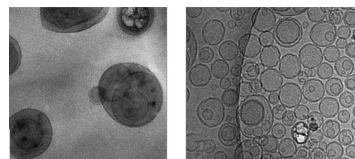


Decorated Magnetoliposomes: An Attractive Idea for Multifunctional Therapeutics

■ Liposomes, particles composed of a thin bilayer shell surrounding an aqueous core, have recently gained attention as a potential biomedical tool for diagnostic or therapeutic use. Hybridizing liposomes with bound or encapsulated nanoparticles could extend their range of functionality, leading to applications including hyperthermia treatments. Though drug delivery remains one of the most promising potential applications, it carries several challenges, including preventing leakage of cargo in circulation and controlling release upon arriving at the target site. In principle, decorating liposomes with bound nanoparticles then supplying selective and local heating to the bilayer could be used to control therapeutic delivery.

To test this idea, Chen *et al.* (p 3215) looked to decorated magnetoliposomes (dMLs), a type of hybrid liposome/nanoparticle assembly. The researchers prepared dMLs of 5 nm Fe₂O₃ (magnetite) capped with oleic acid embedded within lipid bilayers, with various ratios of lipid molecules to nanoparticles. Cryogenic transmission electron microscopy showed that the loaded magnetoliposomes ranged in size from about 156 to 198 nm, with diameter increasing as the ratio of lipid molecule to nanoparticle increased. Tests with carboxyfluorescein showed that the liposomes became more stable and yielded less spontaneous leakage with increasing nanoparticle loading. When the researchers heated the dMLs using

alternating-current electromagnetic fields operating under physiologically acceptable radio frequencies (RFs), they were able to release the fluorescent molecule selectively. Under RF heating, the initial rate and extent of leakage increased significantly as a function of nanoparticle loading and electromagnetic field strength. Though additional tests *in vivo* will be necessary, the researchers note that this system shows promise for therapeutic delivery.



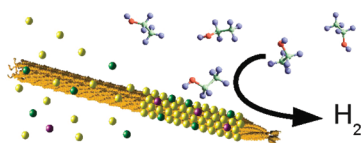
Little Phage, Big Advantages for Ethanol Conversion

■ Since ethanol has a relatively high volumetric energy density at atmospheric pressure, researchers have recently become interested in reforming ethanol into hydrogen gas suitable for fuel cells. A common technique in this area is oxidative steam reforming of ethanol–water mixtures using various catalysts, including rhodium–ceria and rhodium–nickel–ceria. Metal clusters in contact with oxygen vacancies on the surface of ceria have

been found to be the most active sites for catalysis.

Seeking to improve the efficiency of ethanol conversion, Neltner *et al.* (p 3227) created new catalysts by templating nickel, rhodium, and ceria onto the surface of M13 bacteriophages. These phages can be engineered to self-assemble nanowires through the modification of surface proteins, causing the coat to nucleate a variety of materials. The researchers incubated phages in solutions containing these metals, allowing the phages to form ceria nanowires with nickel and rhodium impurities. Characterization by transmission electron microscopy and X-ray diffraction showed that the metals were better incorporated into the ceria structure in catalysts

made using M13 than in catalysts made without the phages. Using the M13 rhodium–nickel–ceria catalysts, the researchers were able to achieve 100% conversion of ethanol at 300 °C with 60% hydrogen gas in the product stream and less than 0.5% carbon monoxide. M13 nickel–ceria catalysts showed similar conversion success at 400 °C. The researchers also found that biotemplating improved the resistance of this catalyst to deactivation over 52 h tests at high flow rates and temperatures. These results suggest that biotemplating can improve the activity and stability of catalysts, leading to significant gains over traditional ethanol conversion catalyst manufacture methods.

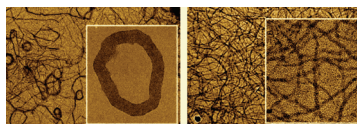


Mixing It Up: Nanowires and Nanorings from Mixed Solvents

■ Conjugated polymers hold significant promise for use in biosensors, thin-film transistors, light-emitting diodes, and solar energy conversion. The semiconductor-like optical and electronic properties of these materials depend on the physical conformation of polymer side chains, which can be controlled by factors including the polymer concentration, presence of side group, and choice of solvents. In contrast with rod–coil block copolymers, which have been the focus of extensive study, research on all-conjugated block copolymers has been limited. The synthesis and self-assembly of rod–rod block copolymers that combine intriguing nanostructures and electronic activity could provide the opportunity for realizing high-performance semiconducting architectures with improved environmental stability and mechanical properties.

Seeking to expand knowledge of these materials, He *et al.* (p 3241) investigated self-assembly of the all-conjugated diblock copolymer poly(3-butylthiophene)-*b*-poly(3-hexylthiophene) (P3BHT) into nanostructured morphologies by manipulating the ratio of solvents anisole and chloroform. Anisole is a poor solvent for poly(3-hexylthiophene) (P3HT) and poly(3-butylthiophene) (P3BT) blocks, whereas chloroform is a good solvent for both

nanowires at a high ratio. X-ray diffraction patterns and UV–vis absorption measurements suggest that the nanowires are formed through strong π – π stacking between the polymer chains, whereas formation of the nanorings relies on kinetic behavior that minimizes unfavorable contacts between anisole and the two blocks at two different temperatures: the P3BT block at about 50 °C and P3HT block below 35 °C. The authors suggest that this strategy can be extended to produce intriguing nanostructures in other all-conjugated block copolymers.



blocks. The researchers found that P3BHT chains experience different kinetic pathways depending on the anisole/chloroform ratio, yielding nanowires at a low ratio and nanorings coexisting with some

Published online June 22, 2010.
10.1021/nn101164k

© 2010 American Chemical Society

Making Waves by Photoembossing on Liquid Crystal Semiconductors

■ Patterned thin films have been well studied in inorganic semiconductors; however, the nanoscale patterning of surfaces of organic semiconductors is a relatively new research area. Such patterning could lead to a variety of optical applications, such as providing distributed feedback in organic lasers and channel waveguides for laser diodes, and enhancing efficiency in organic light-emitting diodes with corrugated structures. Embossing and nanoimprinting have been used to pattern surface features on organic semiconductors. However, these techniques can be expensive and lead to systematic errors for large-area patterning.



Seeking a cost-effective technique for directly imprinting nanometer-scale structures on organic semiconductors, Liedtke *et al.* (p 3248) developed a novel single-step photoembossing method. The researchers irradiated a light-emitting, liquid crystalline, and semiconducting thin film on a glass substrate with collimated light from a HeCd laser of wavelength 325 nm transmitted through a phase mask, creating spontaneous surface relief gratings. Because the irradiance of the laser is too low to cause ablation, the researchers suggest that mass transfer is responsible for the gratings. Further investigation

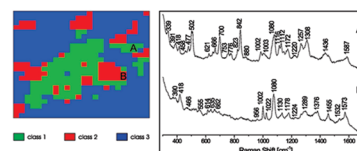
showed that this mass transfer is enhanced by cooperative effects when the incident beam is polarized parallel to the grating wave vector. Using this method, the researchers created surface relief gratings of amplitude up to 140 nm, even though the films were originally only 80 nm deep. Liedtke and colleagues combined this electron-donating film with a layer of an electron-accepting material and tested it in an optoelectronic device, showing that the patterned film significantly enhanced device performance. The authors suggest that their photoembossing process could be a significant contender for applications in photonics.

Hybrid Nanoprobes Make Their Mark on Biological Imaging

■ Interest continues to grow in using surface-enhanced Raman scattering (SERS) signals from probes for bioanalytical applications, ranging from immunoassays to intracellular studies. SERS labels consist of metal nanostructures—typically combinations of aggregates of gold or silver nanoparticles—combined with reporter molecules. These labels are often enclosed by a protective cover, such as glass or polyethylene glycol, to enhance robustness. However, probes without a cover, known as SERS hybrid probes, have a significant multifunctional advantage: they can be identified by the signature of their reporter molecules and deliver sensitive molecular structural information on their biological environment through SERS signals generated by other molecules present

in the local optical fields of the metal nanoaggregates.

SERS labels have enormous multiplexing potential due to the fingerprint-like nature of the vibrational spectrum. However, in previous studies using hybrid probes, researchers have used only visual inspection of reporter spectra or intensity mapping of one band for analysis, without applying fast methods or multivariate statistics. To fully exploit the multiplexing capabilities of these probes, Matschulat *et al.* (p 3259) measured the spectra of five different reporter molecules on gold nanoparticles, showing them to be separable by hierarchical clustering and principle components analysis (PCA). In a live-cell imaging experiment, a combination of



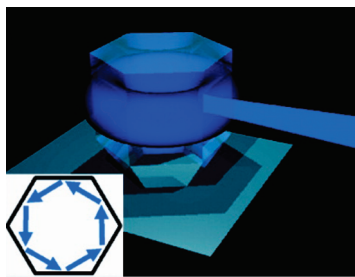
hierarchical cluster analysis, k-means clustering, and PCA successfully highlighted the positions of different types of SERS probes along with spectral information from cellular constituents. In addition, the researchers found that probes containing aromatic thiols as reporters had minimal cytotoxicity. These results suggest that fast, multivariate evaluation of whole sets of multiple probes is feasible, potentially opening up applications for high-density sensing and biological imaging applications.

Lasers Go Around, Come Around in ZnO Nanodisks

■ Whispering galleries, areas beneath circular or elliptical vaults where whispers can be heard clearly at great distances away, have been the inspiration for 1 ultralow-threshold lasers based on a similar principle. Researchers have thus far demonstrated such so-called whisper gallery mode (WGM) lasing in materials and circular structures ranging from lasing microdisks to high-Q silicon nanocrystal resonators. ZnO has already been suggested as an ideal material for creating structures for WGM lasing due to its high exciton binding energy, high optical gain, and propensity for room temperature UV lasing. Though visible and near-infrared WGM lasing has been showing in some subwavelength structures, WGM lasing has yet to be

observed in subwavelength ZnO structures.

In an effort to break new ground in this area, Gargas *et al.* (p 3270) synthesized faceted ZnO nanodisks with tapered bases on silica substrates. They kept the growth of these structures at a low density, which isolated nanodisks for



individual optical and electron microscope characterization. The researchers found that the tapered bases pushed the optical mode away from the substrate and confined it to the upper part of the nanodisk. Results showed that the lasing threshold scaled inversely with the power of the nanodisk diameter rather than with the disk height, providing evidence of WGM lasing rather than Fabry–Perot lasing in the vertical direction. Further investigations showed lasing in a subwavelength diameter nanodisk at 283 nm and 8 K, which is the smallest diameter WGM lasing structure reported to date. The authors suggest that these findings open up promising avenues for mass-scale production of nanoscale lasers and on-chip devices for nanophotonics.