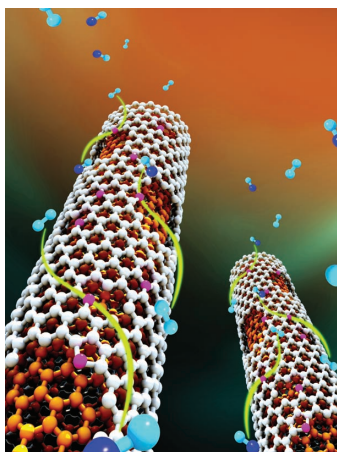


# ADVANCED FUNCTIONAL MATERIALS

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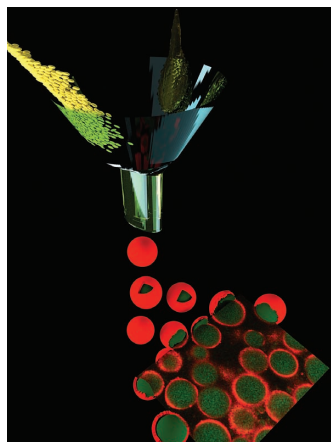


## Catalysts

Carbon nanotubes (CNTs) are selected as the platform to demonstrate the potential of full exposure of “active sites” at the surface by Q. Zhang, D. S. Su, F. Wei, and co-workers on page 5956. Novel nitrogen-doped carbon coaxial nanocables with the pristine CNTs as the core and the N-doped carbon layers as the shell are available. They possess very high electrical conductivity and much enhanced electrocatalytic activity for both oxygen reduction and evolution reaction.

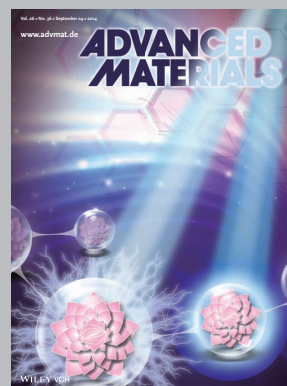
## Nanomedicine

Understanding the complex inter-regulation of the innate physiochemical properties of nanomaterials and the biological milieu is critical to the exploitation of novel nanomaterials for biomedical applications. In the Review on page 5936, C. Y. Tay, D. T. Leong, and team discuss how important nanomaterial parameters such as size, shape, surface charge, as well as the nanomaterial-associated protein corona can critically affect nano-induced biological phenomena that may hold therapeutic value.



## Microcapsules

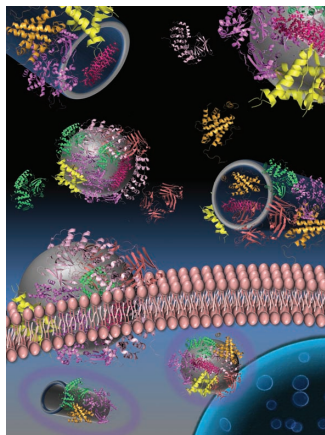
A stable, all-natural, edible, core-shell microcapsule from zein, a protein of corn, and oil is synthesized by E. Filippidi, K. P. Velikov, and colleagues in a one-step process without the use of any stabilizers or surfactants. On page 5962, the zein shell thickness can be controlled and imparts functionality, controlling the rate of hydrolysis of the encapsulated oil (triacylglycerides). The capsules pass the gastric phase and break down in the intestine.



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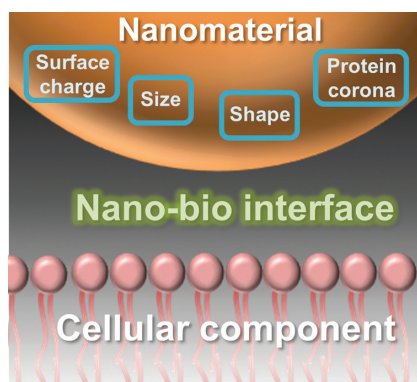
[www.small-journal.com](http://www.small-journal.com)

## FEATURE ARTICLE

## Nanomedicine

C. Y. Tay,\* M. I. Setyawati, J. Xie,  
W. J. Parak, D. T. Leong\* ..... 5936–5955

**Back to Basics: Exploiting the Innate Physico-chemical Characteristics of Nanomaterials for Biomedical Applications**



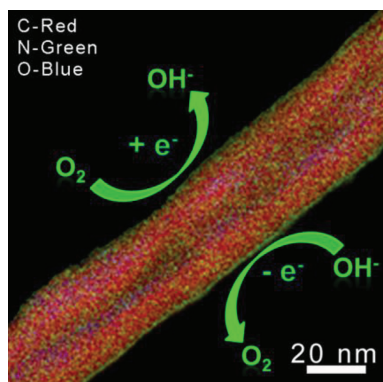
Physicochemical properties of nanomaterials dictate how cells “feel” and respond to nanomaterials by eliciting distinct nanospecific bio-interactions that can be exploited for nanomedicine. Myriad cellular responses can be invoked for medicinal applications via precise tailoring of the size, shape, surface charge, and protein corona formation on the nanomaterial surface.

## FULL PAPERS

## Catalysis

G.-L. Tian, Q. Zhang,\* B. S. Zhang,  
Y.-G. Jin, J.-Q. Huang, D. S. Su,\*  
F. Wei\* ..... 5956–5961

**Toward Full Exposure of “Active Sites”: Nanocarbon Electrocatalyst with Surface Enriched Nitrogen for Superior Oxygen Reduction and Evolution Reactivity**



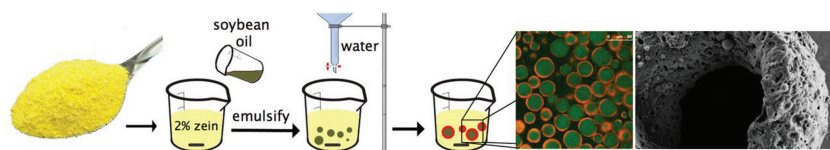
**Nitrogen-doped coaxial carbon nanocables** with most of the active sites fully exposed on the surface are developed. The accessible and efficient utilization of the integrated N atoms enriched on the surface combined with the undestroyed intact inner walls afford the nanocarbon electrocatalysts with much enhanced electrocatalytic activity for both oxygen reduction and evolution reaction.

## Microcapsules

E. Filippidi,\* A. R. Patel,  
E. C. M. Bouwens, P. Voudouris,  
K. P. Velikov\* ..... 5962–5968

**All-Natural Oil-Filled Microcapsules from Water-Insoluble Proteins**

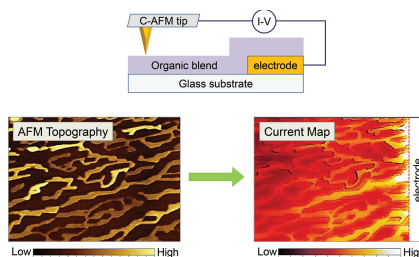
**A stable, all-natural, edible, core-shell microcapsule** from zein, a protein of corn, and oil is synthesized in a one-step process without the use of any stabilizers or surfactants. The zein shell thickness can be controlled and imparts functionality, controlling the rate of hydrolysis of the encapsulated oil (triacylglycerides). The capsules pass the gastric phase and break down in the intestine.



## Thin-Film Transistors

S. Hunter, J. Chen,  
T. D. Anthopoulos\* ..... 5969–5976

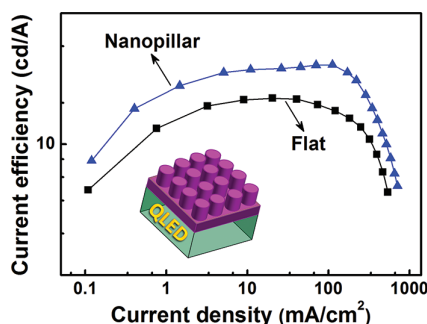
**Microstructural Control of Charge Transport in Organic Blend Thin-Film Transistors**



**A bandgap state explanation for the performance of organic thin film transistors** based on a blend of small molecule and polymer semiconductors is introduced. Organic blend transistors with a range of compositions and mobilities up to  $3 \text{ cm}^2/\text{Vs}$  are investigated by means of conductive atomic force microscopy and low temperature electrical measurements, highlighting the requirements for high performance transistors.

## FULL PAPERS

With a layer of large-scale, periodic ZnO nanopillar arrays grown using a simple, efficient method of non-wetting templates as an optical outcoupling medium, a record high current efficiency (CE) of  $26.6 \text{ cd A}^{-1}$  is achieved in quantum dot light-emitting diodes (QLEDs). This study is the first account of QLEDs offering detailed insight into their light-extraction efficiency enhancement.

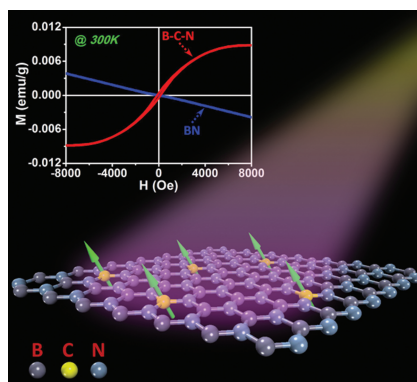


## Light-Emitting Diodes

X. Yang, K. Dev, J. Wang, E. Mutlugun, C. Dang, Y. Zhao, S. Liu, Y. Tang, S. T. Tan, X. W. Sun,\*  
H. V. Demir\* .....5977–5984

## Light Extraction Efficiency Enhancement of Colloidal Quantum Dot Light-Emitting Diodes Using Large-Scale Nanopillar Arrays

Room temperature ferromagnetism is demonstrated in carbon-doped boron nitride (BN) nanosheets with a substantial degree of doping. Notably, the ferromagnetic response disappears upon the controlled removal of carbon dopants from the BN lattice, indicating that the observed magnetism originates from effects of substitutional carbon-doping rather than from extrinsic magnetic impurities.

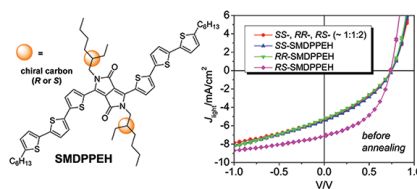


## Ferromagnetics

C. Zhao, Z. Xu, H. Wang, J. Wei, W. Wang,\* X. Bai, E. Wang\* ...5985–5992

## Carbon-Doped Boron Nitride Nanosheets with Ferromagnetism above Room Temperature

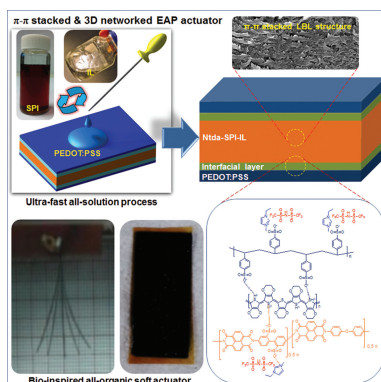
In  $\pi$ -conjugated materials research, the 2-ethylhexyl solubilizing group is commonly used but its stereochemistry (associated with a single chiral carbon) is typically ignored. For a small molecule semiconductor SMDPPEH [2,5-di-(2-ethylhexyl)-3,6-bis-(5'-n-hexyl-[2,2',5',2'']terthiophen-5-yl)-pyrrolo[3,4-c]pyrrole-1,4-dione), the morphology, absorption properties, and optimum processing conditions of thin films used as photovoltaic device active layers are found to be strongly dependent on stereoisomer choice and composition.

 $\pi$ -Conjugation

R. Bou Zerdan, N. T. Shewmon, Y. Zhu, J. P. Mudrick, K. J. Chesney, J. Xue,\*  
R. K. Castellano\* .....5993–6004

## The Influence of Solubilizing Chain Stereochemistry on Small Molecule Photovoltaics

This article describes the construction of  $\pi$ - $\pi$  stacked alternate hydrophilic-hydrophobic nanochannels inside a sulfonated polyimide membrane. Atomic level regio-specific interaction of cations and anions in an ionic liquid with hydrophilic-hydrophobic co-blocks of a sulfonated polyimide block copolymer (SPI) matrix is utilized for constructing a self-assembled 3D networked polymer with continuous and interconnected ion transport nanochannels for high-performance bio-inspired all-organic soft actuators.



## Ionic Membranes

R. K. Cheedarala, J.-H. Jeon, C.-D. Kee, I. K. Oh\* .....6005–6015

Bio-Inspired All-Organic Soft Actuator Based on a  $\pi$ - $\pi$  Stacked 3D Ionic Network Membrane and Ultra-Fast Solution Processing

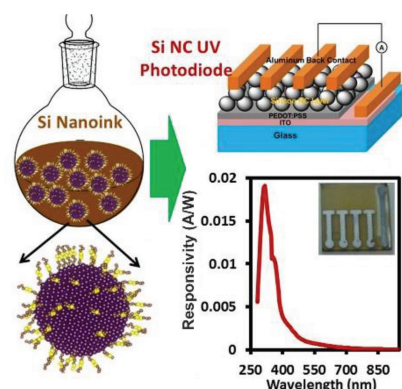


# FULL PAPERS

## Nanocrystals

T. Lin, X. Liu, B. Zhou, Z. Zhan,  
A. N. Cartwright,  
M. T. Swihart\* ..... 6016–6022

### A Solution-Processed UV-Sensitive Photodiode Produced Using a New Silicon Nanocrystal Ink

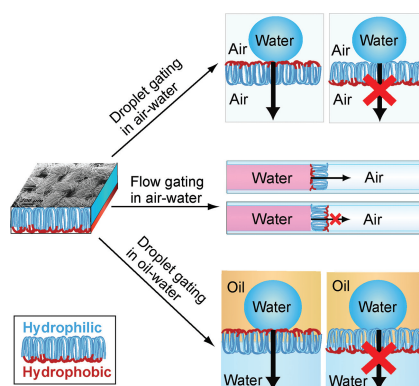


A new nanoink consisting of silicon nanocrystals capped with short allyl disulfide ligands, dispersed in allyl disulfide, is used to fabricate a single-Schottky-junction photodiode by solution-phase processing in air. The unpackaged photodiode exhibits a peak photoresponse of  $0.02 \text{ A W}^{-1}$  to UV light in air, within an order of magnitude of the response of commercially available photodetectors.

## Membranes

X. Tian,\* H. Jin, J. Sainio, R. H. A. Ras,\*  
O. Ikkala..... 6023–6028

### Droplet and Fluid Gating by Biomimetic Janus Membranes



Inspired by passive transport across cell membranes, macroscopic hydrophilic/hydrophobic Janus-type membranes involving chemically asymmetric skin-layer structures are prepared, which show directional and selective “liquid gating” behavior, i.e., transport or blockage of liquids depending on the direction of the membrane and whether the liquid droplets are aqueous or oil.

## Nanostructures

J. Liu, O. Margeat,\* W. Dachraoui, X. Liu,  
M. Fahlman, J. Ackermann\*...6029–6037

### Gram-Scale Synthesis of Ultrathin Tungsten Oxide Nanowires and their Aspect Ratio-Dependent Photocatalytic Activity

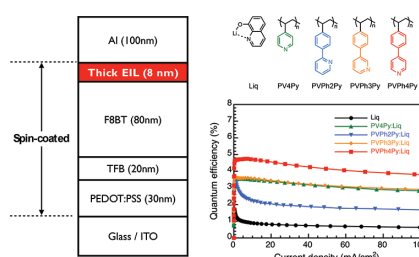
A new top-down synthesis of ultrathin  $\text{W}_{18}\text{O}_{49}$  nanowires using alcohol-assisted solvothermal decomposition of tungstic acid is presented which allows controlling both diameter and length of the wires in a simple way. It is found that the photocatalytic activity is controlled by the length to width ratio of the ultrathin  $\text{W}_{18}\text{O}_{49}$  nanowires leading to the highest efficiency and fastest degradation kinetics in the case of the largest aspect ratio.



## Light-Emitting Diodes

T. Chiba, Y.-J. Pu,\* S. Takahashi,  
H. Sasabe, J. Kido\* ..... 6038–6045

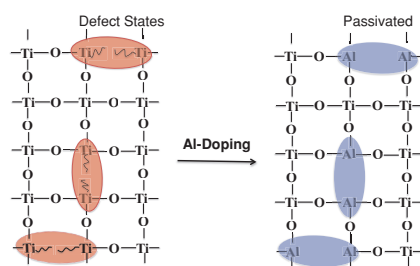
### Lithium Phenolate Complexes with a Pyridine-Containing Polymer for Solution-Processable Electron Injection Layers in PLEDs



Solution-processed multilayer polymer light-emitting devices (PLEDs) are fabricated using a mixture of poly(vinylpyridine)s and lithium 8-quinolate (Liq) as the thick electron injection layer. Poly[4-(4-vinylphenyl)pyridine] (PVPh4Py):Liq exhibits higher efficiencies than the layer of Liq alone and of Liq with the other polymer binders because of interactions between the Li atoms and the pyridine units of PVPh4Py.

## FULL PAPERS

**Reversible, photo-induced performance deterioration in  $\text{TiO}_2$ -containing devices** is reported in an inert environment. This phenomenon is correlated with the activation of deep trap sites in the metal oxide due to stoichiometry. Substitutional incorporation of Al in the anatase lattice, “permanently” passivating electronic trap sites in the bulk and at the surface of the  $\text{TiO}_2$ , results in improved device efficiencies and operational device stability in inert atmospheres.

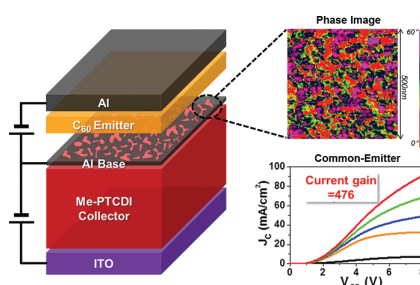


## Solar Cells

S. K. Pathak, A. Abate, P. Ruckdeschel, B. Roose, K. C. Gödel, Y. Vaynzof, A. Santhala, S.-I. Watanabe, D. J. Hollman, N. Noel, A. Sepe, U. Wiesner, R. H. Friend, H. J. Snaith,\* U. Steiner\* .....6046–6055

### Performance and Stability Enhancement of Dye-Sensitized and Perovskite Solar Cells by Al Doping of $\text{TiO}_2$

**High-performance organic permeable metal-base transistors (PMBTs) are demonstrated.** By controlling the Al-base porosity, current gain up to 476 is achieved with output current saturation. Due to the 20 nm-sized pores, potential-pinning at the pore regions induces the current saturation in the common-emitter measurement. This technology is also applicable to fabricate high-performance solution-processed NiO-based inorganic PMBTs.

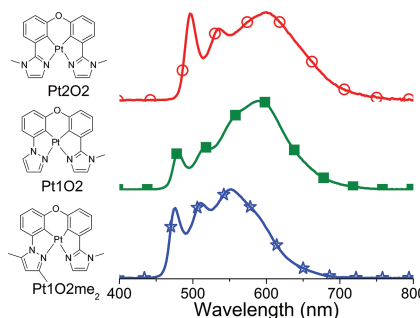


## Transistors

H. Yu, J. H. Kim, W. Chen, D. Y. Kim, J. Guo, F. So\* .....6056–6065

### Effect of Nano-Porosity on High Gain Permeable Metal-Base Transistors

**A series of tetradentate platinum complexes that exhibit both efficient monomer and excimer emission** are developed. Devices of these emitters demonstrate peak external quantum efficiencies of 22% to 27% at all tested concentrations. The halogen-free molecular design affords a high device operational lifetime of 80% of initial luminance estimated at 200–400 h at  $1000 \text{ cd m}^{-2}$  for the various complexes.

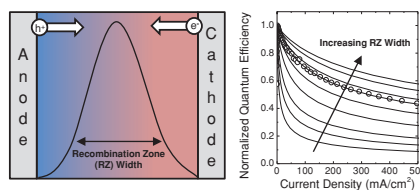


## Light-Emitting Diodes

T. Fleetham, L. Huang, J. Li\* ...6066–6073

### Tetradentate Platinum Complexes for Efficient and Stable Excimer-Based White OLEDs

**Engineering efficiency roll-off in organic light-emitting devices.** The efficiency roll-off in phosphorescent organic light-emitting devices is investigated as a function of device architecture. The loss processes responsible for the roll-off, namely triplet-triplet annihilation and triplet-polaron quenching, are found to depend strongly on device architecture and specifically, the spatial extent of the exciton recombination zone. Devices designed to have a broader recombination zone show a predictable reduction in the severity of the efficiency roll-off.



## Organic Light-Emitting Diodes

N. C. Erickson, R. J. Holmes\* ... 6074–6080

### Engineering Efficiency Roll-Off in Organic Light-Emitting Devices