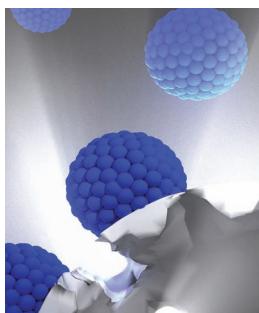


# ADVANCED FUNCTIONAL MATERIALS

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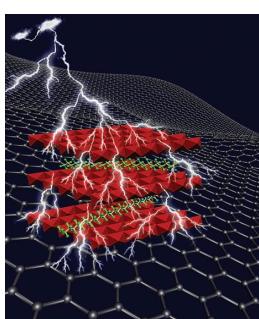
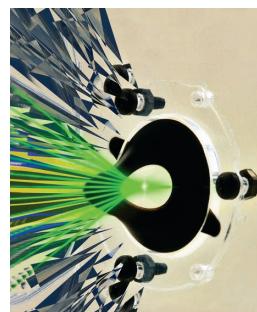


## Superparticles

Mesoporous Pt colloidal nanoparticles are prepared through co-precipitation of both Pt and AgCl nanocrystals on sacrificial substrates of colloidal Ag particles. As reported by Y. Sun, Y. Hu, and Y. Liu on page 1638, this strategy can be extended to other platinum group metals and the mesoporous colloidal nanoparticles exhibit high colloidal stability and ligand-free surfaces to benefit solution-phase heterogeneous catalysis.

## Tunable Optics

On page 1656, S. Rosset, H. Shea, and colleagues present a soft, flexible, and deformable biomimetic lens based on dielectric elastomer actuators (a.k.a. artificial muscles) that is capable of electrically modulating its focal length by 20% in less than 200 microseconds.

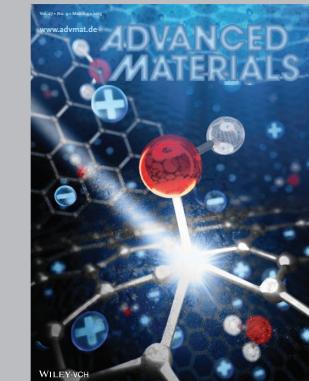
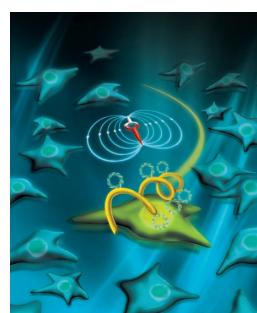


## Energy Storage

Porous Co-Al LDH with dodecyl sulfate anion and graphene sheets as structural and conductive supports, is developed by Z. J. Fan and co-workers on page 1648. Owing to fast ion/electron transport paths, porous and integrated structure, the as-obtained electrode exhibits high specific capacitance, ultra-high rate capability, and high energy density at a very high power density.

## Gene Therapy

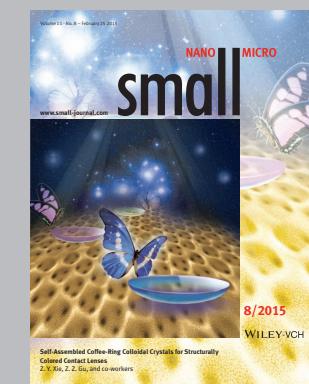
Magnetic helical microswimmers, called artificial bacterial flagella (ABFs), can perform precise 3D navigation in liquids under low-strength rotating magnetic fields ( $<10$  mT), making themselves promising tools for targeted therapies. On page 1666 S. Fijuta, B. J. Nelson, and team show that the ABFs are functionalized with lipoplexes containing plasmid DNA, and the successful wirelessly targeted gene delivery to human embryonic kidney cells *in vitro* using these functionalized ABFs is demonstrated.



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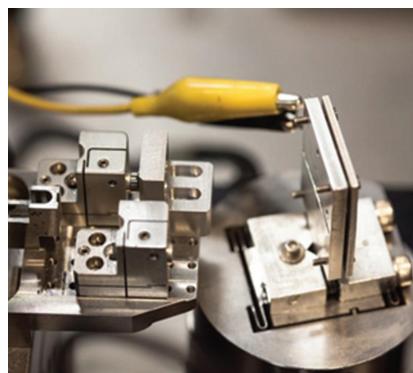
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## FEATURE ARTICLE

**In situ X-ray microscopy** provides a powerful approach to watching battery electrode materials during realistic operations. Such experiments shed light onto operational mechanisms, including degradation and failure. This rapidly growing and developing field is described, focusing on insights gained for these inherently heterogeneous materials.

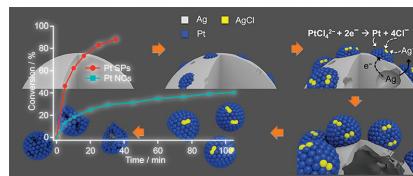


## Energy Storage

J. Nelson Weker,\*  
M. F. Toney\* ..... 1622–1637

## Emerging In Situ and Operando Nanoscale X-Ray Imaging Techniques for Energy Storage Materials

**Colloidal superparticles** consisting of platinum nanocrystals embedded in silver chloride matrix are synthesized through a self-limited coprecipitation on sacrificial substrates of colloidal silver particles. Selective dissolution of silver chloride leads to the formation of porous superparticles of platinum with ligand-free surfaces that are beneficial for solution-phase heterogeneous catalysis.



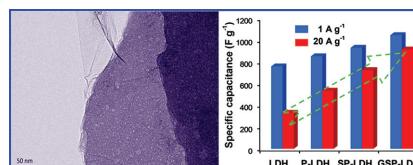
## FULL PAPERS

## Superparticles

Y. Hu, Y. Liu, Y. Sun\* ..... 1638–1647

## Mesoporous Colloidal Superparticles of Platinum-Group Nanocrystals with Surfactant-Free Surfaces and Enhanced Heterogeneous Catalysis

**Integrated porous Co-Al hydroxide nanosheets with dual support system (GS P-LDH)** are synthesized by using dodecyl sulfate anions as structural support and graphene sheets as conductive support. The as-obtained GSP-LDH electrode exhibits high specific capacitance and ultra-high rate capability. Moreover, the assembled porous carbon//GSP-LDH asymmetric supercapacitor exhibits a high energy density up at a very high power density.

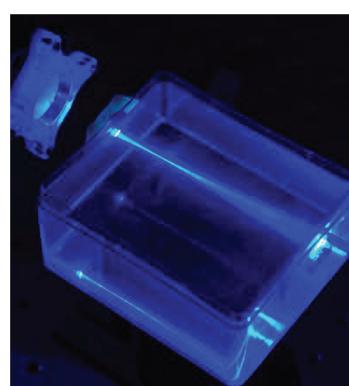


## Supercapacitors

X. L. Wu, L. L. Jiang, C. L. Long, T. Wei, Z. J. Fan\* ..... 1648–1655

## Dual Support System Ensuring Porous Co-Al Hydroxide Nanosheets with Ultrahigh Rate Performance and High Energy Density for Supercapacitors

**Soft and electrically tunable lenses based on dielectric elastomer actuators** are fabricated and exhibit settling time below 175  $\mu$ s. Soft and compliant systems can also display fast response speed by a proper choice of materials and an adequate design. The lens, based on a low-loss commercial silicone, is able to modulate its focal length by 20%.



## Tunable Optics

L. Maffli, S. Rosset,\* M. Ghilardi, F. Carpi, H. Shea\* ..... 1656–1665

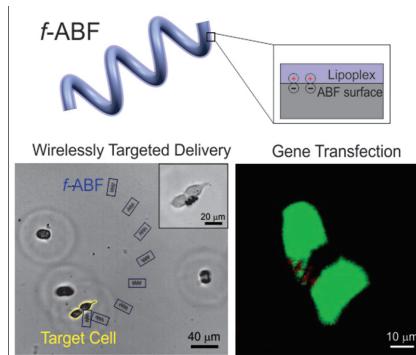
## Ultrafast All-Polymer Electrically Tunable Silicone Lenses

## FULL PAPERS

## Gene Therapy

F. Qiu, S. Fujita,\* R. Mhanna, L. Zhang, B. R. Simona, B. J. Nelson\* ... 1666–1671

**Magnetic Helical Microswimmers Functionalized with Lipoplexes for Targeted Gene Delivery**

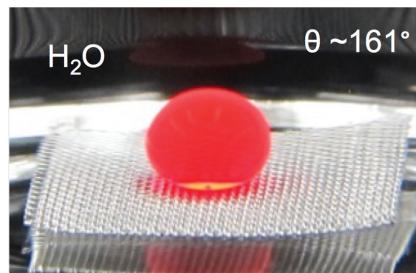


**Magnetic helical microswimmers, called artificial bacterial flagella (ABFs),** can perform precise 3D navigation in liquid under low-strength rotating magnetic fields, making themselves promising tools for targeted therapies. The ABFs are functionalized with lipoplexes containing plasmid DNA, and the successful wirelessly targeted gene delivery to human embryonic kidney cells *in vitro* using these functionalized ABFs is demonstrated.

## Nanoporous Materials

U. Manna, D. M. Lynn\* ..... 1672–1681

**Synthetic Surfaces with Robust and Tunable Underwater Superoleophobicity**

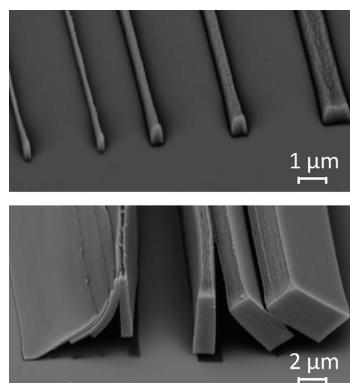


**Nanoporous polymer multilayers** that exhibit robust and tunable underwater superoleophobicity are reported. These entirely organic coatings are tolerant to a broad range of physical, chemical, and environmental insults encountered in harsh or chemically complex media. The results provide new approaches to the design of durable anti-oil-fouling coatings and new principles for control over the transport, manipulation, and separation of oils and organic fluids in aqueous environments.

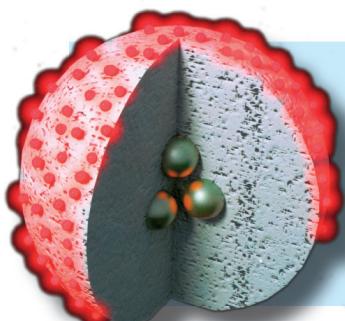
## Photolithography

N. A. Bakhtina, U. Loeffelmann, N. MacKinnon, J. G. Korvink\* ..... 1683–1693

**Two-Photon Nanolithography Enhances the Performance of an Ionic Liquid–Polymer Composite Sensor**



**A novel ionic liquid–polymer composite material** is reported, alongside an approach for its patterning by two-photon nanolithography. The unique properties of the material are combined with a single-step process for its 3D structuring, having nanometer resolution and high aspect ratio. A proof-of-concept multifunctional sensor for temperature and relative humidity sensing is demonstrated.



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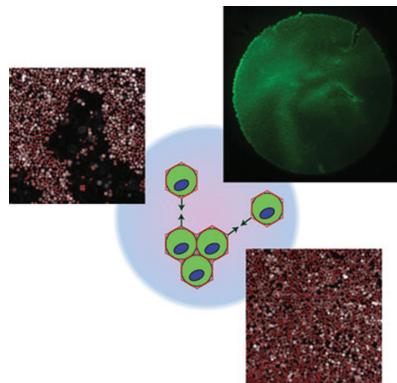
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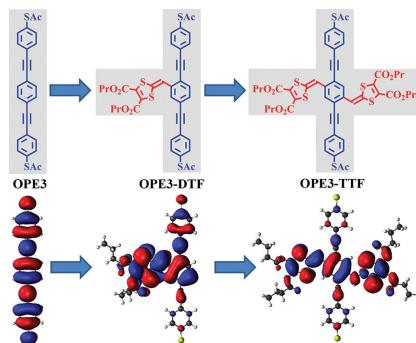
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## FULL PAPERS

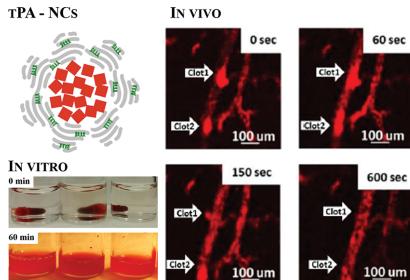
**Macroscopic tissue constructs composed entirely of cells** are formed using the interfacial properties of aqueous two-phase systems. The constructs form rapidly in as little as 2 h using a variety of cell types, offering a new methodology for fabricating tissue-engineered *in vitro* models and cell-based materials for regenerative therapies.



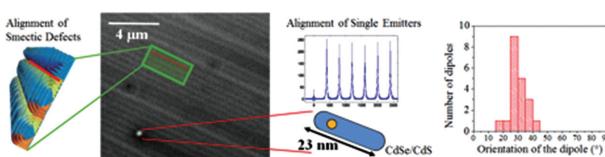
**Molecular heterojunctions** based on self-assembled monolayers of oligo(phenylene ethynylene)s, which have linear to cruciform framework, are measured by conducting probe–atomic force microscopy. Different molecular orbitals are obtained by adding the electron donating redox-active dithiafulvene as substituent group to the OPE3 backbone. The Fermi level of the atomic force microscopy tip is tuned by different metal coating (Ag, Au, and Pt).



**Clustered super-paramagnetic 20 nm iron oxide nanocubes**, stabilized by tissue plasminogen activator molecules and serum albumin, are proposed as thrombolytic agents. *In vitro*, as compared to tissue plasminogen activator, these nanoconstructs demonstrate a  $\approx$ 1000-fold increase in dissolution rate. Intravital microscopy experiments demonstrate blood vessel reperfusion within a few minutes post tail vein injection of tissue plasminogen activator nanocubes.



**The self-alignment of CdSe/CdS dots-in-rods** is realized through their deposition within aligned line defects of smectic liquid crystals. The measurements of numerous single-photon emitters evidences, for a given liquid crystal film, a unique alignment of the in-plane dipoles associated with these particles. Fine control of the polarization of single photons emitters is thus achieved.



## Tissue Engineering

J. P. Frampton, B. M. Leung, E. L. Bingham, S. Cai Lesher-Perez, J. D. Wang, H. T. Sarhan, M. E. H. El-Sayed, S. E. Feinberg, S. Takayama\* ..... 1694–1699

## Rapid Self-Assembly of Macroscale Tissue Constructs at Biphasic Aqueous Interfaces

## Molecular Electronics

Z. Wei, T. Hansen, M. Santella, X. Wang, C. R. Parker, X. Jiang, T. Li, M. Glyvradal, K. Jenum, E. Glibstrup, N. Bovet, X. Wang, W. Hu, G. C. Solomon, M. B. Nielsen, X. Qiu, T. Bjørnholm, K. Nørgaard,\* B. W. Laursen\*... 1700–1708

## Molecular Heterojunctions of Oligo(phenylene ethynylene)s with Linear to Cruciform Framework

## Thrombolytic Agents

E. Voros, M. Cho, M. Ramirez, A. L. Palange, E. De Rosa, J. Key, Z. Garami, A. B. Lumsden, P. Decuzzi\* ..... 1709–1718

## TPA Immobilization on Iron Oxide Nanocubes and Localized Magnetic Hyperthermia Accelerate Blood Clot Lysis

## Liquid Crystals

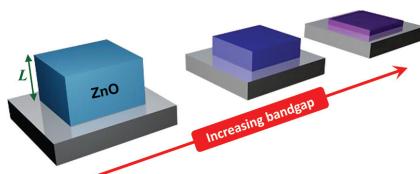
L. Pelliser, M. Manceau, C. Lethiec, D. Coursault, S. Vezzoli, G. Leménager, L. Coolen, M. DeVittorio, F. Pisanello, L. Carbone, A. Maitre, A. Bramati, E. Lacaze\* ..... 1719–1726

## Alignment of Rod-Shaped Single-Photon Emitters Driven by Line Defects in Liquid Crystals

## FULL PAPERS

## Semiconductors

J. G. Labram,\* Y.-H. Lin, K. Zhao, R. Li, S. R. Thomas, J. Semple, M. Androulidaki, L. Sygellou, M. McLachlan, E. Stratakis, A. Amassian, T. D. Anthopoulos\* ..... 1727–1736



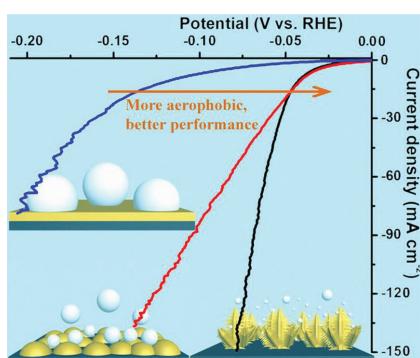
**Signatures of Quantized Energy States in Solution-Processed Ultrathin Layers of Metal-Oxide Semiconductors and Their Devices**

The concept of quantized energy states in ultrathin solution-processed zinc oxide layers is explored. As-deposited layers are found to exhibit a characteristic widening of the energy bandgap with reducing thickness in accordance with theoretical predictions. When the zinc oxide layers are used as quantum-wells in carefully engineered two-terminal electronic devices, negative differential conductance is observed.

## Electrocatalysis

Y. Li, H. Zhang, T. Xu, Z. Lu, X. Wu, P. Wan,\* X. Sun,\* L. Jiang ... 1737–1744

**Under-Water Superaerophobic Pine-Shaped Pt Nanoarray Electrode for Ultrahigh-Performance Hydrogen Evolution**

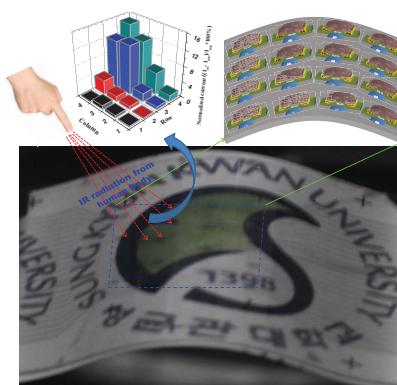


A Pt nanoarray electrode with under-water superaerophobicity is fabricated by a facile and easily scalable electrodeposition technique. This electrode with a lower bubble adhesive force, a higher bubble contact angle in aqueous solution, and lower size of bubbles release, exhibits an ultrahigh electrocatalytic hydrogen evolution reaction performance, excellent durability, no obvious current fluctuation, and dramatically fast current density increase.

## Photodetectors

T. Q. Trung, S. Ramasundaram, N.-E. Lee\* ..... 1745–1754

**Infrared Detection Using Transparent and Flexible Field-Effect Transistor Array with Solution Processable Nanocomposite Channel of Reduced Graphene Oxide and P(VDF-TrFE)**

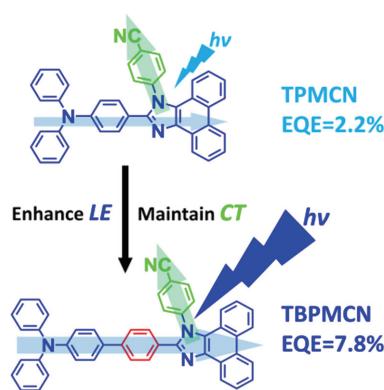


A transparent and flexible infrared photodetector array, using a field-effect transistor structure in which an infrared-responsive nanocomposite layer of reduced graphene oxide and P(VDF-TrFE) is employed as a channel, exhibits high infrared responsivity, stability, and reproducibility under mechanical strain. It is possible to measure the distribution of the infrared responses from each device in a transparent and flexible nanocomposite field-effect transistor array under infrared radiation from the human body.

## Organic Electronics

S. Zhang, L. Yao, Q. Peng, W. Li, Y. Pan, R. Xiao, Y. Gao, C. Gu, Z. Wang, P. Lu, F. Li, S. Su, B. Yang,\* Y. Ma... 1755–1762

**Achieving a Significantly Increased Efficiency in Nondoped Pure Blue Fluorescent OLED: A Quasi-Equivalent Hybridized Excited State**



A newly synthesized material 4-[2-(4'-diphenylamino-biphenyl-4-yl)-phenanthro[9,10-d]imidazol-1-yl]-benzonitrile (TBPMCN) possesses a quasi-equivalent hybridization of the locally emissive and charge-transfer components in its excited state, which gives rise to its overall electroluminescence performance. The blue emissive nondoped organic light-emitting diode of TBPMCN exhibits a very high external quantum efficiency of 7.8% with a Commission Internationale de L'Eclairage coordinate of (0.16, 0.16).