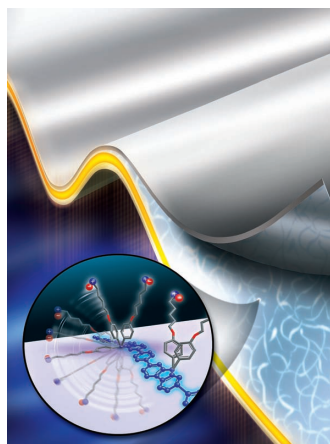


# ADVANCED FUNCTIONAL MATERIALS

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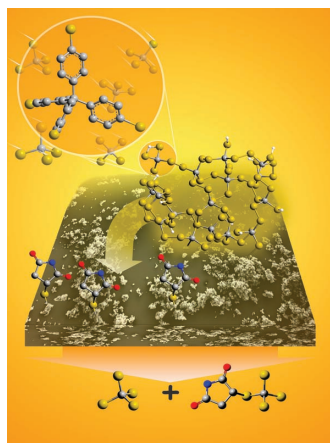


## Polyelectrolytes

H. Y. Woo and co-workers describe an energy level tuning mechanism at the interface between a metal electrode and a conjugated polyelectrolyte. On page 1100, by introducing a series of cationic conjugated polyelectrolytes, the effect of ion density on the energy level tuning process at such an interface in the organic electronic devices is investigated. These series materials indicate that two different electron injection mechanisms must be invoked according to the film thickness of the interfacial layer.

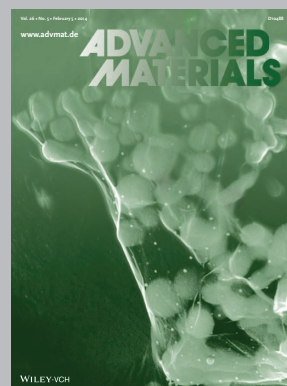
## Antibacterials

A new application of metal–tetracyanoquinodimethane charge-transfer complexes for efficient antimicrobial performance is discovered by V. Bansal and co-workers. On page 1047, long AgTCNQ nanowires of >4000 aspect ratio are grown onto a fabric surface. The high surface area of the 3D interwoven network of AgTCNQ nanowires and the low aqueous solubility of this material allow the AgTCNQ fabric unprecedented antibacterial performance over pristine Ag fabric due to slow Ag<sup>+</sup> ion release characteristics.



## Reversible Polymers

A hypercrosslinked polymer of tetrakis-(4-thiophenyl)methane held together by disulfide bonds is shown by T. Muller, S. Bräse, and co-workers. The powder is made up of condensed spherical particles, with a non-uniform size distribution and diameters ranging from 0.5 to 1.7  $\mu\text{m}$ . On page 1054, the surface can be post-functionalized with maleimides. When this material is depolymerized under controlled mild conditions, only monomer and mono-functionalized monomer in a ratio of 3:1 are obtained.



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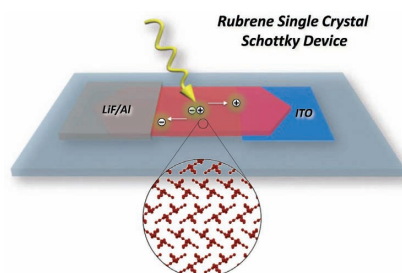
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# FULL PAPERS

## Rubrene

S. Karak, J. A. Lim, S. Ferdous,  
V. V. Duzhko,\*  
A. L. Briseno\* ..... 1039–1046

**Photovoltaic Effect at the Schottky Interface with Organic Single Crystal Rubrene**

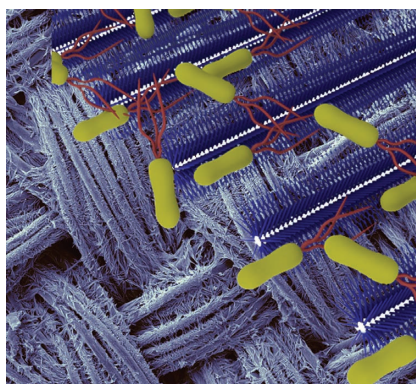


The photovoltaic effect at the Schottky interface of a rubrene single crystal and Al or LiF/Al electrodes in lateral ITO–rubrene–Al and ITO–rubrene–LiF/Al device configurations is demonstrated and explained based on constructed energy band diagrams of the heterostructures.

## Antibacterials

Z. M. Davoudi, A. E. Kandjani,  
A. I. Bhatt, I. L. Kyratzis,  
A. P. O'Mullane, V. Bansal\* ... 1047–1053

**Hybrid Antibacterial Fabrics with Extremely High Aspect Ratio Ag/AgTCNQ Nanowires**



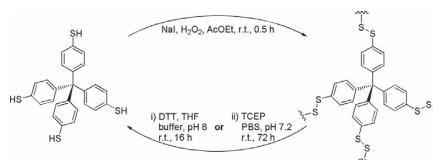
The synthesis of Ag–tetracyanoquinodimethane (TCNQ) nanowires of extremely high aspect ratios (>3000) supported on a metallic silver fabric is reported. These Ag/AgTCNQ fabrics show higher antimicrobial performance against both Gram negative and Gram positive bacteria than pristine Ag fabrics. This study extends the applicability of metal–TCNQ charge transfer complexes beyond electronics applications and opens up new avenues towards flexible electronics.

## Reversible Polymers

L. Monnereau, M. Nieger, T. Muller,\*  
S. Bräse\* ..... 1054–1058

**Tetrakis-(4-thiophenyl)methane: Origin of a Reversible 3D-Homopolymer**

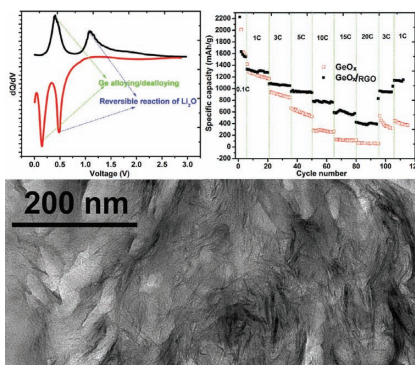
The efficient generation of a hyper-crosslinked poly(disulfide) is described. After high yielding synthesis of the monomer tetrakis-(4-thiophenyl)methane, the polymeric material is obtained in excellent yield under mild reaction conditions. Combination of controlled de-polymerization under bio-compatible conditions and postfunctionalization gives access to the number of free termini at the surface.



## Li-Ion Batteries

D. P. Lv, M. L. Gordin, R. Yi, T. Xu,  
J. X. Song, Y.-B. Jiang, D. Choi,  
D. H. Wang\* ..... 1059–1066

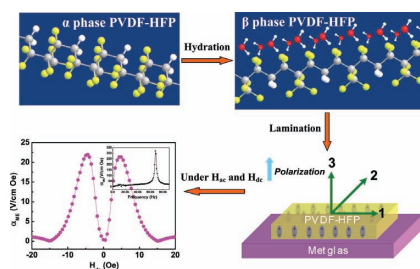
**GeO<sub>x</sub>/Reduced Graphene Oxide Composite as an Anode for Li-Ion Batteries: Enhanced Capacity via Reversible Utilization of Li<sub>2</sub>O along with Improved Rate Performance**



A GeO<sub>x</sub>/reduced graphene oxide (RGO) composite, where amorphous GeO<sub>x</sub> (1.01 < x < 1.07) nanoparticles are in intimate contact with well-dispersed RGO sheets, is successfully synthesized via a facile one-step reduction approach. The introduction of conductive RGO sheets into germanium oxide is a simple but effective strategy for enhancing the reversible utilization of Li<sub>2</sub>O and improving rate capability for Li<sup>+</sup> storage in germanium oxides.

## FULL PAPERS

**Multiferroic composites based on the hydrate salt doped ferroelectric polymers** exhibit state-of-the-art magnetoelectric voltage coefficients under remarkably low magnetic bias fields. The effect of hydrogen bonds on the polarization ordering, coupled with the enhancement of the evolution of the polar phase, of the ferroelectric polymers is investigated, entailing marked improvement in piezoelectricity and magnetoelectric coupling relative to the analogous composites.

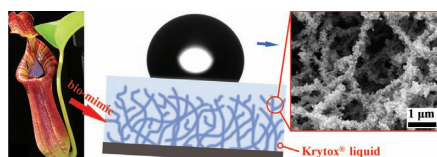


### Composite Materials

J. Jin, F. Zhao, K. Han, M. A. Haque, L. Dong,\* Q. Wang\* .....1067–1073

**Multiferroic Polymer Laminate Composites Exhibiting High Magnetoelectric Response Induced by Hydrogen-Bonding Interactions**

**Nepenthes pitcher inspired anti-wetting coatings** are fabricated by the combination of fluoro-silicone nanofilaments and a perfluoropolyether liquid. The sliding speed of liquid drop and the self-cleaning property can be controlled by composition of the coating, properties of liquid drop, and dirt.

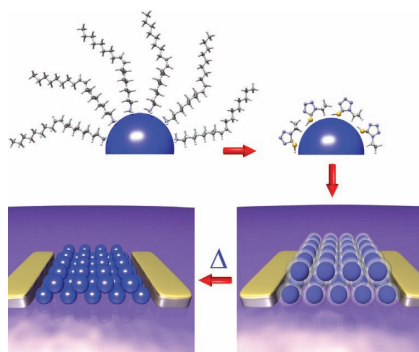


### Surface Chemistry

J. Zhang,\* A. Wang, S. Seeger .....1074–1080

**Nepenthes Pitcher Inspired Anti-Wetting Silicone Nanofilaments Coatings: Preparation, Unique Anti-Wetting, and Self-Cleaning Behaviors**

**A ligand exchange method for Cl(GS) nanocrystals (NCs) with 1-ethyl-5-thio-tetrazole (ETT)** that preserves colloidal stability of the structures is presented. NCs yield ordered films which are heated to 260 °C to completely remove ETT resulting in closely assembled individual NCs with virtually bare surfaces. NC solids show up to four orders of magnitude increased conductivity in ligand-free films compared to ligand-covered ones.

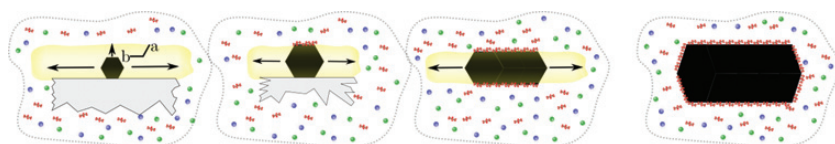


### Nanocrystal Surfaces

J. Lauth, J. Marbach, A. Meyer, S. Dogan, C. Klinke, A. Kornowski, H. Weller\* .....1081–1088

**Virtually Bare Nanocrystal Surfaces: Significantly Enhanced Electrical Transport in CuInSe<sub>2</sub> and CuIn<sub>1-x</sub>Ga<sub>x</sub>Se<sub>2</sub> Thin Films upon Ligand Exchange with Thermally Degradable 1-Ethyl-5-Thiotetrazole**

**Citrate bio-inspired apatite nanoparticles** are characterized in terms of structure, size, morphology, and composition through advanced X-ray total scattering techniques. By cross-coupling size and shape information of crystal domains with atomic force microscopy data for multidomain nanoparticles, a plausible mechanism underlying the amorphous-to-crystal transformation is reconstructed and the origin of platy crystal morphology, breaking the hexagonal symmetry, explained.



### Apatites

J. M. Delgado-López, R. Frison, A. Cervellino, J. Gómez-Morales, A. Guagliardi,\* N. Masciocchi .....1090–1099

**Crystal Size, Morphology, and Growth Mechanism in Bio-Inspired Apatite Nanocrystals**

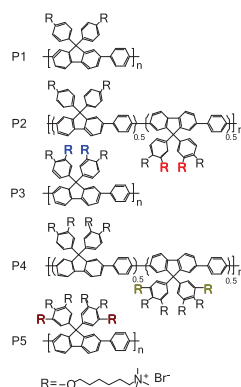


# FULL PAPERS

## Polyelectrolytes

B. H. Lee, I. H. Jung, H. Y. Woo,\*  
H.-K. Shim, G. Kim, K. Lee... 1100–1108

**Multi-Charged Conjugated  
Polyelectrolytes as a Versatile Work  
Function Modifier for Organic Electronic  
Devices**



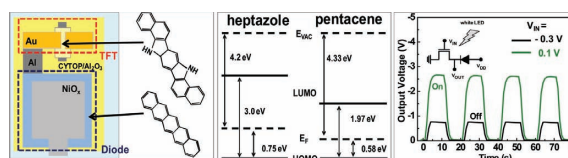
An electron injection mechanism for conjugated polyelectrolyte (CPE) electron transport layers in organic electronic devices is demonstrated by introducing a new series of CPEs with various numbers of ionic functionalities. Energy level tuning at the CPE/metal interface can be determined directly by adjusting ion density in the CPEs. Thickness-dependent electron injection characteristics indicate that two different mechanisms must be invoked according to the CPE thickness.

## Organic Electronics

J. H. Park, H. S. Lee, S. Y. Park,  
S.-W. Min, Y. Yi, C.-G. Cho, J. Han,  
T. W. Kim, S. Im\*... 1109–1116

**Photo-Stable Organic Thin-  
Film Transistor Utilizing a New  
Indolocarbazole Derivative for Image  
Pixel and Logic Applications**

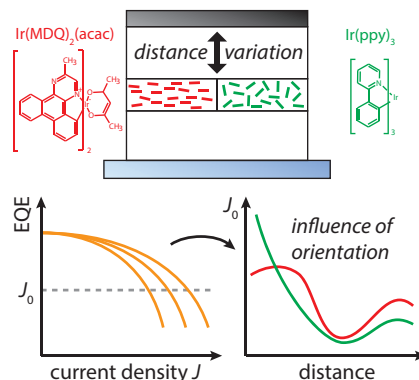
A new indolocarbazole derivative (heptazole) possessing a HOMO-LUMO gap of  $\approx 2.95$  eV is synthesized and shows good photo-stability unlike old pentacene. An image pixel driving our photostable heptazole OTFT connected to a pentacene/Al Schottky photodiode is demonstrated. The heptazole OTFT also conveniently forms a logic inverter coupled with a pentacene OTFT, sharing Au for source/drain.



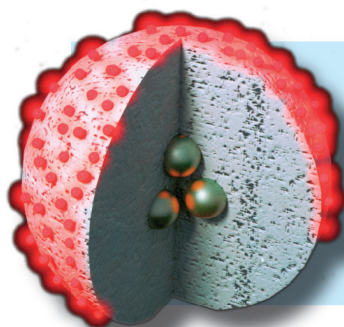
## Organic Electronics

C. Murawski, P. Liehm, K. Leo,  
M. C. Gather\*... 1117–1124

**Influence of Cavity Thickness and  
Emitter Orientation on the Efficiency  
Roll-Off of Phosphorescent Organic  
Light-Emitting Diodes**



The efficiency roll-off of organic light-emitting diodes is studied by varying the distance between emitter and metal cathode. Roll-off is found to depend on the orientation of the emitter molecules, which can be explained by measurements and modeling of the triplet decay rate. Simulations of the roll-off behavior give further insight into the principles of efficient stack design.



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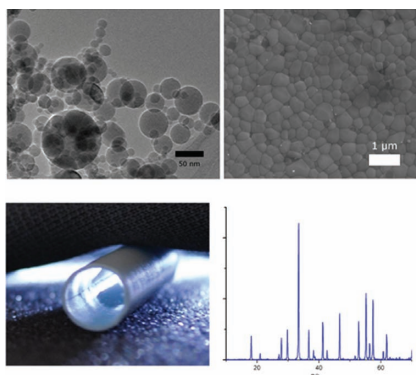
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## FULL PAPERS

**Thermoplastic extrusion of 3:5  $\text{Y}_2\text{O}_3$ - $\text{Al}_2\text{O}_3$  nanopowder mixtures** creates YAG tubes that sinter to 95+% of their theoretical density at 1500 °C with fine grain sizes. Extrusion of highly atomically mixed  $\text{Y}_3\text{Al}_5\text{O}_{12}$  nanopowders creates tubes which only sinter at higher temperatures to larger grain sizes, illustrating a situation in which nanoscale bottom-up synthesis is not advantageous.

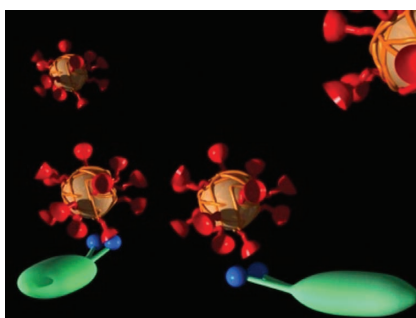


## Ceramics

N. J. Taylor, R. M. Laine\* .....1125–1132

**Extrusion of YAG Tubes Shows that Bottom-up Processing is Not Always Optimal**

**An IgE-aptamer polymer hybrid efficiently stabilizes an emulsion.** Since they specifically recognize immunoglobulin E, the resulting nanocapsules are biological-stimulus responsive.



## Polymer–Aptamers

D. Kedracki, P. Maroni, H. Schlaad, C. Veber-Nardin\* .....1133–1139

**Polymer–Aptamer Hybrid Emulsion Templating Yields Bioresponsive Nanocapsules**

**High surface area organosilica colloids with superacid properties** are prepared from a novel sulfonic acid sol–gel precursor. An aerosol assisted method affords spherical mesoporous particles, which exhibit a high density of surface acid groups. Furthermore, initial anti-fouling studies are conducted.

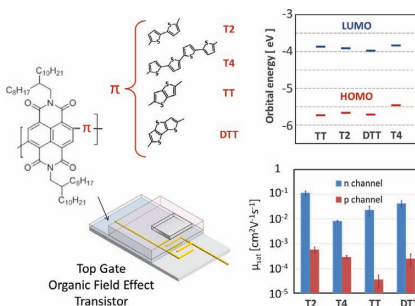


## Mesoporous Materials

J. Gehring, D. Schleheck, M. Luka, S. Polarz\* .....1140–1150

**Aerosol-Synthesis of Mesoporous Organosilica Nanoparticles with Highly Reactive, Superacidic Surfaces Comprising Sulfonic Acid Entities**

**A series of newly synthesized naphthalenediimide-based co-polymers** are investigated in order to unveil the effect of the donor  $\pi$ -conjugation length and the heteroatomic fusion of the thiophene rings on charge transport properties. Physical-chemical and variable temperature electrical properties are complemented with density functional theory calculations to assess the most critical factors determining efficient charge transport in field-effect devices.



## Conjugated Polymers

A. Luzio, D. Fazzi, D. Natali, E. Giussani, K.-J. Baeg, Z. Chen, Y.-Y. Noh,\* A. Facchetti,\* M. Caironi\* .....1151–1162

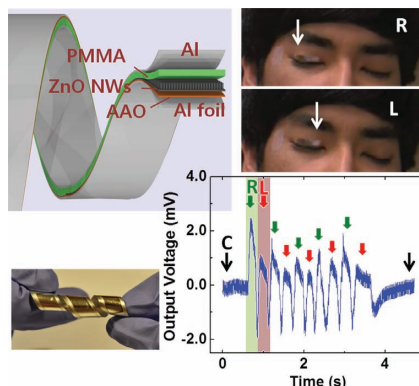
**Synthesis, Electronic Structure, and Charge Transport Characteristics of Naphthalenediimide-Based Co-Polymers with Different Oligothiophene Donor Units**

# FULL PAPERS

## Piezoelectrics

S. Lee, R. Hinchet, Y. Lee, Y. Yang,  
Z.-H. Lin, G. Ardila, L. Montès,  
M. Mouis, Z. L. Wang\* ..... 1163–1168

### Ultrathin Nanogenerators as Self-Powered/Active Skin Sensors for Tracking Eye Ball Motion

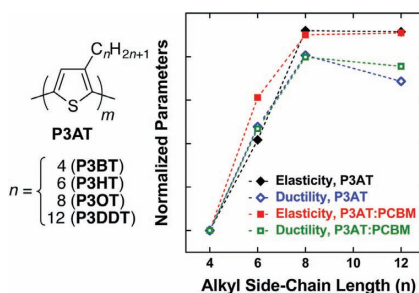


**Ultrathin piezoelectric nanogenerator** is developed as active or self-powered sensor for monitoring local deformation on a human skin. The nanogenerator which detects the motion of the eye ball underneath can be effective in monitoring sleep pattern, tiredness, brain activity, and spirit status of a person, as well as any biological associated skin deformation.

## Stretchable Electronics

S. Savagatrup, A. S. Makaram,  
D. J. Burke, D. J. Lipomi\* ... 1169–1181

### Mechanical Properties of Conjugated Polymers and Polymer-Fullerene Composites as a Function of Molecular Structure



This paper describes the large effect of small changes in a structural characteristic—the length of the alkyl side chain—on the elasticity and ductility of conjugated polymers. Measurements of tensile modulus are complemented with measurements of ductility. These experiments could influence the selection and design of new organic semiconductors in flexible and stretchable applications.