# ADVANCED FUNCTIONAL MATERIALS

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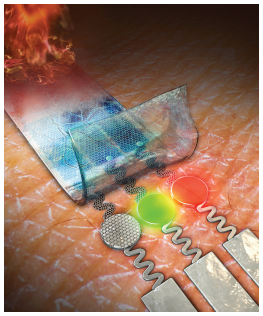
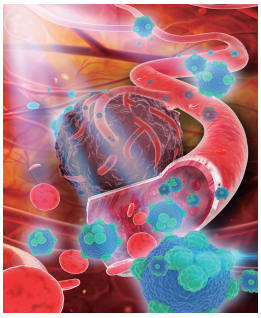


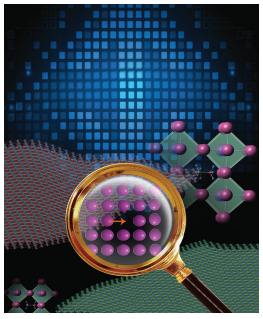
**Wearable Electronics**

On page 7109, J.-H. Kim, D.-H. Kim, and co-workers report a novel graphene transfer technique that allows multiple patterned-graphene transfers at desired locations. Using the thermal-expansion mismatch between the viscoelastic sacrificial layer and the elastic stamp, a "heating and cooling" process precisely positions patterned graphene layers with high transfer yields. The proposed transfer printing successfully integrates graphene-based stretchable sensors, actuators, and LEDs, paving the way toward transparent and wearable multifunctional electronic systems.

**Tumor Detection**

On page 7119, S. J. Zeng, J. H. Hao, and co-workers present a multifunctional upconversion nanoprobe with remarkable enhancement of near-infrared emission for trimodal bioimaging, combining upconversion optical, $T_2$-weighted magnetic resonance, and computed tomography imaging. Importantly, these nanoprobes are successfully used for in vivo diagnosis of small tumors (down to 4 mm) based on upconversion optical and $T_2$-weighted magnetic resonance imaging.





**Solid Electrolytes**

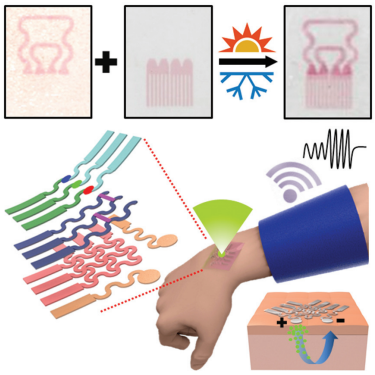
C. Liang, Z. He, W. C. H. Choy, and co-workers demonstrate on page 7226 a new type of perovskite device: perovskite light-emitting electrochemical cells. Organic–inorganic halide perovskites used as solid electrolytes are shown to have an ionic conductivity comparable to polymer electrolytes, which is important for understanding the operation mechanisms and electrical properties of perovskite devices. This suggests future applications for perovskites in energy storage devices.

**Hierarchical Zeolite**

Superior catalysts are formed from ultra-stable Y zeolite are post-synthetic treatment with $NH_4OH$. On page 7130, D. Verboekend, B. F. Sels, and co-workers show that this process results in the selective creation of small mesopores by partial zeolite densification without significant material leaching, similar to digging moles creating an interconnected network of accessible mole runs.

# FULL PAPERS

**A thermally controlled transfer printing method** that is specially designed for the multiple aligned transference of patterned graphene is developed. Through this approach, accurate and high-yield transference of patterned graphene onto diverse substances is achieved, allowing a transparent, stretchable, and wearable all-graphene electronic/optoelectronic system to be fabricated.

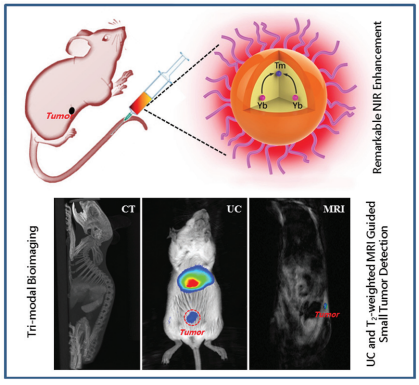


## Wearable Electronics



**Thermally Controlled, Patterned Graphene Transfer Printing for Transparent and Wearable Electronic/Optoelectronic System**

**A remarkable enhancement of NIR emission of multifunctional PEGylated upconversion nanoparticles (UCNPs)** is developed. The nanoparticles serve as bioprobes and contrast agents for upconversion (UC) optical, magnetic resonance imaging (MRI), and CT trimodal bioimaging. Impressively, the developed UCNPs are successfully used for UC and $T_2$-weighted MRI-guided early-stage diagnosis of small tumors.

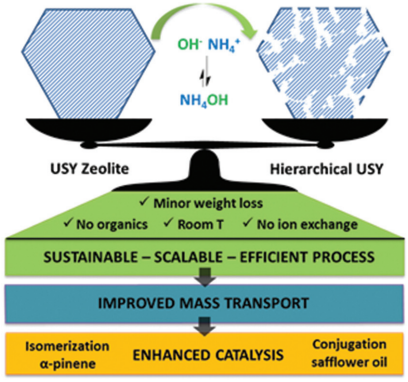



## Tumor Detection



**Remarkable NIR Enhancement of Multifunctional Nanoprobes for In Vivo Trimodal Bioimaging and Upconversion Optical/$T_2$-Weighted MRI-Guided Small Tumor Diagnosis**

**Postsynthetic $NH_4OH$ treatment** is performed on USY (ultra-stable Y) zeolite to sustainably develop superior catalysts. Extensive characterization shows the selective creation of small mesopores by partial zeolite densification without significant material leaching. The hierarchical zeolite outperforms the conventional USY for acid-catalyzed isomerization of $\alpha$-pinene and metal-catalyzed conjugation of safflower oil, which is attributed to its enhanced intracrystalline mass transport capacity.

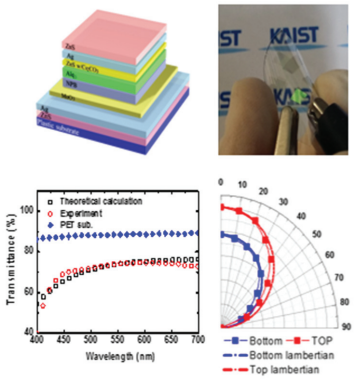



## Hierarchical Zeolite



**Catalyst Design by $NH_4OH$ Treatment of USY Zeolite**

**Highly transparent and flexible organic light-emitting diodes (TFOLEDs)** are fabricated using dielectric layer/metal/dielectric layer (multilayer) electrodes for use as both anodes and cathodes. The structure of multilayer electrodes is optimized to maximize transmittance and to provide flexibility. The fabricated TFOLEDs are highly transparent and show a nearly Lambertian emission pattern without a microcavity effect.




## Organic LEDs

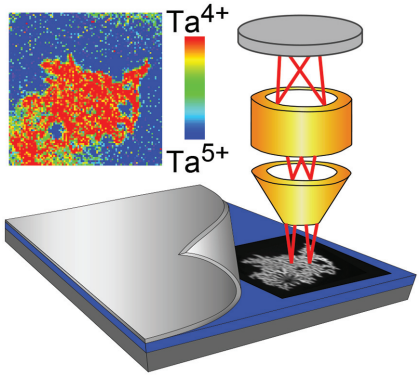


**Highly Transparent and Flexible Organic Light-Emitting Diodes with Structure Optimized for Anode/Cathode Multilayer Electrodes**

# FULL PAPERS

## Resistive Switching

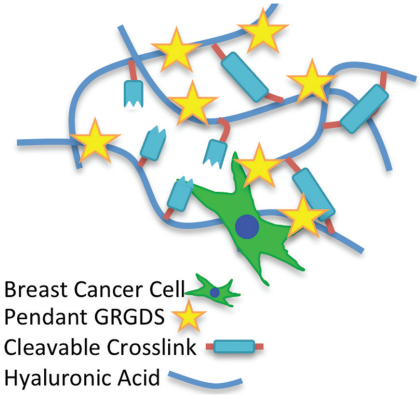





**It is experimentally demonstrated that a pronounced interface adsorbate layer** in $Ta_2O_{5-x}$-based resistive switching devices leads to an avalanche-discharge-induced breakdown instead of a breakdown within a single filament. Moreover, it is explicitly proven that the switching between the low and high resistance state is caused by the reduction/oxidation of $Ta_2O_{5-x}/TaO_2$ in the entire former $Pt/Ta_2O_{5-x}$ interface of the dendrite-like structure.

## Biomimetics

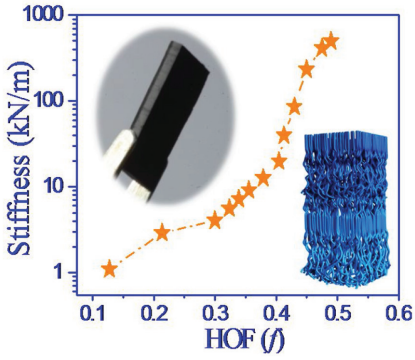




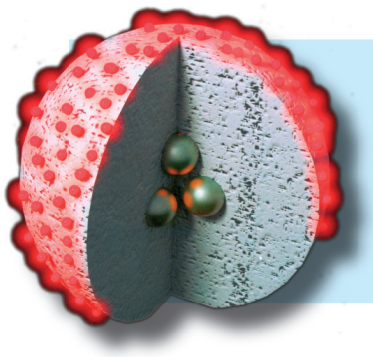

**A hyaluronic acid-based hydrogel crosslinked with protease cleavable crosslinks** is shown to support breast cancer cell invasion. The crosslink and adhesive ligand densities of the hydrogel are decoupled, allowing the effect of each parameter on cell invasion to be studied. A platform is developed capable of recapitulating a wide range of microenvironments.

## Carbon Nanotube Films






**A macroscopic carbon nanotube (CNT) film with gradient structure** is synthesized by one-step CVD. The CNT arrangement gradually changes from well aligned to random distribution in a continuous and smooth way along the thickness direction. Local deformation and mechanical properties such as stiffness and elastic modulus are determined by the Herman's orientation factor and span over three orders of magnitude.



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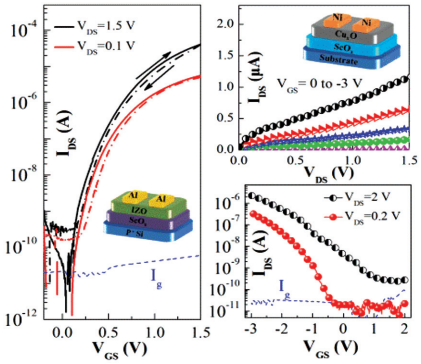
## FULL PAPERS

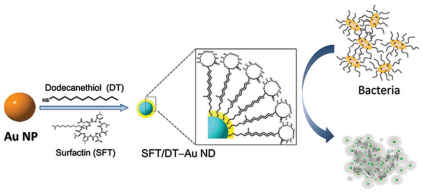
**A novel way of preparing low-voltage n-type and p-type oxide thin-film transistors (TFTs) with improved electrical performance** is shown. The water-induced, high-*k* $ScO_x$ is proven to be an attractive channel–insulator interface constituent and exhibits excellent electrical properties. The solution-processed p-type CuO/$ScO_x$ TFTs exhibit superior hole-transport characteristics with a field-effect mobility of 0.8 $cm^2\ V^{-1}\ s^{-1}$ at the low operating voltage of 3 V.




### Thin-Film Transistors



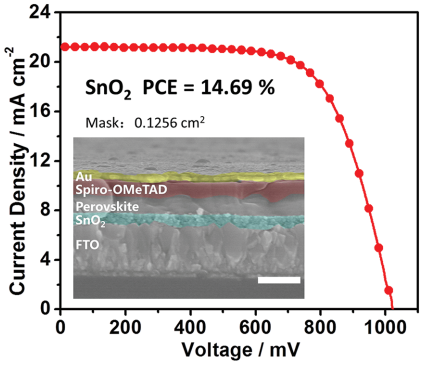
**Surfactin, an antimicrobial lipopeptide, when self-assembled on photoluminescent gold nanodots (Au NDs)** exhibits an >80-fold improvement in its antimicrobial activity against multidrug-resistant bacteria. Antibacterial wound-healing assays further reveal that the surfactin–Au ND hybrid material is superior to that of surfactin alone on a bacteria-infected flesh wound in rats.




### Wound Healing



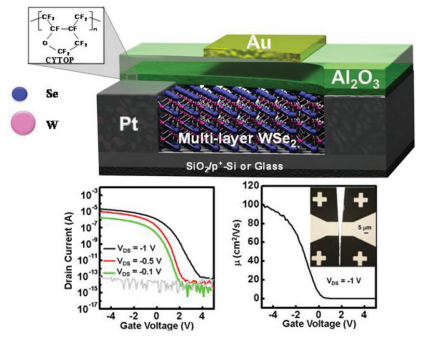
**$SnO_2$ nanocolloids are synthesized for planar $CH_3NH_3PbI_3$ perovskite solar cells**. A champion efficiency of 14.69% is achieved for the $SnO_2$-based solar cell, which is superior to the $TiO_2$-based solar cell (13.38%) due to a higher electron mobility and negative conduction band, facilitating the electron injection, charge separation, and collection, which contribute to the improvement of photovoltaic performance.




### Perovskite Solar Cells



**A bilayer gate dielectric composed of a high-*k* $Al_2O_3$ layer and a low-*k* fluoropolymer layer** yields field-effect transistors (FETs) with excellent gating properties. The proposed top-gate p-channel $WSe_2$ FETs demonstrate a high hole mobility of 100 $cm^2\ V^{-1}\ s^{-1}$ and an $I_{ON}/I_{OFF}$ ratio of $>10^7$ on a glass substrate. Furthermore, the top-gate FET shows a very good stability in ambient air up to 7 days after device fabrication.




### Field-Effect Transistors

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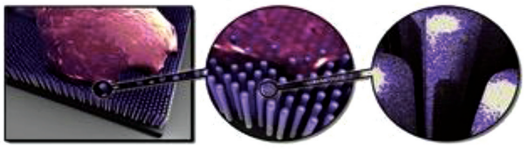
## Gene Delivery

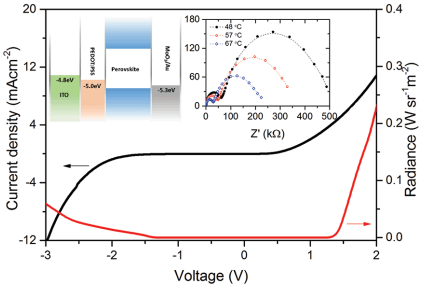


**An easy-to-implement approach to control geometrical parameters in vertically aligned silicon nanowire arrays**—which are used in gene delivery by means of mechanical transfection—is provided. This is realized by combining nanosphere lithography and templated metal-assisted wet chemical etching. Optimized nanowire array configurations produce transfection efficiencies approaching 95%.



## Solid Electrolytes

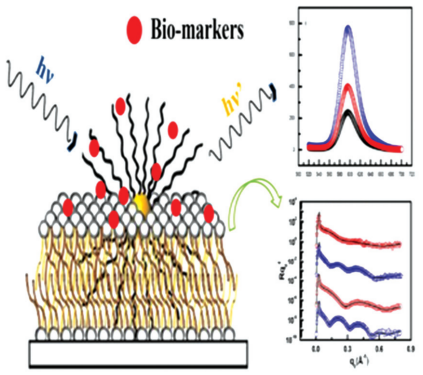





**Light-emitting electrochemical cells (LECs) of organic–inorganic perovskite ($CH_3NH_3PbI_3$) with two high work function electrodes** are demonstrated. Results indicate that $CH_3NH_3PbI_3$ has an ionic conductivity of $\approx 10^{-8}$ S cm$^{-1}$. The accumulated ions at the interfaces result in a large capacitance, which suggests a potential application in electrochemical energy-storage devices, such as solid-state supercapacitors and batteries.

## Biomarkers






**A novel method for ultrasensitive biomarker sensing is achieved by plasmonic bio-membrane templates** for a wide range of fluorophores. Gold nanoparticle assemblies are used on lipid bilayer to get an emission enhancement through Förster resonance energy transfer. Furthermore, the role of nanoparticle membrane binding and penetration as well as its consequence on observed enhanced bio-fluorophore detection sensitivity is elucidated.