ed fluorophosphates glass composition possess a better thermal stability which can achieve a larger working range during optical fiber drawing. Investigation of the doped glass IR transmission spectrum shows that the transmittance of the glass in the infrared is as high as 90% and that the absorption around 3 μm, related to the OH^- absorption band, is negligible. Finally the infrared photoluminescence studies show a strong 2.7 μm emission band for the codoped Er^{3+}/Pr^{3+} glass, which is not present for the only Er-doped glass. Analysis of the upconversion spectra in the green visible range shows that this behavior is due to an energy transfer process in which the presence of Pr ions participate, and as a result the 1.55 μm Er emission is weakened while the 2.7 μm emission is enhanced. Furthermore, peak of calculated emission cross-section in Er^{3+}/Pr^{3+} doped fluorophosphates glass at 2708 nm achieves $(6.57 \pm 0.11) \times 10^{-21}$ cm^2 which is higher than the result of Er^{3+} doped oxyfluoride transparent glass ceramics (4.3×10^{-21} cm^2) and ZBLAN glass (5.7×10^{-21} cm^2).

Rosalía Serna

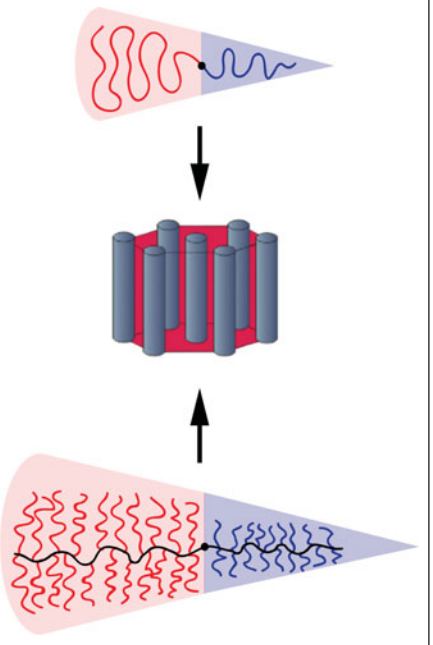
Nano Focus

Bottlebrush copolymers expand size range of nanopores

The wide variety of nanostructured morphologies derived from the self-assembly of block copolymers provides a useful route to nanoporous materials. Degrading one of the polymer blocks leaves a porous network of the remaining polymer, which can be used for filtration and selective crystallization. Their main limitation is the small pore sizes currently accessible, but recent research by J. Rzayev and J. Bolton at the University at Buffalo and T.S. Bailey of Colorado State University shows that this range can be significantly extended by the use of so-called "bottlebrush" copolymers, in which polymer side-chains fan out from a central backbone.

The morphology of self-assembled block copolymer materials is normally controlled by altering the length ratio of the two blocks, giving rise to segregated regions in the form of flat planes, cylinders, or spheres. Bottlebrush copolymers, which can have polymer side-chains of different lengths, offer another variable with which to alter the space taken up by each block and thus the morphology they adopt. The research, published in the January 31st online edition of *Nano Letters* (DOI: 10.1021/nl103747m), uses asymmetrical bottlebrush polymers consisting of a block with long polystyrene side-chains and one with shorter polyactide side-chains. Using a combination of controlled radical and ring-opening polymerizations, the team synthesized a methacrylate-based block copolymer and then grew the side-chains sequentially from this backbone. Melt pressing and annealing the polymer results in randomly oriented polyactide cylinder domains, which were aligned by channel die processing. Degrading the polyactide chains in alkaline conditions leaves a polystyrene material with nanoscale channels (55 ± 16 nm) running the width of the sample. This represents a substantial increase in size over pores derived from ordinary block copolymers (up to 35 nm), and it is likely that a much greater range is accessible by appropriate tailoring of the side-chains.

A potentially useful side effect of fabricating the material in this way is that the polymethacrylate backbone remains intact and present within the pores. The most striking consequence of this is that despite the material being principally polystyrene, the pores are hydrophilic and can uptake water. These leftover backbones could also provide a useful scaffold for chemically modifying the pores in a host of ways.



Asymmetry in the side-chains of bottlebrush block copolymers (bottom) can be used to obtain the same self-assembled morphologies as asymmetric linear copolymers (top). Reproduced with permission from *Nano Lett.* (2011) DOI: 10.1021/nl103747m. © 2011 American Chemical Society.

Tobias Lockwood

Energy Focus

Light-trapping Si PVs obtained by UV-nanoimprint lithography

Light-trapping is necessary to achieve low-cost and high-efficiency thin-film Si photovoltaics devices. Many nano-architectures leading to light scattering have greatly improved efficiencies although their ideal characteristics remain uncertain. C. Battaglia and coworkers from the École Polytechnique Fédérale de Lausanne recently used UV-nanoimprint lithography to fabricate 12% efficiency micromorph (a-Si :H/μc-Si :H) tandem cells with identically nanostructured ZnO and In_2O_3:H front electrodes.

As described in the February 9th issue of *Nano Letters* (DOI: 10.1021/nl1037787; p. 661), the researchers used

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a high-resolution replication process to copy the nanostructured interface of a randomly oriented pyramidal ZnO electrode (master) onto an In_2O_3:H electrode (replica). The master is used to mold a UV-sensitive solgel stamp, which in turn is used to obtain a positive replica of the master (on glass). This is the transparent substrate onto which a In_2O_3:H electrode was sputtered. Tandem Si cells were then deposited by plasma-enhanced chemical vapor deposition.

External quantum efficiencies (EQE) and current–voltage characteristics show that the replica exhibits comparable overall performances as the master, as opposed to a flat reference structure without light-trapping. The nanostructuring allows light scattering in the device, as proved by the disappearance of interferences in the EQE spectra. Efficiencies of the nanostructured electrodes devices reach 12%, against 7% for the flat substrate device. This increase is due to the doubling of the short-circuit current (almost 26 mA/cm^2 for the nanostructured replica).

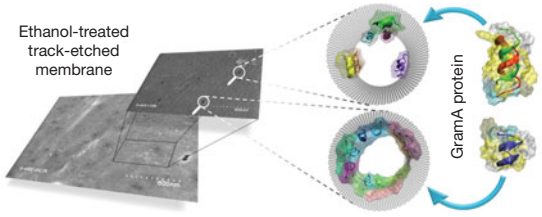
On the material side, the larger bandgap of In_2O_3:H compared to ZnO implies a larger EQE at short wavelengths, whereas the EQE is improved at long wavelengths due to the low free carrier absorption of In_2O_3:H with respect to ZnO. These EQE improvements both lead to an increase in short-circuit current. Moreover, the nanotextured replica-In_2O_3:H interface acts as an antireflection layer, in contrast to the flat glass-ZnO interface.

Elsa Couderc

Bio Focus

Biomimetic membrane constructed by confining biological ion channel in nanopores of solid-state polymer

Membranes have ubiquitous application ranging from food, agricultural industry, potable water production, water treatment, biotechnology, and nanofiltration to desalination of sea water and saline aquifer. The challenge of current membrane technology is to combine two antagonistic properties: high ion permittivity and selectivity with the same efficiency as biological cell membranes having well-controlled ion transport and outstanding permeability and selectivity. This will help in the creation of tunable nanodevices such as microfluidic transistors, diodes, and sensors that can differentiate between ions and recognize single molecules. Two avenues have been explored in the past. One is confining artificial water channel aquaporin and Gramicidin A in a copolymer matrix, but this lacks the required mechanical stability. The second was by using a mechanically strong inorganic material like a carbon nanotube as a confining matrix; however, this approach was never tried in reality. Recently, researchers from Montpellier and Franche-Comte Universities, France have prepared a hybrid nanoporous membrane by confining Gramicidin A (GA) in cylindrical nanopores of track-etched polycarbonate thin film (see Figure) and obtained enhanced ionic permeability.



The bioinspired hybrid membrane shows the orientation of Gramicidine A inside the cylindrical nanopores. Reproduced with permission from *Nano Lett.* **11** (2)(2011), DOI: 10.1021/nl103841m; p. 712. © 2011 American Chemical Society.

As reported in the February 9th issue of *Nano Letters* (DOI: 10.1021/nl103841m; p. 712), S. Balme and co-researchers used hydrophobic polyvinylpyrrolidone (PVP)-coated track-etched polycarbonate membranes which are 5 μm thick with a nanopore diameter of 15 nm and a density of 7×10^8 per cm^3. These were treated in ethanol to make the outer surface less hydrophobic compared to the inner surface since GA prefers a hydrophobic surface. When this ethanol-treated membrane was soaked in a GA-containing solution for 72 hours, the GA molecules become attached inside the nanopores.

Fluorescent signal measurement using labeled protein confirmed that GA is uniformly inserted throughout the nanopores of the membrane and in a higher concentration for an ethanol-treated membrane. GA-impregnated membranes exhibited improved ion diffusion for 10^{-1}, 10^{-2}, and 5×10^{-3} mol L^{-1} solution of Na^+, K^+, Ca^+, and Mg^+ chlorine solutions. Furthermore, molecular dynamics simulation revealed that double-stranded (ds) GA dimer conformation is more stable inside the nanopores than a single-stranded (ss) one. Since ds-dimers can accommodate either monovalent or divalent ions, these hybrid membranes lack ion selectivity as compared to the biological membranes where GA is mostly single stranded.

According to the researchers, this work opens a promising avenue for research in nanobiofiltration and tunable nanodevices with differential ion conduction.

Mousumi Mani Biswas

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