# ADVANCED FUNCTIONAL MATERIALS

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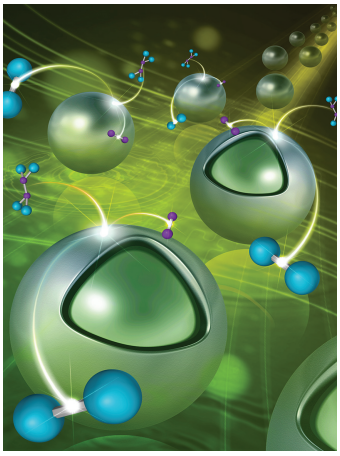
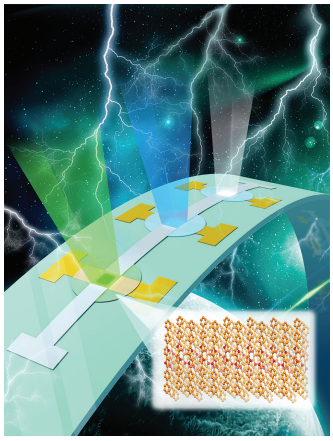


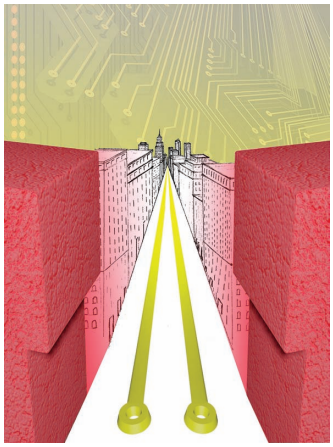
**Nanocatalysts**

On page 7073 Y. Zhang and co-workers report the design and synthesis of novel non-precious Cu@$Fe_5Ni_5$ core@shell nanocatalysts, exhibiting 100% $H_2$ selectivity and high activity for the complete decomposition of hydrous hydrazine under ambient conditions, which would certainly promote the effective application of hydrous hydrazine as a promising hydrogen storage material.

**Organic Crystals**

Organic single-crystal-based organic light-emitting devices (OLEDs) with bright and homogeneous luminescence are realized by J. Feng, H.-B. Sun, and colleagues on page 7085 by employing a template stripping technique. Both surface and edge emission are realized by using two kinds of crystals. Highly polarized EL and white emission are also observed from the crystal-based OLEDs with high flexibility and mechanical robustness. This method can be adopted to fabricate the crystal-based optoelectronic devices, providing an avenue to promote their broad applications.





**Self-Assembly**

Beyond Manhattan type profiles in block copolymer nanostructures. On page 7078 C. He and M. P. Stoykovich present an approach, analogous to that in bilayer photoresist films, to achieve tunable interface shapes and sidewall profiles in block copolymers self-assembled in thin films. Such interfacial control provides the unique opportunity to design block copolymer nanostructures specially tuned for pattern transfer into functional materials. Cover design by Chunlin He and Kathryn Morrissey.

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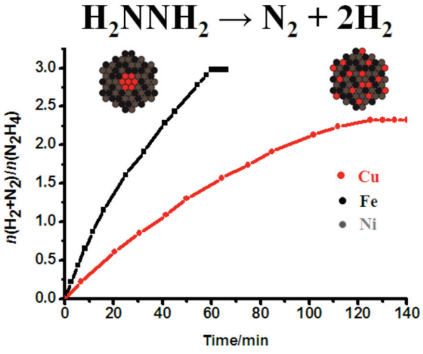
## Nanocatalysts

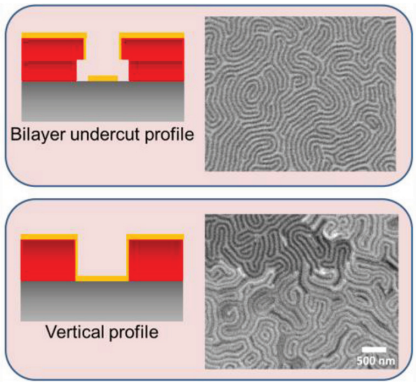





**Hydrous hydrazine** has great potential as a suitable liquid-hydrogen storage material, provided that a low-cost and high-performance dehydrogenation catalyst is developed. The core@shell nanocatalyst $Cu@Fe_5Ni_5$ enables hydrazine decomposition such that the $H_2$-producing reaction is completely favored over the ammonia-producing reaction, making hydrous hydrazine a promising hydrogen storage material.

## Self-Assembly



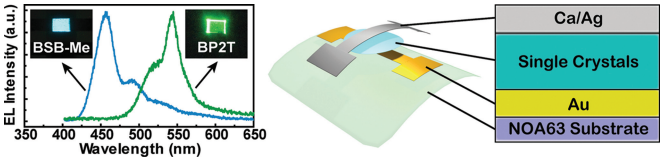



**Bilayer thin films of lamellar-forming poly(styrene-*block*-methyl methacrylate)** are self-assembled and thermally cross-linked on wafer substrates in a layer-by-layer process. This layer-by-layer approach can provide novel control over the interface profile of block copolymer nanostructures and enables an undercut sidewall profile that enhances metal lift-off processes for pattern transfer.

## Organic Crystals

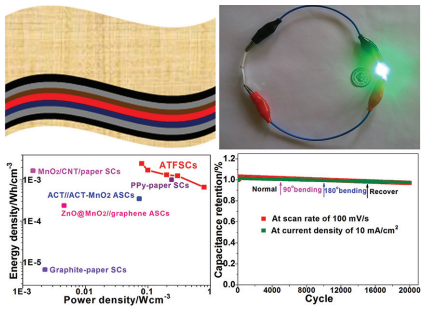


**Organic single-crystal-based LEDs with bright and homogeneous luminescence** are realized due to an improved contact between the crystals and both top and bottom electrodes by employing the template stripping technique. Both surface and edge emission are realized by using two kinds of crystals. Highly polarized EL and white emission are also observed from the crystal-based OLEDs. Moreover, the crystal-based OLEDs exhibit high flexibility and mechanical robustness.




## Supercapacitors






**Cellulose paper (CP)-based asymmetrical thin film supercapacitors** are assembled by using sandwich-structured graphite/$Ni/Co_2NiO_4$-CP as positive electrode and graphite/Ni/AC-CP as negative electrode. The assembled devices exhibit large $C_{sp}$ (7.6 F/cm$^3$ at 5 mV/s), high volumetric energy density (2.48 mWh/cm$^3$, 80 Wh/kg), high volumetric power density (0.79 W/cm$^3$, 25.6 kW/kg), and excellent cycle stability (less 4% $C_{sp}$ loss after 20 000 cycles).

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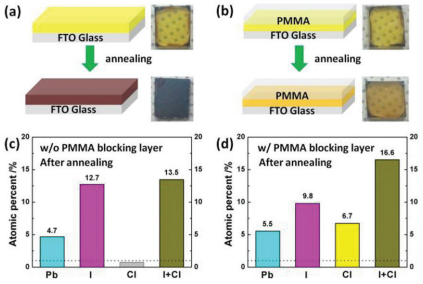
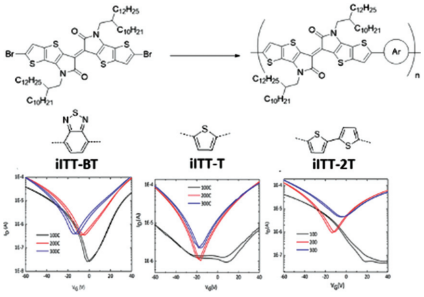
**To understand theformation mechanism of $CH_3NH_3PbI_{3-x}Cl_x$ perovskite,** two testing structures, perovskite (precursor mixture)/FTO and PMMA (polymethyl methacrylate)/perovskite (precursor mixture)/FTO, are designed. The different annealing results of these two structures suggest that the formation of $CH_3NH_3PbI_{3-x}Cl_x$ perovskite is likely driven by the release of gaseous $CH_3NH_3Cl$ through an intermediate organolead mixed halide phase.




## Photovoltaics



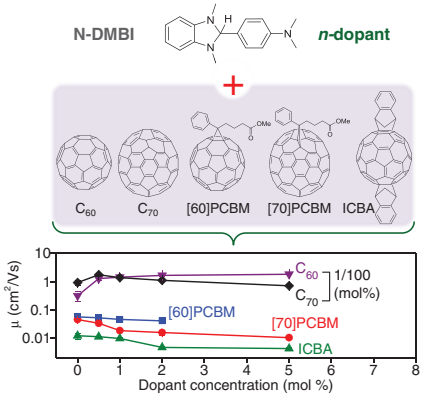
**A series of new isoindigo semiconducting polymers with thieno[3,2-*b*] thiophene as the donor moiety** are synthesized. By fusing an extra aromatic ring to the isoindigo core, absorption profiles are shifted into the near-IR with optical band gaps as narrow as 1.05 eV. Organic top-gate bottom-contact transistor devices are fabricated demonstrating good ambipolar mobilities.




## Conjugated Polymers



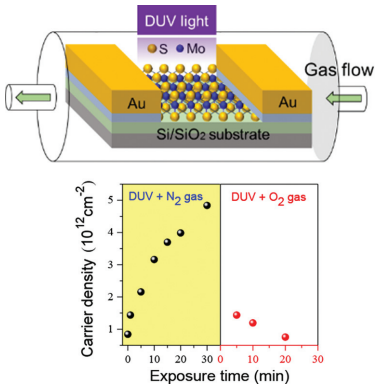
**Doping of organic semiconductors** is a key technology for tuning their charge transport properties. Here a systematic comparison of n-type doping of solution-processed un/substituted fullerenes with regard to optical, electrical, and morphological properties, is presented. In case of $C_{60}$ and $C_{70}$, n-doping is found to both increase the electron mobility and improve the bias stress stability of the transistors.




## Molecular Doping



**The charge-carrier density of single-, bi-, and few-layer $MoS_2$ nanosheets** can be finely and reversibly tuned with $N_2$ and $O_2$ gas in the presence of deep-ultraviolet (DUV) light. The exposure to $N_2$ gas in the presence of DUV light significantly improves the drain-to-source current, carrier density, and charge-carrier mobility for $MoS_2$ nanosheets.




## Charge Transport

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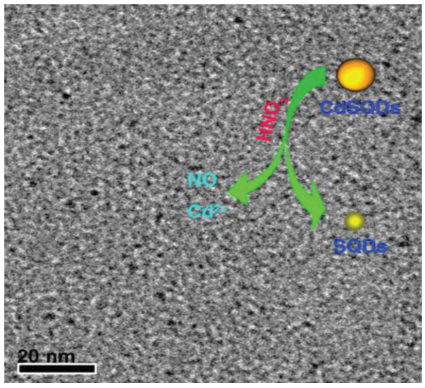
## Quantum Dots

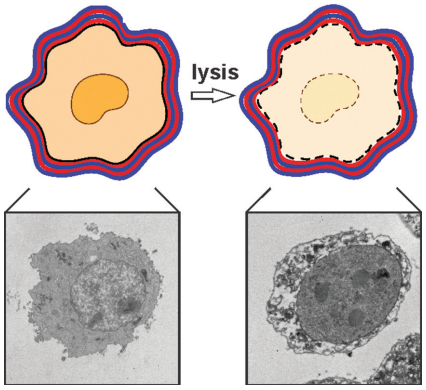





**Sulphur quantum dots** are first synthesized by a ox-red reaction at the water–oil interface. The sulphur quantum dots show good water solubility, excellent stability, and lowly toxicity. Sulphur quantum dots sensitized $TiO_2$ photocatalyze the generation of $H_2$ from a water/methanol mixture upon irradiation with UV. A $Fe^{3+}$ ions fluorescence sensor demonstrates good linearity and high selectiveness.

## Immune Therapy

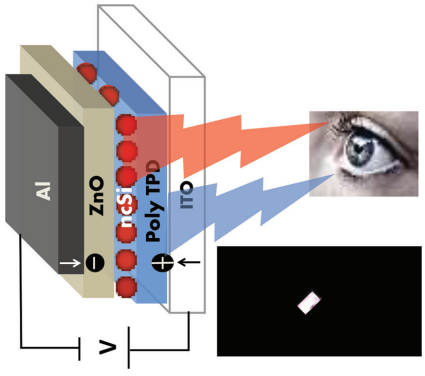




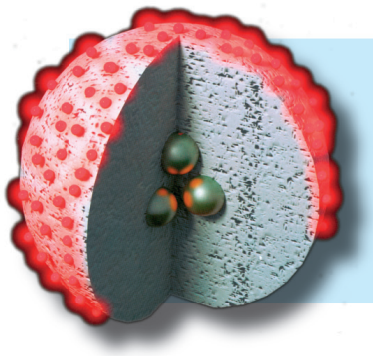

**Melanoma cells** are coated via layer-by-layer deposition of poly(vinylpyrrolidone) and tannic acid followed by lysis through hypo-osmotic treatment. The coating is optimized to preserve the cellular integrity and optimal retention of the cellular proteins within the cell-templated capsules. In addition, a proof-of-concept study is performed to demonstrate the encapsulation of heat shock proteins as potential immune-activators.

## Hybrid Electronics






**A novel design of white light emitting diodes** emerges to meet the growing global demand for resource sustainability while preserving health and environment. The proposed WLED contains a hybrid bilayer of silicon nanocrystals (ncSi) and luminescent polymer in its device active region, and works at sufficiently low turn-on voltage (3.5 V) by taking advantages of the large Stokes shift inherent to ncSi.



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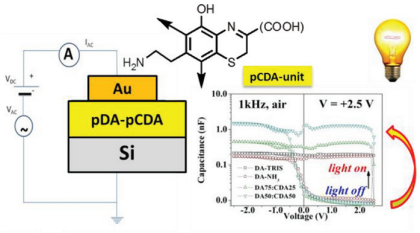
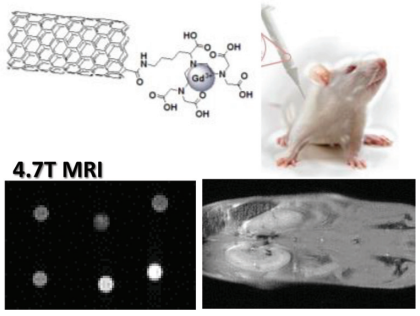
**Incorporation of cysteinyldopamine(CDA)-derived units into polydopamine (pDA)** leads to an innovative bioinspired material combining the photosensitizing properties of red human hair pigments with the electrical properties of mdelanins. The resulting mixed-type biopolymers exhibit a markedly enhanced response to UV light and open the doorway to unprecedented bio-inspired metal-insulator-semiconductor photo-capacitor hybrid devices with tunable optical response for light sensing applications.




## Light Sensing



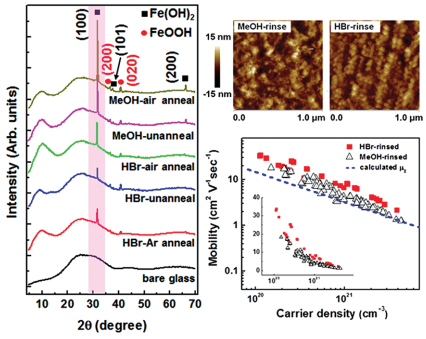
**Oxidized multi-walled carbon nanotubes** are provided with positive MRI contrast properties by covalent functionalization with the chelating ligand DTPA followed by chelation to $Gd^{3+}$. Despite the intrinsic $T_2$ contrast of oxidized CNTs, the covalent anchoring of paramagnetic gadolinium ions on CNT sidewall allows high dispersibility and efficient positive MR contrast both in vitro in labeled cells and in vivo after intravenous injection of CNTs in mice.




## Nanomedicine



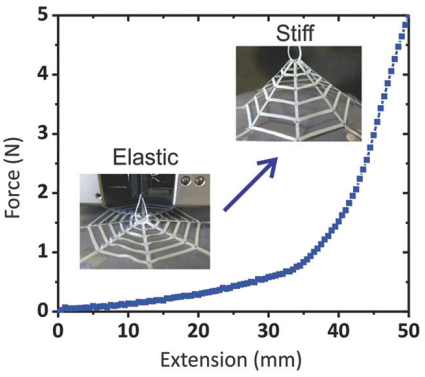
**Heavily-doped poly(3,4-ethylenedioxythiophene)(PEDOT) films with carrier density higher than ~$10^{20}$ $cm^{-3}$** are produced using oxidative chemical-vapor-deposition. The mechanisms for the conductivity decrease and carrier transport behavior in heavily-doped PEDOT, which are important to organic optoelectronic device applications that show a strong effect of air-exposure and low temperature annealing on the device stability and performance, are suggested.




## Conducting Polymers



**Adaptive Young's moduli of composites** are demonstrated by combining different materials and controlling their geometries. As applied strain increases, the critical component that dictates the mechanical strength of the composite shifts from an elastic material to a stiff material, resulting in discrete steps in increasing moduli. The characteristics of the steps can be engineered to accommodate specific requirements of applications.




## Adaptive Materials

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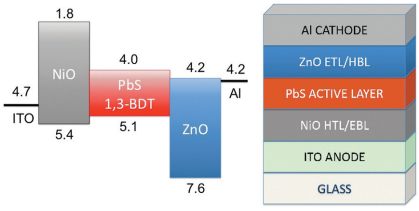
## Photodetectors

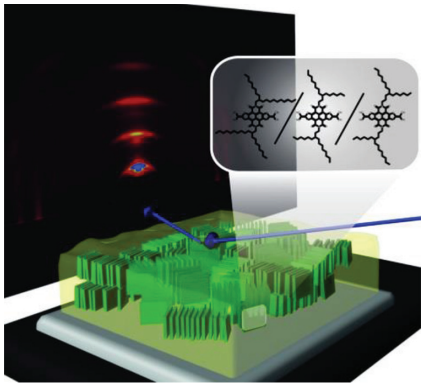





**Air-stable, all-solution processed all-inorganic multispectral photodetectors** using PbS quantum dots as the photoactive layer, colloidal ZnO nanoparticles as the electron transport/hole blocking layer, and solution-derived NiO as the hole transport/electron blocking layer are reported. The resulting devices have very low dark current density with a noise equivalent power on the order of tens of picowatts across the detection spectra. The performance parameters are comparable to commercially available Si, Ge, and InGaAs photodetectors and the device has a long unencapsulated storage lifetime in air.

## Organic Electronics





**In situ grazing incidence wide angle X-ray scattering** monitors the crystallinity and phase behavior of thin film organic systems during heating. In the case of solution-processed core expanded naphthalene diimide small molecules, the branching location of alkyl side chains tunes in-plane thermal expansion coefficients which in turn correlate with mobility of the quenched film.