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).

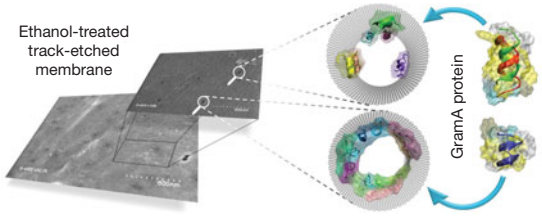
On the material side, the larger bandgap of In_2O_3:H compared to ZnO implies a larger EQE at short wavelengths, whereas the EQE is improved at long wavelengths due to the low free carrier absorption of In_2O_3:H with respect to ZnO. These EQE improvements both lead to an increase in short-circuit current. 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.

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