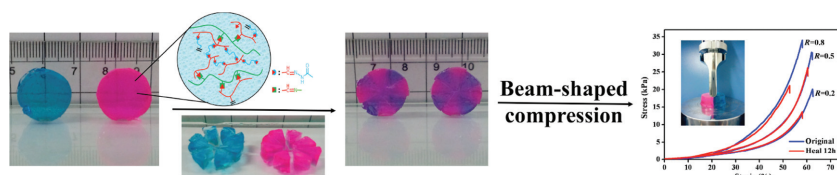


## Hydrogels

L. Cai, R. E. Dewi, S. C. Heilshorn\* ..... 1344–1351

## Injectable Hydrogels with In Situ Double Network Formation Enhance Retention of Transplanted Stem Cells

**A novel biocompatible polysaccharide-based self-healing hydrogel** containing dynamic imine and acylhydrazone bonds can be prepared by the dynamic reaction of *N*-carboxyethyl chitosan, adipic acid dihydrazide with oxidized sodium alginate. The self-healing efficiency can autonomously achieve 95% under physiological conditions, holding great potential for applications in biomedical field.



## Self-Healing Materials

Z. Wei, J. H. Yang, Z. Q. Liu, F. Xu, J. X. Zhou, M. Zrínyi, Y. Osada, Y. M. Chen\* ..... 1352–1359

## Novel Biocompatible Polysaccharide-Based Self-Healing Hydrogel

**Unique wrinkling patterns with oscillating amplitudes in any arbitrarily complex fashion** are generated by controlling the alignment director of a liquid crystal network using photoalignment layers in combination with photomasks. The wrinkled gold surfaces are strikingly visual which is interesting for applications ranging from diffractive elements to fine jewelry. Image adapted with permission. Copyright 1973, Pink Floyd Music Ltd.



## Photopatterning

L. T. de Haan, P. Leclère, P. Damman, A. P. H. J. Schenning, M. G. Debije\* ..... 1360–1365

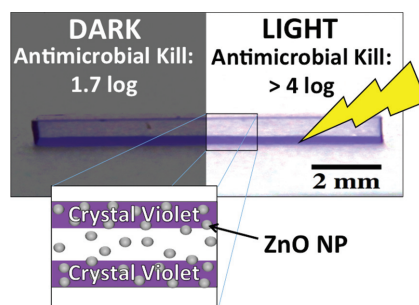
## On-Demand Wrinkling Patterns in Thin Metal Films Generated from Self-Assembling Liquid Crystals

## FULL PAPERS

## Antimicrobial Surfaces

S. Noimark, J. Weiner, N. Noor, E. Allan,  
C. K. Williams, M. S. P. Shaffer,  
I. P. Parkin\* ..... 1367–1373

### Dual-Mechanism Antimicrobial Polymer–ZnO Nanoparticle and Crystal Violet-Encapsulated Silicone

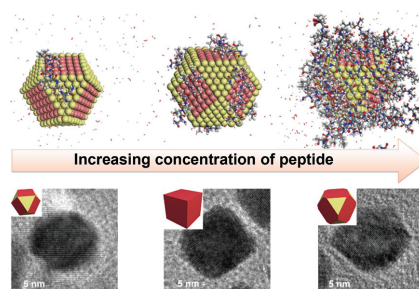


Using a simple dipping strategy to incorporate zinc oxide nanoparticles and crystal violet dye in a silicone polymer, a versatile and potent antimicrobial surface is reported to demonstrate high kills under both dark and light conditions, against both Gram-positive and Gram-negative bacteria.

## Biomolecular Assembly

H. Ramezani-Dakhel, L. Ruan,  
Y. Huang,\* H. Heinz\* ..... 1374–1384

### Molecular Mechanism of Specific Recognition of Cubic Pt Nanocrystals by Peptides and of the Concentration-Dependent Formation from Seed Crystals

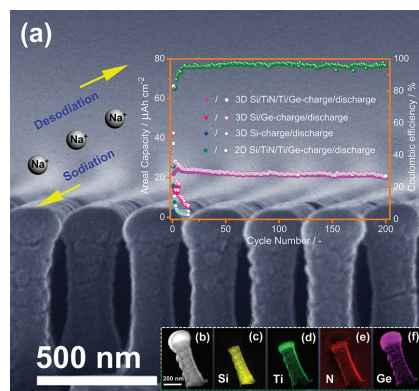


The mechanism of selective peptide recognition of nanocrystals and peptide-directed growth into specific shapes is explained using molecular dynamics simulations and experiments. The adsorption strength of the peptides depends on the spatial location on the surface and on the concentration, in addition to the sequence. Preferences in facet coverage and binding energies correlate with nanocrystal shape, size, and yield.

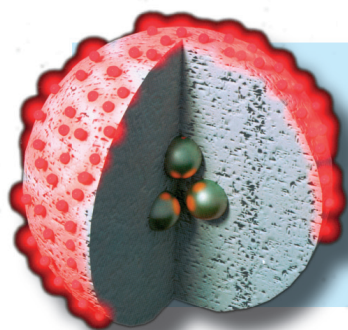
## Batteries

C. Yue, Y. Yu, S. Sun, X. He, B. Chen,  
W. Lin, B. Xu, M. Zheng, S. Wu, J. Li,\*  
J. Kang, L. Lin ..... 1386–1392

### High Performance 3D Si/Ge Nanorods Array Anode Buffered by TiN/Ti Interlayer for Sodium-Ion Batteries



3D hexagonal Si/TiN/Ti/Ge NR arrays as anodes in sodium-ion batteries (SIBs) present high reversible areal/specific capacity and superior cycling stability imposed by high current densities. This kind of unique wafer-scale 3D Si-based composite electrode portends a promising future for lab-on-chip micro/nanoSIBs with practical applications in integrated circuit systems, micro/nano-electro mechanical systems, or other smart electronic devices.



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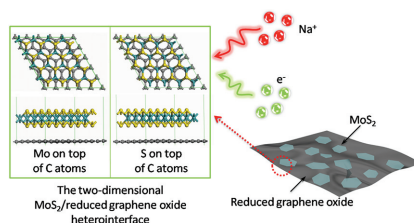
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## FULL PAPERS

**MoS<sub>2</sub>/reduced graphene oxide nanocomposites** are prepared as anode materials for sodium-ion batteries. The performance of MoS<sub>2</sub>/reduced graphene oxide nanocomposites is closely related to the heterointerfacial areas. Computational investigations reveal that the 2D MoS<sub>2</sub>/reduced graphene oxide heterointerface can increase the conductivity of MoS<sub>2</sub>, adsorb more Na atoms, and maintain high diffusion mobility of Na on MoS<sub>2</sub> surface and electron transfer efficiency from Na to MoS<sub>2</sub>.

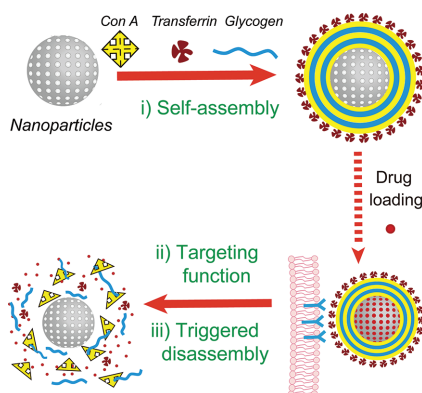


### Anode Materials

X. Xie, Z. Ao, D. Su, J. Zhang,  
G. Wang\* ..... 1393–1403

### MoS<sub>2</sub>/Graphene Composite Anodes with Enhanced Performance for Sodium-Ion Batteries: The Role of the Two-Dimensional Heterointerface

**Biology routinely uses nanoparticles to target the delivery of molecular and macromolecular cargo.** Here, biological materials and mechanisms are listed for the fabrication of a nanoparticle coating that: i) self-assembles through biospecific interactions (sugar–lectin binding), ii) confers targeting function (selective cellular uptake through receptor-mediated endocytosis), and iii) is triggered to disassemble for cargo release in response to physiologically relevant stimuli (endosomal pH).

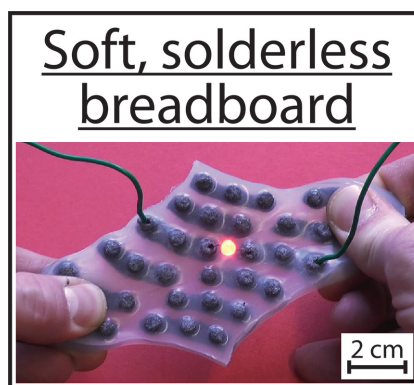


### Nanoparticle Coating

J. Li, X. Qu,\* G. F. Payne, C. Zhang,  
Y. Zhang, J. Li, J. Ren, H. Hong,  
C. Liu\* ..... 1404–1417

### Biospecific Self-Assembly of a Nanoparticle Coating for Targeted and Stimuli-Responsive Drug Delivery

**Soft devices** can be bent, stretched, and compressed reversibly, but conventional wires are rigid. This work describes stretchable composites that are easily fabricated with simple tools and commodity materials, and that can provide a strategy for electrical wiring that meets certain needs of soft devices. The utility of this composite is demonstrated in several devices, including a soft, solderless breadboard.

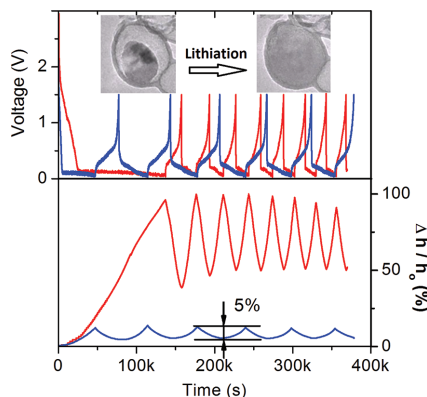


### Soft Materials

J. Lessing, S. A. Morin, C. Keplinger,  
A. S. Tayi, G. M. Whitesides\*... 1418–1425

### Stretchable Conductive Composites Based on Metal Wools for Use as Electrical Vias in Soft Devices

**Si–C yolk–shell** is applied to regulate the breathing effect and one order of magnitude of reduction on thickness changes at the electrode level during cycling is achieved: the electrode thickness variation reduces down to 10%, comparing with 100% in the electrode with Si nanoparticles as active materials.



### Batteries

X. Xiao,\* W. Zhou, Y. Kim, I. Ryu,  
M. Gu, C. Wang, G. Liu, Z. Liu,  
H. Gao\* ..... 1426–1433

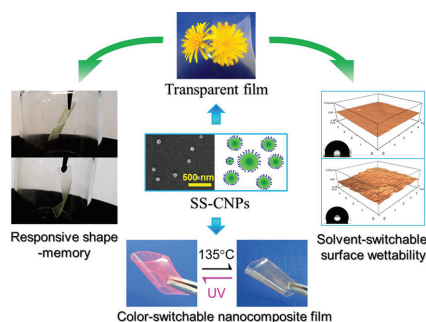
### Regulated Breathing Effect of Silicon Negative Electrode for Dramatically Enhanced Performance of Li-Ion Battery

## FULL PAPERS

## Cellulose

Y. Wang, L.-O. Heim, Y. Xu,  
G. Buntkowsky, K. Zhang\*... 1434–1441

### Transparent, Stimuli-Responsive Films from Cellulose-Based Organogel Nanoparticles



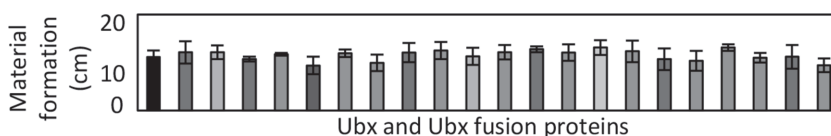
**Novel cellulose-based organogel nanoparticles**, called surface-stearoylated cellulose nanoparticles (SS-CNPs), are synthesized after the surface esterification of cellulose fibers under heterogeneous reaction conditions. SS-CNPs form stimuli-responsive organogels and transparent, self-standing films by solvent casting. The films show solvent-responsive surface wettability, responsive shape-memory properties as well as switchable optical colors by forming nanocomposite films containing stearyl rhodamine spiroamide.

## Proteins

S.-P. Tsai, D. W. Howell, Z. Huang,  
H.-C. Hsiao, Y. Lu, K. S. Matthews,  
J. Lou, S. E. Bondos\* ..... 1442–1450

### The Effect of Protein Fusions on the Production and Mechanical Properties of Protein-Based Materials

**A wide range of proteins** can be incorporated into protein-based materials via gene fusion, to produce a single polypeptide capable of self-assembly and the function of interest. 24 proteins are fused to Ultrabithorax, a protein which self-assembles in vitro. Whereas the appended proteins determine the solubility and purification yield of the corresponding fusion protein, all fusion proteins self-assemble equally well.

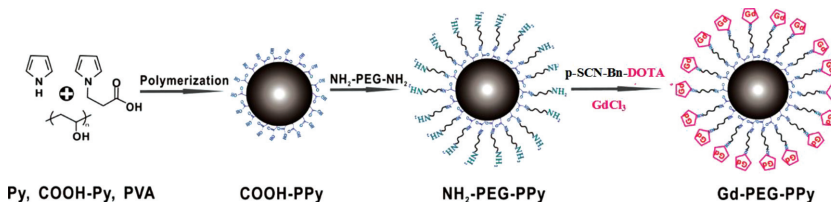


## Polypyrrole Nanoparticles

X. Liang,\* Y. Li, X. Li, L. Jing, Z. Deng,  
X. Yue, C. Li, Z. Dai\* ..... 1451–1462

### PEGylated Polypyrrole Nanoparticles Conjugating Gadolinium Chelates for Dual-Modal MRI/Photoacoustic Imaging Guided Photothermal Therapy of Cancer

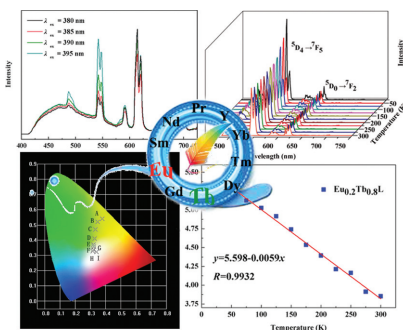
**A theranostic agent with excellent physiological stability, strong NIR absorption, and high magnetization** is fabricated from PEGylated polypyrrole nanoparticles conjugating gadolinium chelates (Gd-PEG-PPy NPs). The passive targeting and high MRI/photoacoustic contrast capability of Gd-PEG-PPy NPs are favorable for precise cancer diagnosing and locating tumor sites to guide external laser irradiation for photothermal ablation of tumors without damaging surrounding healthy tissue.



## Metal-Organic Frameworks

S.-N. Zhao, L.-J. Li, X.-Z. Song,  
M. Zhu, Z.-M. Hao, X. Meng,  
L.-L. Wu, J. Feng, S.-Y. Song,\*  
C. Wang,\* H.-J. Zhang ..... 1463–1469

### Lanthanide Ion Codoped Emitters for Tailoring Emission Trajectory and Temperature Sensing



**Codoped Ln-metal-organic frameworks  $\text{Eu}_x\text{Tb}_{1-x}\text{L}$**  are synthesized based on the isostructural Ln-metal-organic frameworks using lanthanide ion emitters. With careful adjustment of the relative concentration of the lanthanide ions and the excitation wavelength, the emission trajectory can be modulated, allowing white emission. Furthermore,  $\text{Eu}_{0.2}\text{Tb}_{0.8}\text{L}$  allows for the design of a thermometer operating over a wide range, from 40 to 300 K.