ADVANCED FUNCTIONAL MATERIALS

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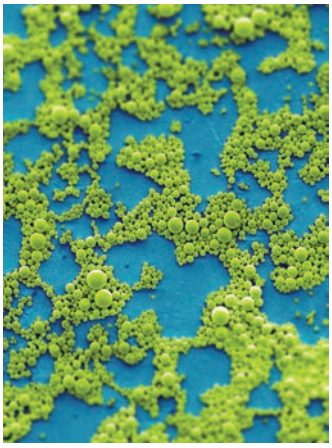
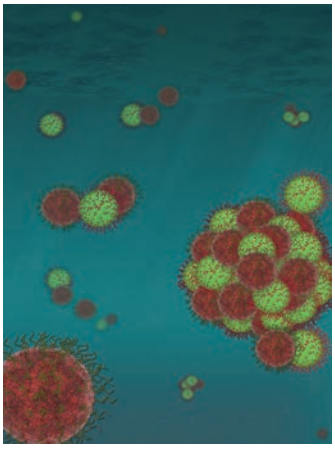


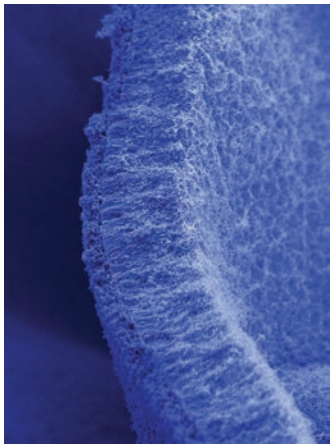
Tissue Engineering

A new composite platform for the delivery of bioactive molecules is obtained by embedding mesoporous silicon particles in poly(DL-lactide-*co*-glycolide) (PLGA) microspheres. As reported on page 282 by Ennio Tasciotti and co-workers, this system can be synthesized and tuned to tailor size, density, and delivery kinetics to the application of choice. This hybrid system displays emerging features and properties that depend on the interactions of the two materials at the molecular and nanoscale.

Nanocomposites

The fabrication of high-energy Al/CuO nanocomposites by nanoparticle DNA-directed assembly is reported by Aurélien Bancaud, Carole Rossi, and co-workers on page 323. The complementarity of the strands attached to the Al and CuO nanoparticles enables the assembly of micrometer-sized aggregates, which release heat upon thermal actuation, to be directed. The actuation temperature of 410 °C of these materials is among the lowest reported. The image shows an artistic view of Al/CuO nanocomposite fabrication through DNA-directed assembly.





Self-Assembly

The superposition of intermolecular interactions and extrinsic forces can be used to control the properties of self-assembled materials. On page 369 Samuel I. Stupp and co-workers investigate the role of electric fields during the interfacial self-assembly of a hierarchically ordered membrane from oppositely charged molecules and demonstrate profound changes in the growth rate and orientation, as well as properties.

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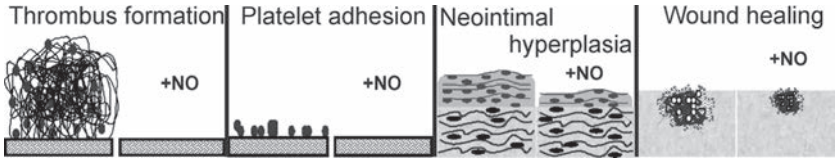
FEATURE ARTICLE

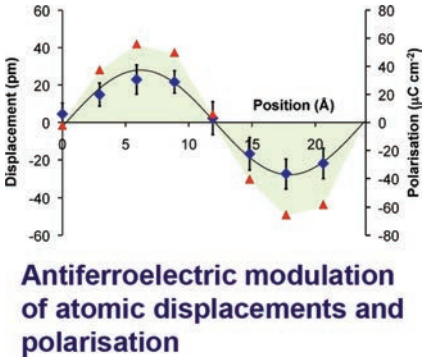
Biomedical Materials

Nitric oxide-releasing and -generating polymeric materials are currently under investigation for biomedical applications. Clinical complications such as thrombus formation (first panel), platelet adhesion (second panel), neointimal hyperplasia (third panel), and wound healing (last panel) may benefit from advances in this field. Recent progress in the topic is reviewed herein.



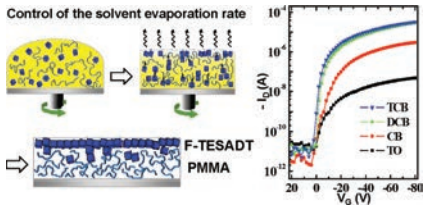
FULL PAPERS

Atomic-Scale Imaging



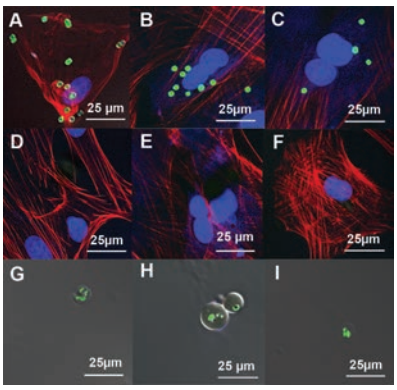
The structure of two stacking sequences in incommensurate antiferroelectric (Pb,La)$(Zr,Ti)O_3$ is determined using quantitative scanning transmission electron microscopy, with the lead atom positions located with an outstanding precision of about 6 pm. This allows the estimation of local polarisation, and this is found to vary in an approximately sinusoidal fashion along the stacking direction with peak values matching exceptionally well to reported values for commensurate $PbZrO_3$.

Organic Field-Effect Transistors



By controlling the solvent evaporation rate of spin-cast difluorinated-triethylsilylethynyl anthradithiophene (F-TESADT)/poly(methyl methacrylate) (PMMA) blend solution, a bilayer structure consisting of highly ordered F-TESAT crystals on the top and low-trap PMMA dielectric on the bottom can be fabricated by a one-step process. The use of F-TESADT/PMMA blend films in transistors produces much higher field-effect mobilities and greater stability than homo F-TESADT films.

Issue Engineering



Poly(DL-lactide-co-glycolide)/porous silicon (PLGA/pSi) composite microspheres are synthesized by a solid-in-oil-in-water (S/O/W) emulsion method. These composite microspheres can exhibit sustained protein release, preserve protein bioactivity, stimulate mineralization, neutralize the acidic pH due to the PLGA degradation by-products, and avoid uptake by cells. These microspheres are developed for the long-term controlled delivery of biomolecules for orthopedic tissue engineering applications.

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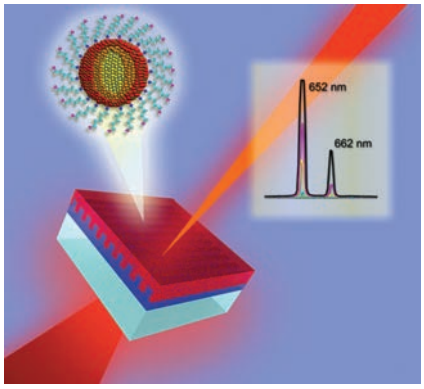
Drug Delivery

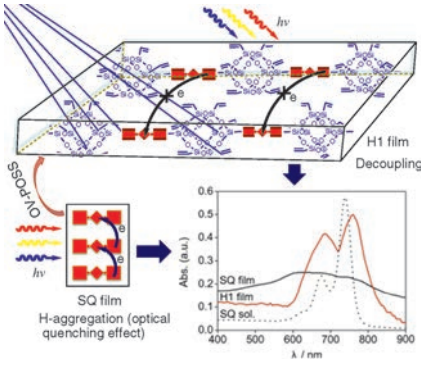
A fabrication method to produce silk biopolymer microstructures with the high aspect ratios required to manufacture microneedle systems is reported. Room temperature and aqueous-based micromolding allows the bulk loading of these microneedles with sensitive drugs. Controlled release of a model drug is achieved by adjusting the post-processing conditions of the microneedles, mainly by controlling the silk protein secondary structure.

Quantum Dots

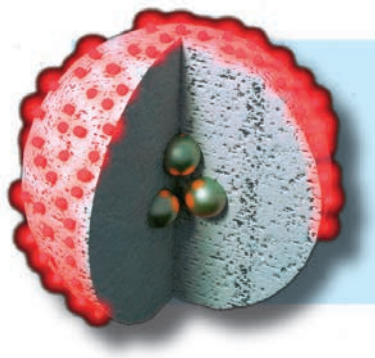


By exploiting sol–gel chemistry and the nanoimprinting process, a low-cost up-converted distributed feedback laser is realized. Properly synthesized graded CdSe–CdZnS–ZnS quantum dots are used as active gain material. The laser prototype efficiently works in the visible region, by pumping with one- or two-photon processes. This solution-processed device opens the way to the production of emission-tunable compact lasers.

Optical Materials



Add POSS to make definite improvement: Incorporation of "huge" inorganic polyhedral oligomeric silsesquioxane (POSS) nanoparticles into organic optical materials via covalent bonding can effectively decrease the strong dipole–dipole and π–π stacking interactions, and inhibit intermolecular charge transfer between the chromophores to enable preparation of stable optical materials with enhanced thermal, chemical, and photostabilities.



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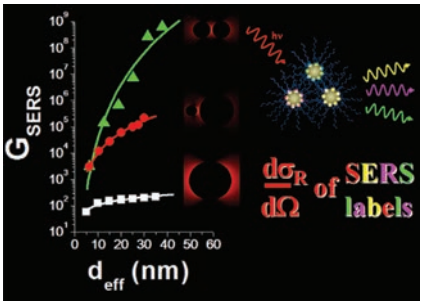
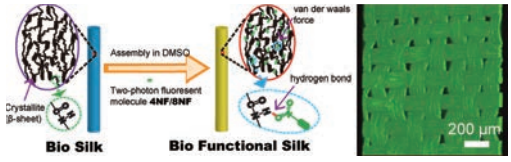
The brightness of surface enhanced Raman scattering (SERS) labels can be increased by several orders of magnitude by selecting the proper Raman active molecule and by controlling the size and the aggregation of the noble metal nanoparticles.



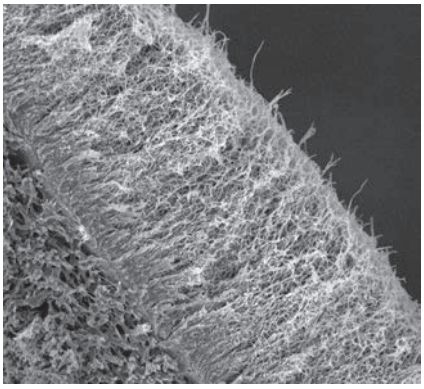
Gold Nanoparticles

Luminescent silk fibers that exhibit two-photon fluorescence are prepared by combining *Bombyx mori* silk with fluorene derivatives. The enhancement mechanism is based on biomolecular recognition by decoupling the molecules in the special silk fibers. This work provides a promising solution for imaging of scaffolds in a noninvasive, high-resolution, 3D, and real-time manner.



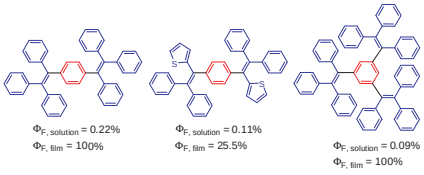
Photoluminescence Switching

The dynamic self-assembly between negatively charged polyelectrolytes and positively charged peptide amphiphiles results in the formation of a hierarchically ordered membrane at the interface between two solutions. The superposition of an external electric field with the self-assembly forces can be used to control the material's growth rate, structure, and elastic properties.



Self-Assembly

Benzene-cored luminogens with multiple triarylvinyl units exhibit aggregation-induced emission. The high solid-state fluorescence quantum yields and high thermal and morphological stabilities of such emitters gave light-emitting diodes with sky-blue to greenish-blue light in high luminance and efficiencies. The emission can be quenched exponentially by picric acid, or selectively by Ru^{3+}, making them highly sensitive (and selective) chemosensors for explosives and metal ions.



Organic Light-Emitting Diodes

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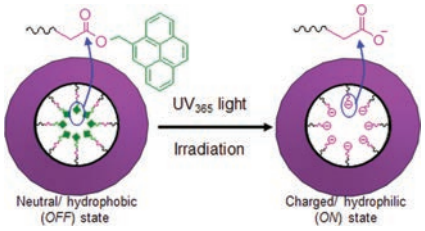
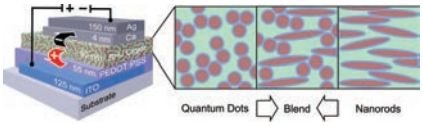
Nanostructures



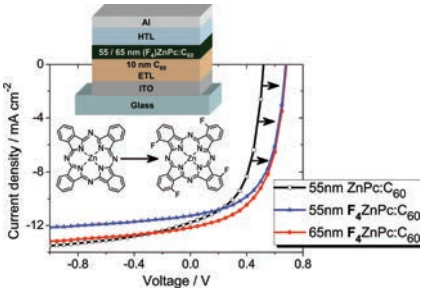
Synthetic ion channels modified with photosensitive moieties exhibit UV light-controlled ionic transport. Upon UV light irradiation the inner environment of the nanochannel is switched from a hydrophobic nonconducting (off) state to a hydrophilic conducting (on) state, allowing for the permselective transport of ionic species.

Solar Cells

The performance of hybrid solar cells based on CdSe nanocrystals incorporated into a polymer matrix is enhanced by using a blend of spherical quantum dots and elongated nanorods. Short-circuit current and power conversion efficiency peak for a certain blend composition compared to the respective single acceptor devices, which is attributed to an improved inorganic network providing better percolation pathways for electrons. High power conversion efficiencies of up to 3.6% are achieved.

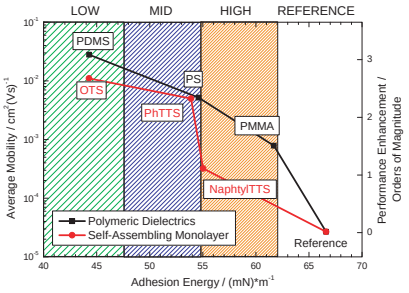


Solar Cells



Organic solar cells with bulk heterojunctions of C_{60} as acceptor and either zinc phthalocyanine (ZnPc), or fluorinated ZnPc (F_4ZnPc) as donor materials are presented. Substrate heating of F_4ZnPc:C_{60} devices during film deposition strongly increases fill factor and photocurrent. Furthermore, the replacement of ZnPc by F_4ZnPc in otherwise identical devices leads to an improvement of open circuit voltage of 30%, increasing the efficiency from 3.3% (ZnPc:C_{60}) to 4.6% (F_4ZnPc:C_{60}).

Organic Thin-Film Transistors



Dielectric surface modifications can improve the performance of organic thin-film transistors (OTFTs) significantly. Devices utilizing tailored dielectric surface modifications based on polymers and trichlorosilane-terminated self-assembled monolayers have been produced. The application of these novel dielectric surface modifications facilitates perylene thin-films with a superior film quality and high-performance perylene based OTFTs with a high charge-carrier mobility.

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