ADVANCED FUNCTIONAL MATERIALS

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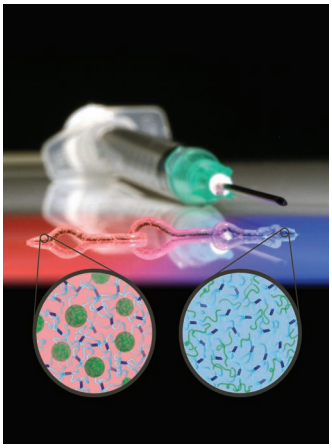
Magnetic Nanoparticles

Nanoparticles with a magnetic core are coated with highly porous metal organic frameworks (MOFs) using liquid phase epitaxy. As demonstrated using X-ray diffraction (XRD), transmission electron microscopy (TEM), and Brunauer–Emmitt–Teller (BET) analysis, a well-defined number of layers is deposited. On page 1210, Christof Wöll and co-workers report that such magnetic MOF particles can be used for catalysis, as chromatographic media, and for the fabrication of core/shell/shell particles.

Biomimetics

The distinct surface design of tree-frog toe pads inspires new strategies for improving attachment in the presence of fluid layers. Tree-frog toe pad mimicks consisting of microstructured soft polymeric surfaces with hexagonal pillars separated by narrow channels reveal the role and the potential of surface patterning for wet adhesion. As reported by Aránzazu del Campo and co-workers on page 1137, the right combination of surface topograhy and surface energy allows enhancing of adhesive and frictional forces by favoring fluid drainage and establishment of direct contact forces.



Self-Assembly

Triblock copoylmers with associative protein midblocks and thermoresponsive endblocks form shear thinning hydrogels that can be injected at low temperature. On page 1182, Bradley D. Olsen and co-workers report that when warmed to body temperature, the gel is responsively reinforced as the endblocks self-assemble into a secondary block copolymer network, leading to large increases in modulus and yield stress, and decreased erosion and creep compliance.

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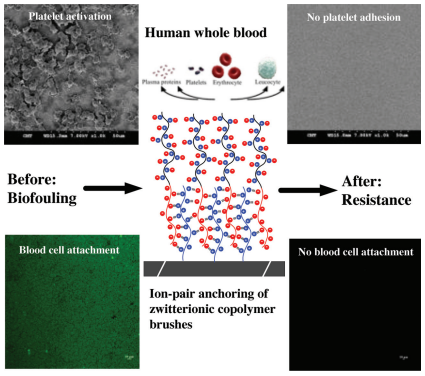
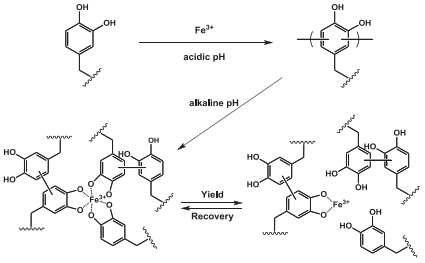
Biomaterials



Blood-inert surfaces are achieved in human whole blood by a simple and robust method using ion-pair anchoring of diblock copolymers with well-defined zwitterionic and charged segments. A systematic investigation is performed to study how chain lengths and surface packing densities of zwitterionic polymer brushes affect blood compatibility. This provides a new class of materials to effectively control biofouling in complex media for charged biomaterials.

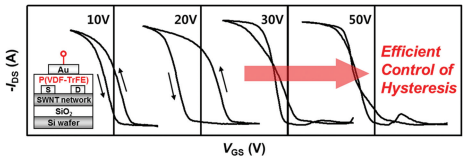
Biomimetics



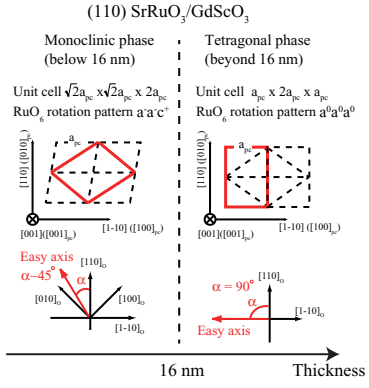
Novel bioinspired and tough hydrogels are designed by regulating the pH of the reaction between catechol-terminated poly(ethylene glycol) (PEG) and Fe^{3+}. A covalently cross-linked network is fortified with a series of coordination bonds, which act as sacrificial and reversible interactions to dissipate energy during deformation. These hydrogels represent a novel class of mussel-mimetic biomaterials inspired in both content and processing.

Field-Effect Transistors

A simple and robust method is developed to control the characteristic current hysteresis of single-walled carbon nanotube (SWNT) network field-effect transistiors (FETs) by non-volatile ferroelectric polarization. A top-gate FET with a solution-processed SWNT network channel layer and a ferroelectric poly(vinylidene fluoride-trifluoroethylene) (P(VDF-TrFE)) gate insulator effectively suppresses the current hysteresis when the gate-voltage sweep exceeds the coercive voltage of the P(VDF-TrFE) film.



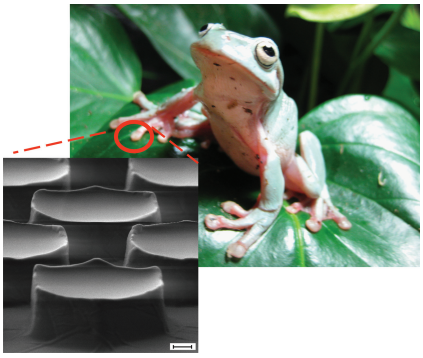
Thin Films



Thickness-dependent structure–property relationships in strained $SrRuO_3$ thin films are reported. The thin film changes from the monoclinic structure below 16 nm to the tetragonal structure above the thickness. The thickness-dependent structure is ascribed to the substrate-induced modification in the RuO_6 octahedral rotation pattern. Physical properties such as magnetic anisotropy are closely related to the thin-film structure.

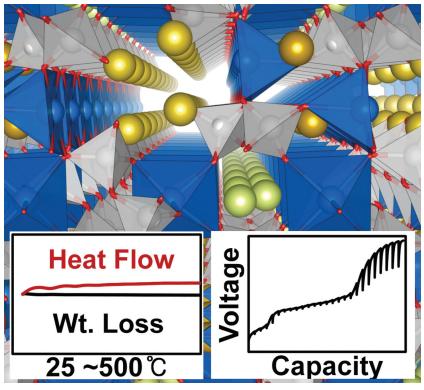
FULL PAPERS

Studies in artificial tree-frog mimics show the benefits of the surface design (topography and hydrophilicity) for adhesion and friction under wet conditions. Capillary and direct-contact forces can be combined in patterned surfaces to enhance adhesion and friction performance in the presence of fluid films. Design rules for a new generation of artificial "wet" adhesives are presented.



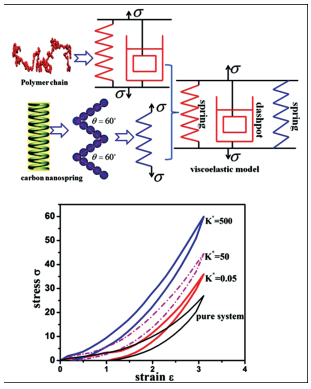
Biomimetics

$Na_2FeP_2O_7$ is reported as the first member in the pyrophosphate family for sodium battery cathodes. Utilizing the well-defined channel structure, $Na_2FeP_2O_7$ exhibits a reversible capacity of ≈90 mAh g^{-1} with several different plateaus corresponding to distinctive Na sites. The thermodynamic and kinetic behaviors of this compound during battery operations are explained well using first principles calculations.



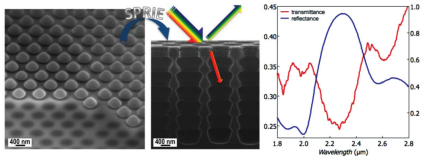
Batteries

Carbon nanosprings are found to have the capability to tune the mechanical and viscoelastic properties of elastomeric polymer materials. It is inferred that elastomer/carbon nanostructured materials with good flexibility and reversible mechanical response (i.e., carbon nanosprings, nanocoils, nanorings, and thin graphene sheets) have both excellent mechanical properties and low hysteresis loss.



Nanomaterials

Three-dimensional photonic crystals are fabricated by a one-step processing protocol. Two-dimensional masks are obtained using nanosphere lithography, while sequential passivation reactive ion etching (SPRIE) is applied to add ordering in the third dimension.



Photonics

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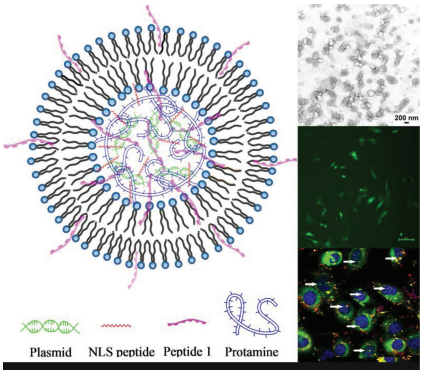
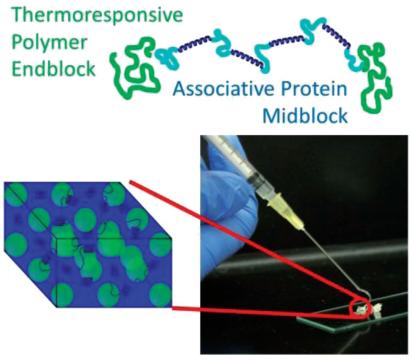
Gene Transfer



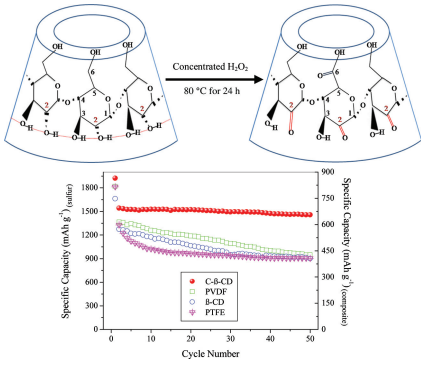
A liposome protamine/DNA lipoplex integrated with a nuclear localization signal (NLS) peptide and rMSC-homing peptide is constructed for targeted delivery of transposon system to rat mesenchymal stem cells (rMSCs). A phage display technique is employed to identify the rMSC-homing peptide, which targets the MSCs. Both the NLS peptide and rMSC-homing peptide can execute a synergetic effect to promote transfection activity.

Hydrogels

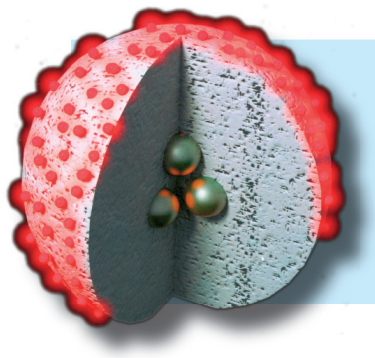


Hybrid triblock copolymers prepared from associative proteins and thermoresponsive polymers form shear thinning gels with a low yield stress at low temperatures. Upon increasing temperature, an orthogonal network of reinforcing nanostructures is formed that results in gels with significantly higher stiffness, resistance to shear thinning, higher toughness, reduced erosion rates, and lower creep compliance at physiological temperatures.

Lithium Batteries



The sulfur utilization and cycling stability of composite cathodes in rechargeable lithium batteries are enhanced by carbonyl-β-cyclodextrin (C-β-CD) as the binder in sulfur composite cathodes. This is made possible by the fact that C-β-CD is highly soluble in water, ca. 100 times more soluble than β-CD at room temperature, and because it exhibits strong bonding strength.



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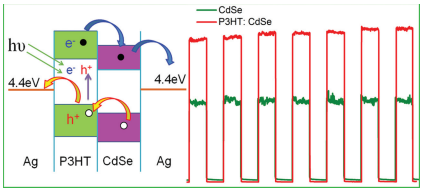
FULL PAPERS

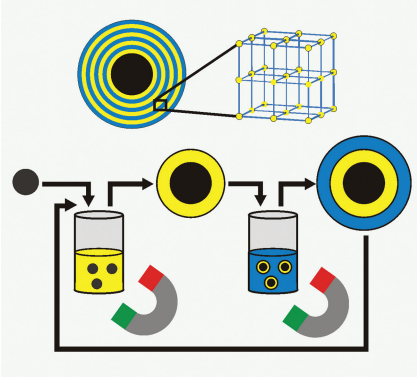
Organic-inorganic photodetectors based on poly(3-hexylthiophene) (P3HT):CdSe nanowire heterojunctions with an enhanced photoresponse are successfully fabricated on rigid substrates. Hybrid photodetectors with high mechanical flexibility, good folding strength, excellent wavelength-dependent electrical stability, and very fast response to high-frequency light signals are constructed on poly(ethylene terephthalate) (PET) and printing paper, which may apply to the flexible optoelectronic devices.



Flexible Electronics

High-Performance Organic-Inorganic Hybrid Photodetectors Based on P3HT:CdSe Nanowire Heterojunctions on Rigid and Flexible Substrates

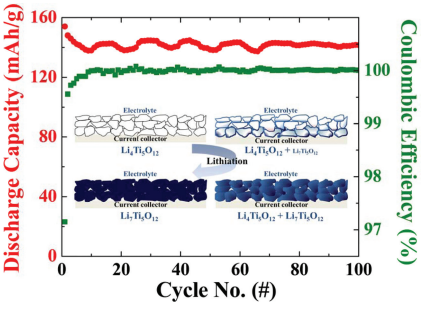
A novel method for the homogeneous coating of magnetic nanoparticles with metal organic frameworks (MOFs) is reported. Using a liquid phase epitaxy process, a well-defined number of $[Cu_3(btc)_2]nH_2O$, HKUST-1, layers are grown on COOH-terminated silica magnetic beads. Potential applications of particle-based MOF films include catalytic coatings and chromatographic media.



Magnetic Nanoparticles

Magnetic Cores with Porous Coatings: Growth of Metal-Organic Frameworks on Particles Using Liquid Phase Epitaxy

Li-ion battery electrodes based on $Li_4Ti_5O_{12}$, an electronic insulator, can be successfully cycled without any conducting additives, even at high rates. The mechanisms of phase propagation and origin of such good performance are investigated. The importance of interparticle contact and the transport properties of the intermediate states during cycling are highlighted.



Batteries

Mechanism of Phase Propagation During Lithiation in Carbon-Free $Li_4Ti_5O_{12}$ Battery Electrodes