ADVANCED FUNCTIONAL MATERIALS

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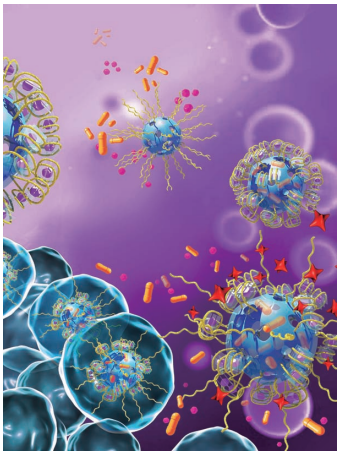
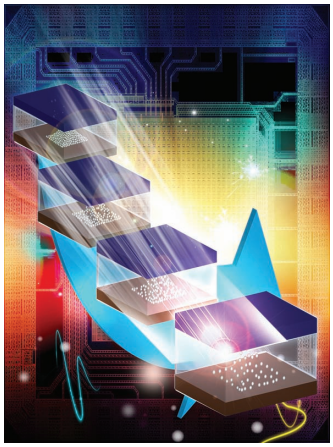


Mesoporous Nanoparticles

On page 5662, I. Willner and team show how K^+-ion-stabilized G-quadruplexes act as locks for the entrapment of substrates in mesoporous silica nanoparticles. The pores are unlocked by the Kryptofi × [2.2.2] (KP) through the removal of the K^+ ions. Also, programmed duplex structures lock the anticancer drug doxorubicin in mesoporous silica nanoparticles. The pores are unlocked by the separation of the duplex through the formation of a G-quadruplex.

Nanocomposites

Hybrid hierarchical nanocomposite is demonstrated on page 5671 by S. H. Ko and colleagues to provide efficient multiscale electron transport path with Ag nanowire current backbone collector and local CNT percolation network by combining the enhanced mechanical compliance, electrical conductivity, and optical transparency of small CNTs and the enhanced electrical conductivity of relatively bigger Ag nanowire backbone. It is also applied to demonstrate highly flexible, stretchable, and transparent conductors.



Memory Switching

Q. Liu, M. Liu, and co-workers present direct evidence to illuminate microscopic mechanism of threshold and memory resistive switching in oxide-electrolyte RRAM on page 5679. The conversion between two switching modes results from morphology change of conductive filament based on SEM and TEM observations. Combing with *I–V* fitting and in situ AFM analysis, the conduction mechanisms of both switching modes are demonstrated.

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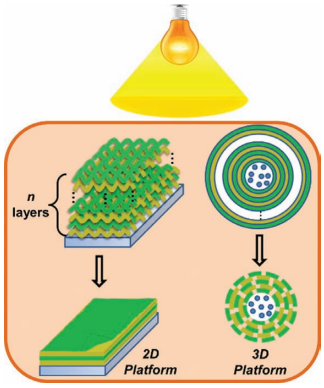
FEATURE ARTICLE

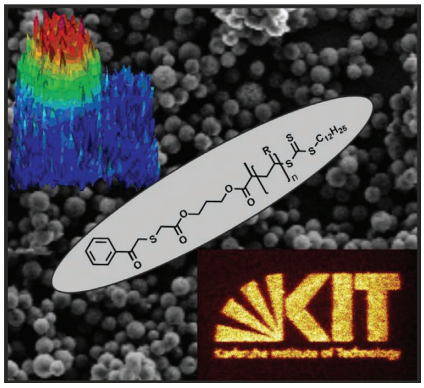
Multilayer Assemblies



Photoresponsive layer-by-layer polymeric multilayer systems have been widely studied and developed by modifying surfaces with stimuli-responsive polymeric materials that ideally exhibit reversible switchable physicochemical properties, precisely tailored structures, compositions, and functions. A comprehensive overview of the recent advancements in designing and fabricating 2D and 3D light-responsive polymeric multilayer systems is given along with their potential applications, future challenges, and opportunities.

FULL PAPERS

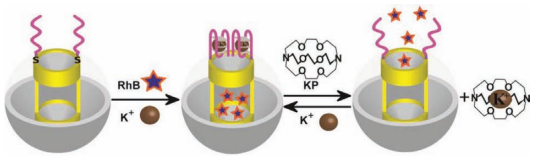
Surface Modification



A reversible addition-fragmentation chain transfer (RAFT) agent containing a photocaged thioaldehyde allows the controlled polymerization of various (functional) polymers and subsequent photografting to porous polymeric microspheres. In combination with two-photon direct laser writing, planar surfaces can be patterned with RAFT polymers, which can be visualized with time-of-flight secondary ion mass spectrometry.

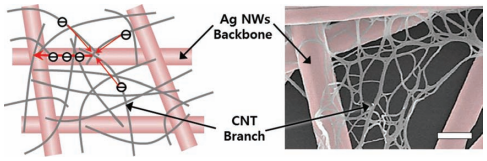
Mesoporous Nanoparticles

K^+-ion-stabilized G-quadruplexes act as locks for the entrapment of substrates in mesoporous silica nanoparticles. The pores are unlocked by the Kryptofix [2.2.2] (KP) through the removal of the K^+ ions. Also, programmed duplex structures lock the anticancer drug doxorubicin in mesoporous silica nanoparticles. The pores are unlocked by the separation of the duplex through the formation of a G-quadruplex.



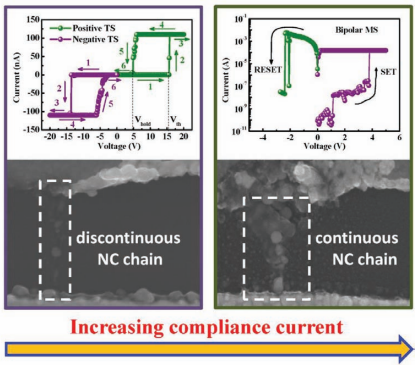
Nanocomposites

Highly stretchable, flexible, or transparent conductors are developed from a hierarchical multiscale nanocomposite to realize wearable electronics. The hybrid nanocomposite shows the enhanced mechanical compliance, electrical conductivity, and optical transparency by providing efficient multiscale electron transport path with a relatively big AgNW ($d \approx 150$ nm) current backbone collector and local small CNT ($d \approx 1.2$ nm) percolation network.



FULL PAPERS

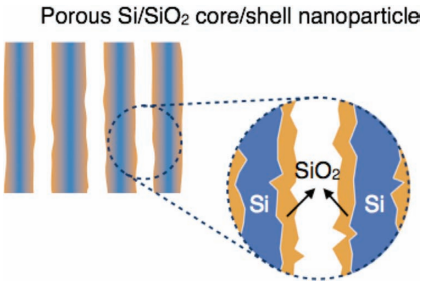
The coexistence of volatile threshold and non-volatile memory switching phenomena is observed in oxide-electrolyte-based resistive random access memory (RRAM). The switching behaviors of the device transform from threshold to memory switching when increasing the compliance current in electroforming. Analysis reveals that the threshold and memory switching behaviors correspond to the conductive filament consisting of isolated Ag nanocrystals and continuous Ag nanocrystals, respectively.



Memory Switching

Direct Observation of Conversion Between Threshold Switching and Memory Switching Induced by Conductive Filament Morphology

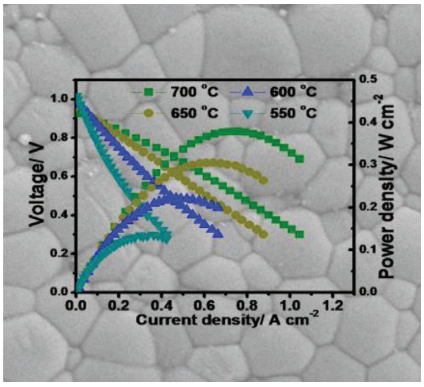
Systematic activation of photoluminescent porous silicon/silicon oxide core/shell nanoparticle provides a material with greater physiological stability and improved photoluminescence quantum yield (up to 23%). Borax treatment promotes surface oxidation of the porous silicon skeleton and consequently generates an electronically passivated Si–SiO_2 interface.



Photoluminescence

Photoluminescent Porous Si/SiO_2 Core/Shell Nanoparticles Prepared by Borate Oxidation

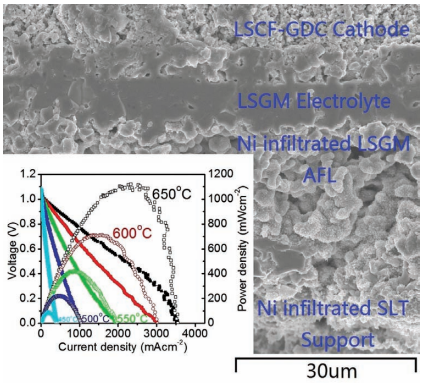
An easily sintered and chemically stable proton conductor $BaZr_{0.8}Y_{0.15}In_{0.05}O_{3-\delta}$ is developed. The fuel cell with a 12-μm-thick $BaZr_{0.8}Y_{0.15}In_{0.05}O_{3-\delta}$ electrolyte film delivers a peak power density of as high as 379 mW cm^{-2} at 700 °C. The result demonstrates that Y and In co-doping is an effective strategy for exploring sintering active and chemically stable $BaZrO_3$-based proton conductors for high performance proton-conducting solid oxide fuel cells.



Solid Oxide Fuel Cells

An Easily Sintered, Chemically Stable, Barium Zirconate-Based Proton Conductor for High-Performance Proton-Conducting Solid Oxide Fuel Cells

Thin-$(La_{0.9}Sr_{0.1})_{0.98}Ga_{0.8}Mg_{0.2}O_{3-\delta}$ (LSGM)-electrolyte SOFCs on $Sr_{0.8}La_{0.2}TiO_{3-\alpha}$ (SLT) supports, yielding high power densities at temperatures ≤ 650 °C, e.g., 1.12 Wcm^{-2} at 650 °C, are fabricated using a novel processing method. First, ceramic layers—porous SLT support, porous LSGM anode functional layer (AFL), and dense LSGM layer—are co-fired and then nanoscale Ni is infiltrated into the porous layers.



Solid Oxide Fuel Cells

A High Power Density Intermediate-Temperature Solid Oxide Fuel Cell with Thin $(La_{0.9}Sr_{0.1})_{0.98}(Ga_{0.8}Mg_{0.2})O_{3-\delta}$ Electrolyte and Nano-Scale Anode

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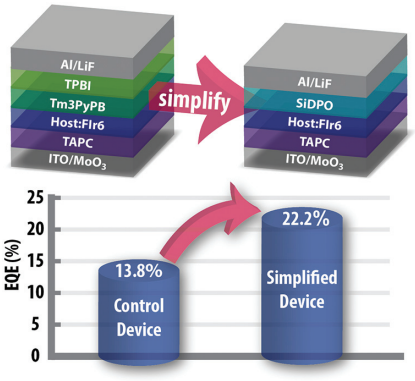
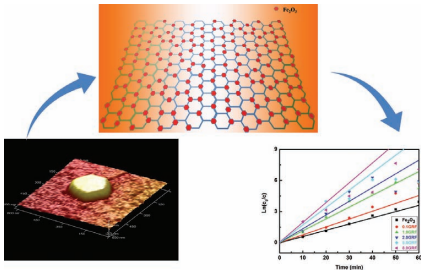
Organic Electronics



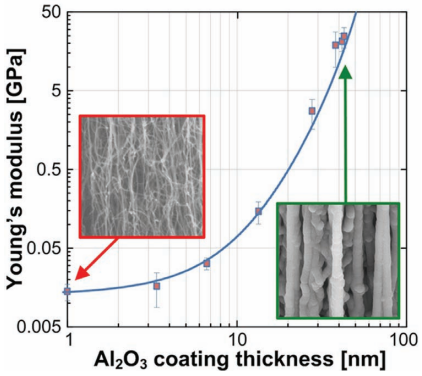
A three-organic-layer blue phosphorescent organic light-emitting diode (PhOLED) with external quantum efficiency up to 22.2% is demonstrated by employing tetraarysilane-based host and electron-transporting materials. The introduction of an orange emitter realizes an all-phosphor warm-white PhOLED with a peak power efficiency of 47.2 lm W^{-1}. This work reveals that judicious molecular design of functional materials holds promise in simplifying structure of PhOLEDs while maintaining high efficiency.

Catalysts

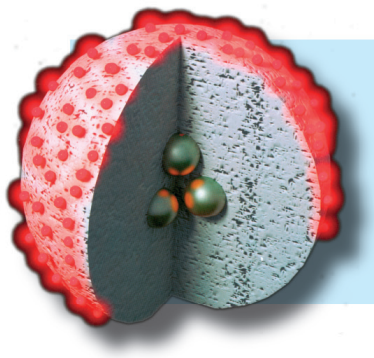


Hexagonal nanoplates of α-Fe_2O_3/graphene composites are synthesized for the first time using a simple one-step template-free hydrothermal method. This achieves the effective reduction of graphene oxide to graphene and intimate, large contact interfaces of the α-Fe_2O_3 nanoplates with graphene. The effective charge transfer leads to significant improvement in the photocatalytic activity of the α-Fe_2O_3/graphene.

Nanotubes



Composite foams are manufactured by aligned carbon nanotube (CNT) growth followed by conformal nanoscale ceramic coating. Via this method, approximately 1000-fold control of Young's modulus, ultimate compressive strength, and energy absorption is realized. The strength and toughness values exceed commercial aluminum foams by 10-fold. This combination of mechanics and morphology is especially attractive for catalysis, filtration, and thermal protection.



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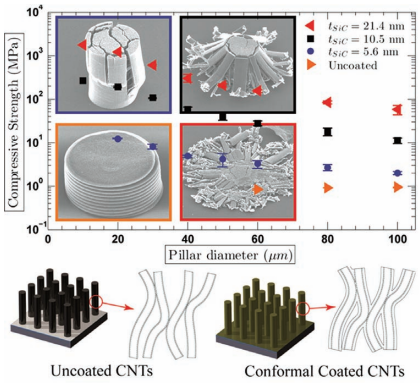
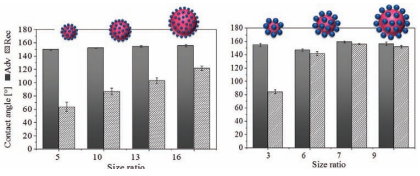
The effects of nanoscale conformal coatings of amorphous silicon carbide on the mechanical properties of CNT pillars are investigated. Several interesting mechanical failure modes such as "bamboo" and brittle-like composite rupture are observed as the coating thickness increases. A remarkable increase in strength, makes the fast growing coated CNT arrays useful as structural material for high-aspect-ratio 3D micro-architectures.



Carbon Nanotubes

Tailoring the Mechanical Properties of High-Aspect-Ratio Carbon Nanotube Arrays using Amorphous Silicon Carbide Coatings

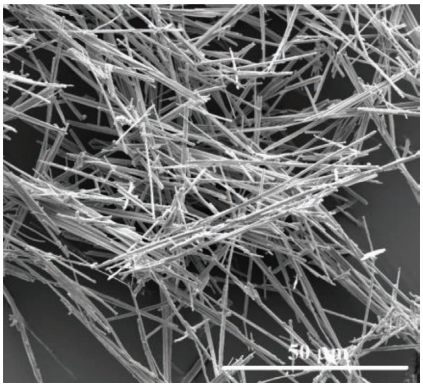
The roughness factors to fine-tune the superhydrophobicity of practical films are determined based on monolayers of well-defined raspberry silica–silica nanoparticles with variable dual-scale roughness size and ratio. To reach superhydrophobicity, the smaller features must have a minimum size and size ratio. These new insights on wetting of rough surfaces can direct the design of practical superhydrophobic surfaces.



Superhydrophobicity

Fine-Tuning of Superhydrophobicity Based on Monolayers of Well-defined Raspberry Nanoparticles with Variable Dual-roughness Size and Ratio

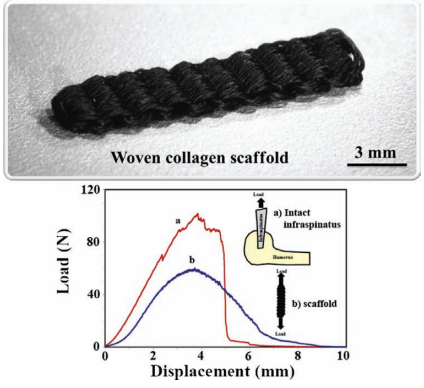
A well-scalable and economic synthesis technique, viz. a re-crystallization, is reported. This new approach allows the "one-pot" preparation of a CaO-based, MgO-stabilized CO_2 sorbent. The synthetic material stabilized with 8 wt% of MgO possesses an excellent CO_2 uptake of 10.71 mmol(CO_2) g(sorbent)$^{-1}$ after 10 cyclic experiments of calcination and carbonation under very harsh regeneration conditions (900 °C, 100% CO_2 atmosphere).



CO_2 Capture

Development of Highly Effective CaO-based, MgO-stabilized CO_2 Sorbents via a Scalable "One-Pot" Recrystallization Technique

Electrophoretically aligned collagen threads are woven as mechanically robust biotextiles. Mechanical properties of the scaffold approached those of the native tendon. Porosity enables mesenchymal stem cell (MSC) seeding throughout the scaffold. Cells proliferate and become elongated within the woven collagen artifacts. Topographical cues provided by the aligned collagen threads induce the MSCs to undergo tenogenic differentiation without growth factor supplementation.



Collagen Scaffolds

Tenogenic Induction of Human MSCs by Anisotropically Aligned Collagen Biotextiles