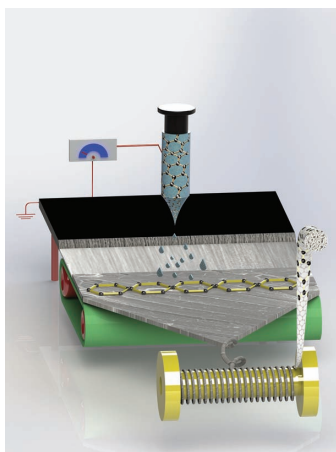


# ADVANCED FUNCTIONAL MATERIALS

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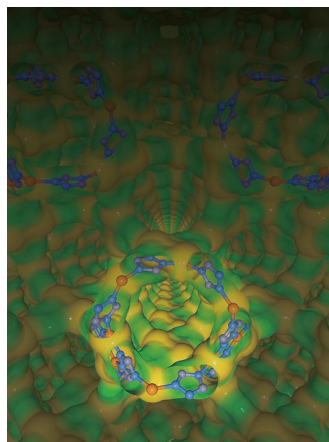
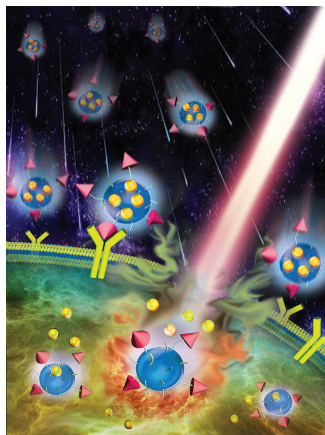


## Hybrid Yarns

A new process to manufacture highly conductive textile yarn for use in wearable electronics for energy storage, low-loss interconnects, sensors, and artificial muscles is described by J. Foroughi and team on page 5859. Graphene dispersions are electrospun onto the continuously drawn multi-walled carbon nanotube sheets and transformed into yarn filaments by twist insertion.

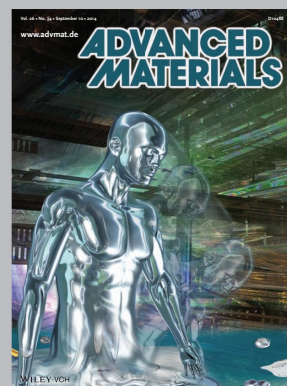
## Photodynamic Therapy

On page 5781, targeted delivery of photosensitizer (PS) and therapeutic photodynamic effect are achieved by folic acid (FA) conjugated carbon dot (CD) as a carrier of PS, zinc phthalocyanine (ZnPc). D.-H. Min, B.-S. Kim and colleagues demonstrate how the CDs prepared by thermal decomposition of  $\alpha$ -cyclodextrin are biocompatible, highly fluorescent, and water dispersible. The ZnPc-loaded FA-conjugated CD shows excellent efficacy as photodynamic therapy to the target cancer cells upon irradiation.



## Photoluminescence

A noble-metal-free porous coordination polymer is successfully developed as high-performance sensor for gaseous oxygen. On page 5866, J.-P. Zhang and co-workers show that the long-lifetime phosphorescence of a Cu(I)-based porous metal azolate framework MAF-2 is extremely sensitive to molecular oxygen. Moreover, a counter-diffusion crystal-growth method is introduced to composite the fragile crystals with silicone rubbers to fabricate mechanically robust and soft membrane sensors.



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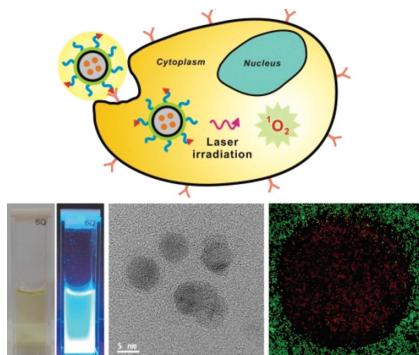
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# FULL PAPERS

## Photodynamic Therapy

Y. Choi, S. Kim, M.-H. Choi,  
S.-R. Ryoo, J. Park, D.-H. Min,\*  
B.-S. Kim\* ..... 5781–5789

**Highly Biocompatible Carbon Nanodots for Simultaneous Bioimaging and Targeted Photodynamic Therapy In Vitro and In Vivo**

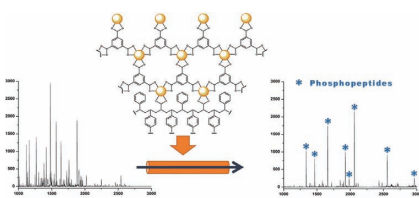


Targeted delivery of a photosensitizer and a therapeutic photodynamic effect are achieved by folic acid (FA)-conjugated carbon dots (CDs), used as carriers of the zinc photosensitizer phthalocyanine (ZnPc). The CDs prepared by thermal decomposition of  $\alpha$ -cyclodextrin are biocompatible, highly fluorescent, and water dispersible. The ZnPc-loaded FA-conjugated CDs show excellent efficacy as a photodynamic therapy, targeting cancer cells upon irradiation.

## Porous Materials

A. Saeed, F. Maya, D. J. Xiao,  
M. Najam-ul-Haq, F. Svec,  
D. K. Britt\* ..... 5790–5797

**Growth of a Highly Porous Coordination Polymer on a Macroporous Polymer Monolith Support for Enhanced Immobilized Metal Ion Affinity Chromatographic Enrichment of Phosphopeptides**

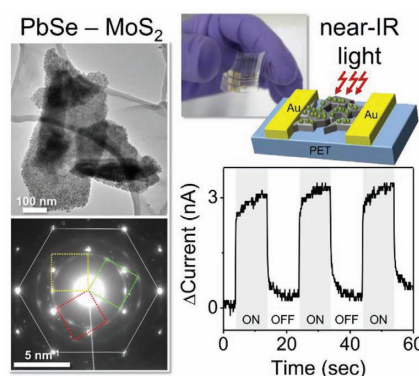


A metal-organic polymer hybrid (MOPH) with a thin film of porous iron(III) benzenetricarboxylate coordination polymer on the internal surface of a macroporous polystyrene-divinylbenzene-methacrylic acid polymer monolith is reported. The MOPH has high surface area ( $389 \text{ m}^2 \text{ g}^{-1}$ ) and thermal stability ( $>250^\circ \text{C}$ ). It is used to enrich phosphopeptides from digested protein mixtures and this approach is likely adaptable to many coordination polymers.

## Quantum Dots

J. Schornbaum, B. Winter, S. P. Schießl,  
F. Gannott, G. Katsukis, D. M. Guldi,  
E. Spiecker,\* J. Zaumseil\* .... 5798–5806

**Epitaxial Growth of PbSe Quantum Dots on  $\text{MoS}_2$  Nanosheets and their Near-Infrared Photoresponse**

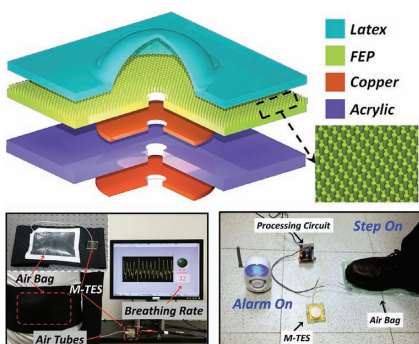


A simple wet-chemical synthesis of hybrid materials consisting of PbSe quantum dots (QDs) and  $\text{MoS}_2$  nanoflakes is demonstrated. PbSe QDs grow epitaxially on  $\text{MoS}_2$  resulting in a direct and linker-free contact between the two components. Solution-processed, flexible, and air-stable photodetectors based on PbSe- $\text{MoS}_2$  hybrids exhibit clear photoswitching when illuminated with near-infrared light.

## Triboelectric Sensors

P. Bai, G. Zhu, Q. Jing, J. Yang,  
J. Chen, Y. Su, J. Ma, G. Zhang,  
Z. L. Wang\* ..... 5807–5813

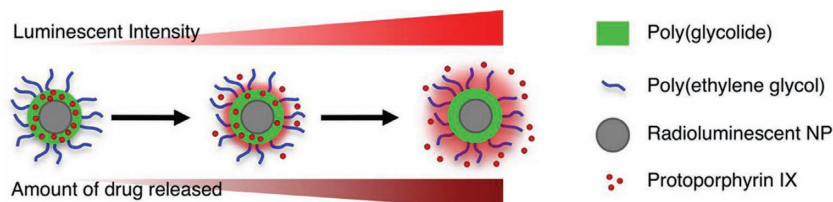
**Membrane-Based Self-Powered Triboelectric Sensors for Pressure Change Detection and Its Uses in Security Surveillance and Healthcare Monitoring**



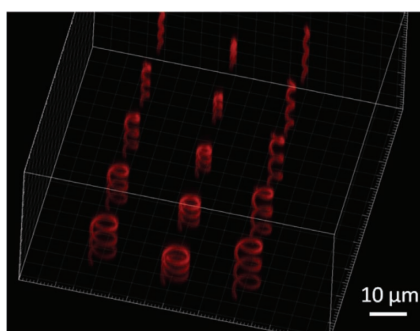
A new membrane-based triboelectric sensor (M-TES) is reported with extremely high detection resolutions as a self-powered approach for air pressure change sensing, surveillance, and healthcare monitoring. The performance of the device, influence factor of the sensitivity, and the robustness have been investigated. Practical applications of M-TES in sensing footsteps, respirations, and heartbeat have been demonstrated.

## FULL PAPERS

**Using X-ray excited optical luminescent nanoparticles (XEOL NPs)**, it is possible to quantitatively measure intracellular drug release. Specifically, XEOL NPs, or radioluminescent NPs, are loaded with the photoactive drug protoporphyrin IX (PpIX). The overlap between the XEOL NP emission and the PpIX absorption enables a quantitative approach to measure drug loading and release kinetics in both buffer solution and into cells.



**This first true 3D-patterning of nano-composite materials** is achieved in silver-containing zinc-phosphate glasses. In a first step, silver clusters are structured in space by means of a near-infrared femtosecond laser. A subsequent thermal treatment allows the space-selective growth of silver nanoparticles. This direct approach opens new routes towards the processing of plasmonic devices for sensing, photonics, and metamaterials applications.



## Theranostics

T. L. Moore, F. Wang, H. Chen,  
S. W. Grimes, J. N. Anker,  
F. Alexis\* .....5815–5823

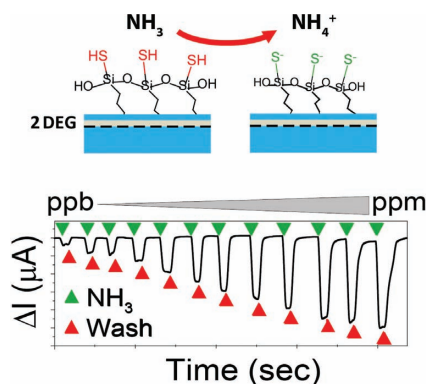
**Polymer-Coated Radioluminescent Nanoparticles for Quantitative Imaging of Drug Delivery**

## Silver Nanoparticles

N. Marquestaut,\* Y. Petit, A. Royon,  
P. Mounaix, T. Cardinal,  
L. Canioni .....5824–5832

**Three-Dimensional Silver Nanoparticle Formation Using Femtosecond Laser Irradiation in Phosphate Glasses: Analogy with Photography**

**A molecularly controlled semiconductor resistor coated with a thin polymer film** is applied for detecting ammonia in physiological solutions. The detection of ammonia in gastric fluids is possible by covering the device with a dialysis membrane, thus enabling the diffusion of only small molecules to the sensing area. Analytical expression is given describing the response of the device both on the pH of the solution and the ammonia concentration.

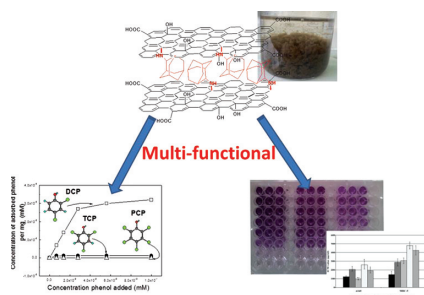


## Biosensors

T. A. Kumar, E. Capua, M. Tkachev,  
S. N. Adler, R. Naaman\* .....5833–5840

**Hybrid Organic-Inorganic Biosensor for Ammonia Operating under Harsh Physiological Conditions**

**A new type of multifunctional pillared, layered material** synthesized by the intercalation of cage-shaped adamantylamine molecules into the interlayer space of graphite oxide and layered aluminosilicate nanoclays is developed, exhibiting antiproliferative activity for cells, as well as high adsorption ability to small organic pollutants from aqueous solutions.



## Nanostructures

K. Spyrou, G. Potsi, E. K. Diamanti,  
X. Ke, E. Serestatidou, I. I. Verginadis,  
A. P. Velapoulou, A. M. Evangelou,  
Y. Deligiannakis, G. V. Tendeloo,  
D. Gournis,\* P. Rudolf\* .....5841–5850

**Towards Novel Multifunctional Pillared Nanostructures: Effective Intercalation of Adamantylamine in Graphene Oxide and Smectite Clays**

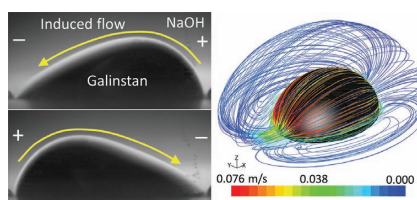


## FULL PAPERS

### Liquid Metals

S.-Y. Tang,\* V. Sivan, P. Petersen,  
W. Zhang, P. D. Morrison,  
K. Kalantar-zadeh,\* A. Mitchell,\*  
K. Khoshmanesh\* ..... 5851–5858

#### Liquid Metal Actuator for Inducing Chaotic Advection

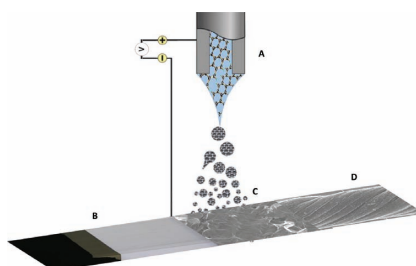


A **soft actuator** is developed which utilizes a droplet of Galinstan liquid metal to induce harmonic Marangoni flow at the surface of liquid metal when activated by a sinusoidal signal. This liquid metal actuator has no rigid parts and can be readily integrated into other microfluidic components for a wide range of applications.

### Hybrid Yarns

J. Foroughi,\* G. M. Spinks, D. Antiohos,  
A. Mirabedini, S. Gambhir, G. G. Wallace,  
S. R. Ghorbani, G. Peleckis,  
M. E. Kozlov, M. D. Lima,  
R. H. Baughman..... 5859–5865

#### Highly Conductive Carbon Nanotube-Graphene Hybrid Yarn

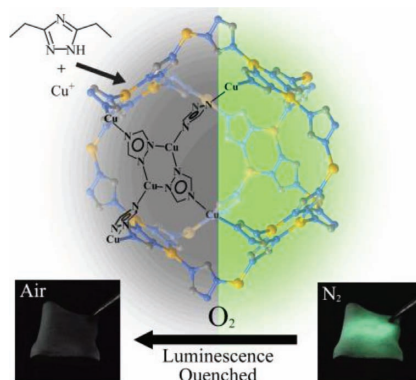


**Highly conductive hybrid multi-walled carbon nanotubes/graphene yarn** are produced in a continuous, scalable process. Graphene dispersions are deposited onto the MWNT sheets by electrospinning to form a composite structure that is transformed by twist insertion into yarn filaments. The novel hybrid yarns will be useful in wearable electronic textiles applications such as batteries, high-performance supercapacitors, high current capable cables, and artificial muscles.

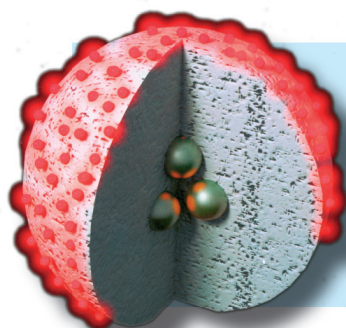
### Photoluminescence

S.-Y. Liu, X.-L. Qi, R.-B. Lin,  
X.-N. Cheng, P.-Q. Liao, J.-P. Zhang,\*  
X.-M. Chen..... 5866–5872

#### Porous Cu(I) Triazolate Framework and Derived Hybrid Membrane with Exceptionally High Sensing Efficiency for Gaseous Oxygen



The porous **Cu(I) diethyltriazolate framework MAF-2** can serve as an extremely sensitive phosphorescent oxygen-sensing material with relatively long phosphorescent lifetime and very low limit of detection. MAF-2 also can be composited with silicone rubbers to fabricate mechanically robust and soft membrane sensors with enhanced stability even in acid atmosphere.



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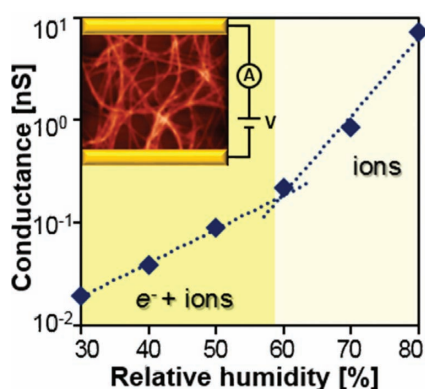
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## FULL PAPERS

**Contribution of both protons and electrons to the conduction of self-assembled peptide fibril networks** is demonstrated under low humidity. Moreover, exponential dependence of proton transport on relative humidity leads to a unique bimodal dependence of the conductance on the relative humidity. This behavior can lead to the development of bioelectric devices that use either or both types of charge carriers for their function.

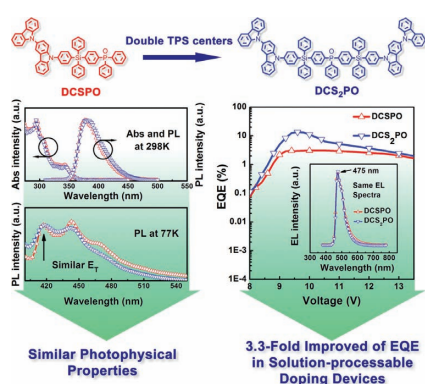


## Charge Transport

M. Amit, S. Appel, R. Cohen, G. Cheng, I. W. Hamley, N. Ashkenasy\* ...5873–5880

## Hybrid Proton and Electron Transport in Peptide Fibrils

**Solution-processable wide-bandgap materials** are synthesized by incorporating carbazole and PO moieties into double-bridged tetraphenylsilanes. This design strategy endows them with good solubility, high thermal stability, and excellent film-forming ability without lowering the triplet energies. A maximum current efficiency of  $26.5 \text{ cd A}^{-1}$  and external quantum efficiency of 13.6% is achieved for DCS<sub>2</sub>PO/Flrpic blue phosphorescent device.

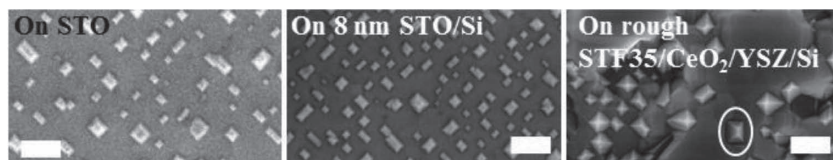


## Electrophorescent Devices

H. Liu, Q. Bai, L. Yao, D. Hu, X. Tang, F. Shen, H. Zhang, Y. Gao, P. Lu,\* B. Yang, Y. Ma .....5881–5888

## Solution-Processable Hosts Constructed by Carbazole/PO Substituted Tetraphenylsilanes for Efficient Blue Electrophosphorescent Devices

**CoFe<sub>2</sub>O<sub>4</sub> pillars in a BiFeO<sub>3</sub> matrix** are grown on (001) Si with two types of buffer layers to form epitaxial BiFeO<sub>3</sub>–CoFe<sub>2</sub>O<sub>4</sub> nanocomposites. When the buffered Si substrates are smooth, the same crystallographic orientation and morphology are observed as that on single crystal SrTiO<sub>3</sub>. On rough substrates, a few CFO pillars are rotated 45°.

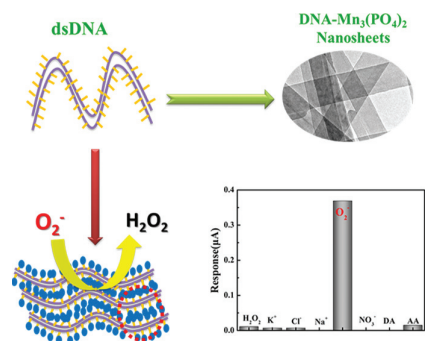


## Nanocomposites

D. H. Kim, N. M. Aimon, X. Y. Sun, L. Kornblum, F. J. Walker, C. H. Ahn, C. A. Ross\* .....5889–5896

Integration of Self-Assembled Epitaxial BiFeO<sub>3</sub>–CoFe<sub>2</sub>O<sub>4</sub> Multiferroic Nanocomposites on Silicon Substrates

**A Mn<sub>3</sub>(PO<sub>4</sub>)<sub>2</sub> nanosheet, a biomimetic enzyme-based biosensor**, is synthesized and further architected on the nano-scale using DNA as a template. The biosensor sensitively, specifically, and durably detects O<sub>2</sub><sup>•−</sup> in situ. This work provides a powerful platform built on low-cost and highly durable artificial enzymes for in situ and sensitive live-cell assay and drug therapy effect screening.



## Biosensors

X. Ma, W. Hu, C. Guo, L. Yu, L. Gao, J. Xie, C. M. Li\* .....5897–5903

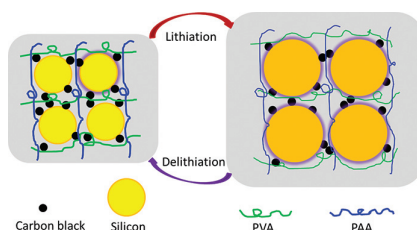
## DNA-Templated Biomimetic Enzyme Sheets on Carbon Nanotubes to Sensitive In Situ Detect Superoxide Anions Released from Cells

## FULL PAPERS

## Silicon Anodes

J. Song, M. Zhou, R. Yi, T. Xu,  
M. L. Gordin, D. Tang, Z. Yu, M. Regula,  
D. Wang\* ..... 5904–5910

**Interpenetrated Gel Polymer Binder for  
High-Performance Silicon Anodes in  
Lithium-ion Batteries**

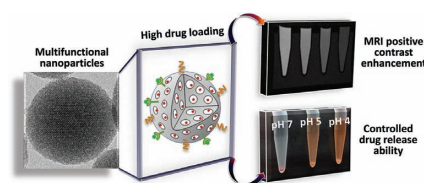


A PAA–PVA gel polymer binder with a deformable polymer network and strong adhesion on silicon particles can effectively accommodate the large volume change of silicon anodes upon lithiation/delithiation, leading to an excellent cycling stability and high Coulombic efficiency even at high current densities or high mass loading.

## Drug Delivery

M. Bouchoucha, R. C.-Gaudreault,  
M.-A. Fortin,\* F. Kleitz\* ..... 5911–5923

**Mesoporous Silica Nanoparticles:  
Selective Surface Functionalization for  
Optimal Relaxometric and Drug Loading  
Performances**



A selective surface functionalization of mesoporous silica nanoparticles with MRI probe molecule and polyethylene glycol is a straightforward and efficient strategy that leads to the design of potential theranostic nanoparticles without porosity loss and with high drug loading capacity. These nanoparticles not only have a remarkable MRI positive contrast enhancement but also allow a controlled drug release in physiological conditions.