ADVANCED FUNCTIONAL MATERIALS

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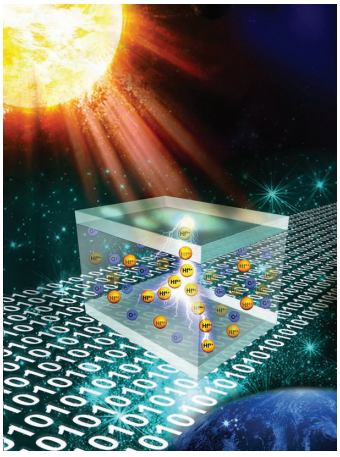
Soft Robotics

Four separate soft robotic fingers progressively curl to play notes on a keyboard. The finger-like actuators are made of a silicone elastomer molded from 3D printed parts by G. M. Whitesides and co-workers. On page 2163, these soft fingers are shown to be capable of bending fully in less than 50 ms, actuating over 1 million cycles, and bending along different paths based on their rate of pressurization.

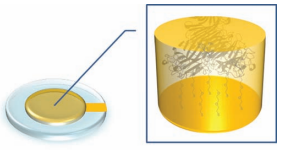


Transparent Electronics

Thermally stable and transparent resistive random access memories (T-RRAM) are developed by G. Liu, R.-W. Li, and co-workers on page 2171. Based on ion migration and formation of metallic conductive filaments in an indium–tin oxide/hafnium oxide/indium–tin oxide sandwich structure, the T-RRAM device demonstrates great optical transmittance, a robust antithermal shock capability, and stable resistive switching behaviors that are promising for outer-space applications under extreme working conditions.

Biosensors

A hybrid material is prepared on a quartz crystal microbalance sensor by F. W. Scheller and co-workers. On page 2233, they use electrodeposition to create a surface-confined molecularly imprinted polymer film. The fabrication is directly on a transducer surface, making it excellent for biosensor applications. This hybrid shows both high affinity for the target protein and discrimination against its analogues, which is characterized in real time using the quartz crystal microbalance.



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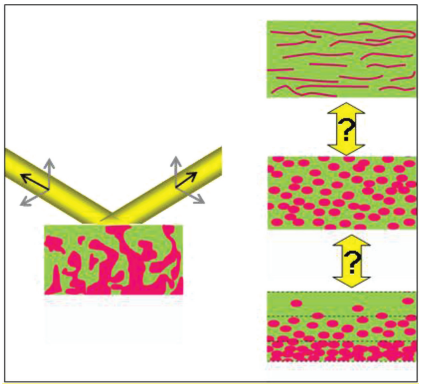
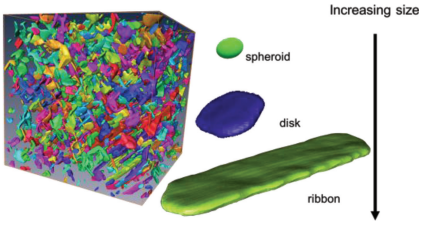
FEATURE ARTICLES

Organic Semiconductors



Advanced characterization tools are helping the development of the different technologies based on organic semiconductors. Here, the recent progress on the application of fast and non-destructive spectroscopic ellipsometry for the determination of the optical, structural, and thermodynamic properties of conjugated polymer films, including the dielectric function, vertical segregation, anisotropy, and real time studies, is reviewed.

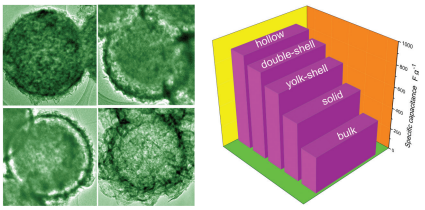
Thermoelectrics



This article describes how to quantitatively control the microstructure in advanced composite materials through a thorough examination of thermoelectric materials. It begins by describing the potential structure types, then transitions to the methods of control relating to morphology, size, and packing density of the resulting structures.

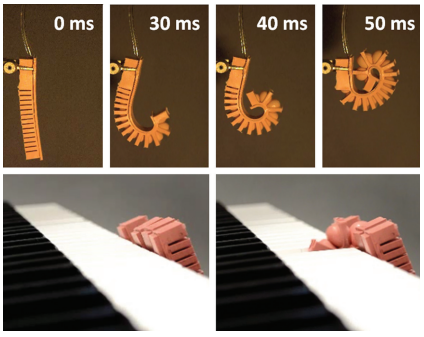
FULL PAPERS

Hollow Spheres



CoS_2 and NiS_2 hollow spheres with tunable interiors are obtained through a facile solution method. The obtained CoS_2 hollow spheres demonstrate superior performances in supercapacitors and dye-sensitized solar cells.

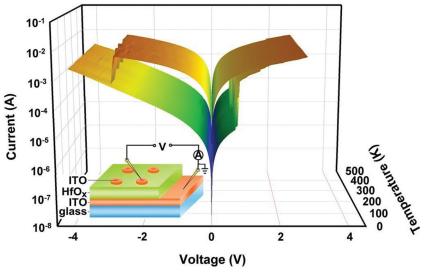
Soft Robotics



Soft pneumatic actuators bend rapidly by expanding their walls along the direction of bending. The improved use of the expanding material minimizes the overall change in volume of the actuator, prolongs its lifespan, and increases the force that it exerts upon full inflation. These actuators respond to different inflation rates by bending along different paths, demonstrating a new capability of soft actuators.

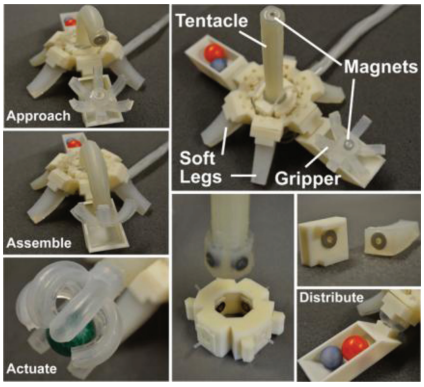
FULL PAPERS

ITO/HfO$_x$/ITO structure is fabricated with promising optical transmittance. The all-oxide device demonstrates forming-free resistive switching behaviors that are stable over a wide temperature range. The electrical switching of the transparent devices is attributed to the field-induced formation and rupture of metal-rich conductive filaments across the mixed-structure hafnium oxide thin film, and are of great potential for thermally stable transparent electronic applications.



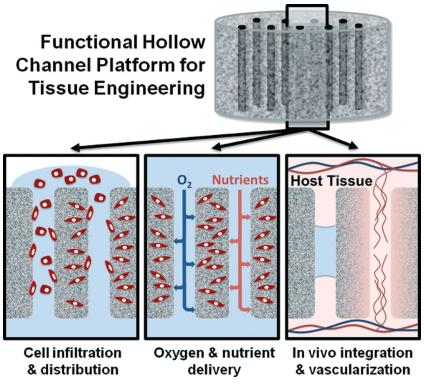
Transparent Electronics

Reconfigurable, hybrid robots are modularly assembled from soft actuators and hard structural elements using magnetic couplers. These robots can be modified manually, or remotely using pneumatic controls. This method simplifies the integration of soft actuators of different structural designs and material composition and, thus, it enables rapid prototyping more advanced robots.



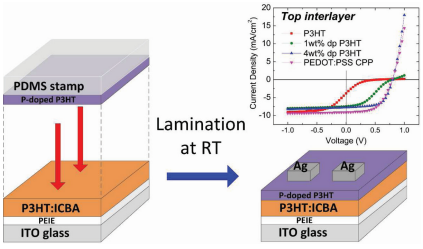
Soft Robots

Arrays of hollow channels within porous silk scaffolds exhibit beneficial characteristics for engineering large, physically relevant tissue constructs. The hollow channels improve seeded cell infiltration into the scaffold and enhance delivery of oxygen and large molecules through the scaffold bulk. Implanted hollow channeled scaffolds improve host tissue integration and vascularization compared to the unchanneled controls.



Tissue Engineering

An ultrathin layer of P3HT p-doped with the soluble, oxidizing molecule Mo(tfd-CO_2Me)$_3$, is transferred onto the active layer of a device via soft-contact lamination from a PDMS stamp. This novel approach can be used to introduce a spatially-confined highly-doped layer on a solution-processed device, thereby creating an efficient hole-collecting or -injecting contact. An application to solar cells is demonstrated.



Polymer Films

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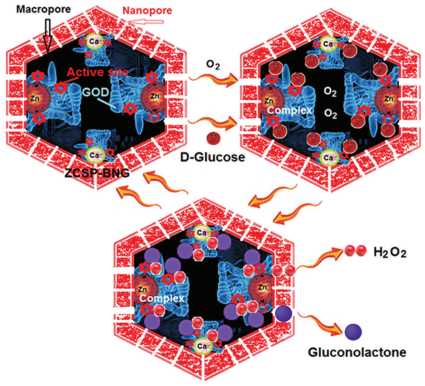
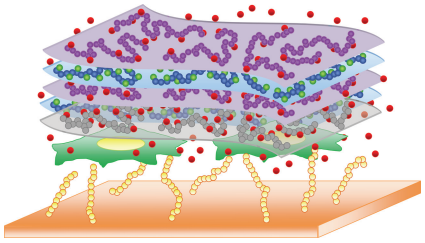
FULL PAPERS

Bioactive Glass



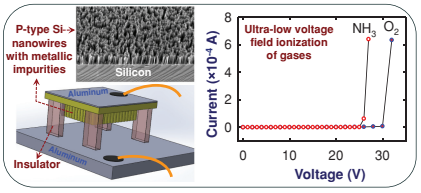
ZnO-CaO-SiO_2-P_2O_5 bioactive nanostructured glass (ZCSP-BNG) is an ideal immobilization matrix for glucose oxidase (GOD). GOD molecules are spontaneously trapped in the highly curved macropores (200–500 nm) via multipoint metal ion binding in electrical double layers. Its unique chemical surface properties and hierarchical nanoporous structure enhance the catalytic activity of directly immobilized GOD.

Biomimetics

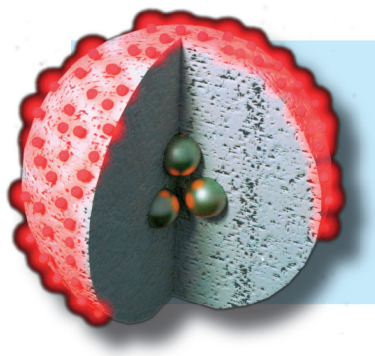


A cell-compatible cell-lined layered nano-membrane is developed. Bioactive molecules are mounted on a nanomembrane and later released to its lined cell sheet. The cell-lined membrane is in a free-standing form to regulate cellular functions. This methodology provides a versatile approach to construct biomimetic tissues for clinical applications.

Gas Sensors



Pristine nanowires with controlled introduction of metallic impurities are demonstrated to offer unique advantage for field ionization applications due to high density of surface states associated with the impurities, geometrical field enhancement, and polarizabilities of gas particles at the semiconductor nanotips. Sensing devices designed using this scheme are capable of fingerprinting a broad range of analytes at very low voltage with high selectivity.



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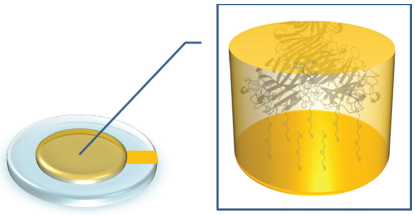
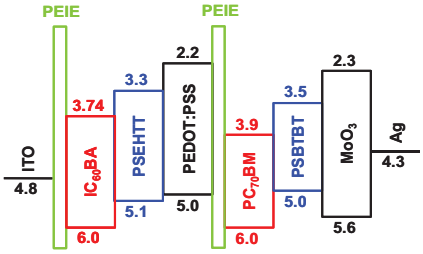
FULL PAPERS

A hybrid material is prepared on a quartz crystal microbalance sensor by electrodeposition of a concanavalin A imprinted polymer on top of a mannose terminated self-assembled monolayer. The hybrid shows both high affinity to the target protein and discrimination against its analogues. All steps are directed on the transducer surface, making it excellent for biosensor applications.



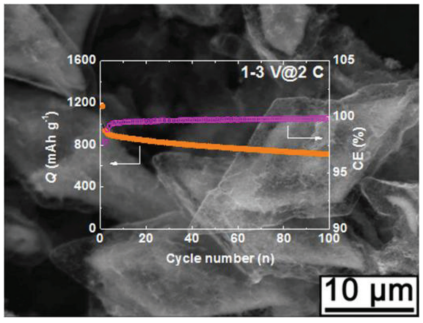
Biosensors

An inverted tandem solar cell with 8.91% efficiency is demonstrated utilizing a polymeric interconnecting layer along with a high fill factor.



Solar Cells

3D carbon nanotube frameworks with bipyramidal sulfur particles are formed via a one-pot synthesis. The conducting frameworks enclosing both sulfur and sulfur-free regions maintain high electronic conductivity. Additional coating of the framework using conductive additives aids in mitigating the polysulfide shuttle. These structures, employed in cathodes for Li–S batteries, provide high rate stability and reversibility during deep 100 cycles.



Rechargeable Batteries