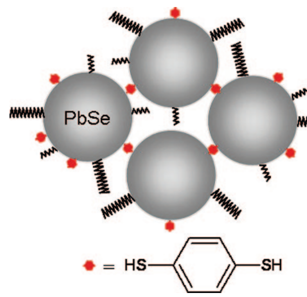
Here Comes the Sun—and Photovoltaic Quantum Dots

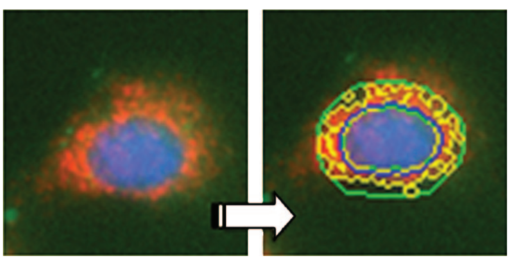
Solar cells that are low-cost, cover a large area, and are physically flexible hold numerous advantages over traditional solar cells, possibly allowing their use in many devices where traditional cells cannot be placed. However, while traditional solar cells can take advantage of infrared light, which accounts for half the sun's power, progress in developing new solution-based solar cells has focused mainly on organic and polymer materials possessing absorption onsets in the visible region of the spectrum. Seeking the best of both worlds, Koleilat *et al.* (p 833) developed solution-cast quantum dot photovoltaics that have 3.6% power conversion efficiency in the infrared region. The quantum dots, made of PbSe, were synthesized with benzenedithiol, a strongly bound bidentate linker. Devices made with this material adsorbed on an indium tin oxide substrate were stable for weeks without requiring fresh deposition of their top electrical contacts. The best devices reached external quantum efficiencies of 46% in the infrared and 70% across the visible spectrum. This quality was shown to be reliable and reproducible, with 40 devices produced with similar efficiencies. When the researchers investigated the physical mechanisms underlying the device performance, they found that the short benzenedithiol linker effectively cross-linked the PbSe nanoparticles, providing a pathway for diffusion of electron and holes over hundreds of nanometers. The researchers indicate that such solution-cast quantum dots, prepared with the addition of a stabilizing bidentate linker, could be a promising step toward the development of future photovoltaic devices.



Fingerprinting a Killer: High Content Screen for Nanotoxicity

Nanoparticles have been suggested for a variety of biological and biomedical applications, ranging from luminescent labels for biological imaging to therapeutic agents. However, some nanoparticles are cytotoxic, a factor that precludes biological use. For nanoparticles that have not been tested, the situation is uncertain. Researchers have highlighted the need for developing a rapid, standard assessment tool to evaluate the cytotoxicity of nanoparticles and nanomaterials systematically.

Jan *et al.* (p 928) demonstrate such a tool based on high-content screening (HCS) technology, a recent advance in the integration and automation of quantitative fluorescence microscopy and image analysis. The researchers test the ability of HCS to identify cytotoxicity in two different systems: CdTe quantum dots in murine neuroblastoma cells, and Au nanoparticles in human hepatocellular carcinoma cells. In the first system, the researchers imaged cells exposed for various time periods and different concentrations of quantum dots capped with thyoglycolic acid (TGA-QDs) and compared this to dots produced in the presence of gelatin (Gelatin-QDs), looking for apoptotic or necrotic cells and effects on neurite outgrowth. The researchers also used a cocktail of fluorescent probes to visualize other effects on cellular health that could indicate toxicity, including nuclear count, mitochondrial membrane potential, and intracellular free calcium concentration. These same probes were used to evaluate Au nanoparticles. Each test generated a unique "fingerprint" of cytotoxicity that could reliably estimate the hazardous effects of the particles in each cell type. The authors suggest that this tool could eventually be used to screen various nanoparticles to generate a database of toxicity in various cells and tissues.

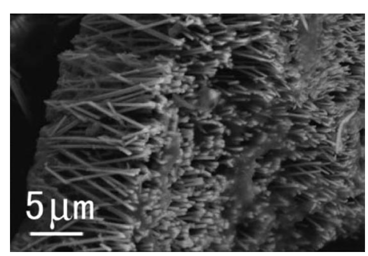


Barrier Method: Membranes Make Templates for Nanostructures

Though researchers have developed techniques for producing high-quality carbon nanotubes, there have been numerous challenges in crafting 1-D structures from other materials, including binary oxides of the transition metals Zn, Cu, and Fe. As these structures are useful model systems and have diverse applications, many researchers are working on developing techniques for fabricating these materials into nanowires and nanotubes that have well-defined and reproducible size, shape, monodispersity, purity, chemical composition, and stability. Often, these methods involve high temperatures, expensive equipment, and the use of toxic precursors or byproducts. However, template-directed synthesis has been explored recently as an alternative method that avoids these problems and has been used to synthesize various 1-D nanomaterials.

In a new twist on this method, Wong and Zhou (p 944) created nanowires, nanotubes, and associated arrays of ZnO, CuO, and α-Fe_2O_3 (hematite) using the pores in commercially available membranes as templates. Mounting membranes made of either alumina or polycarbonate between two halves of a U-tube cell, the researchers flooded the half-cells with solutions of precursors. These solutions diffused toward each other through the membrane pores, making them microenvironments for nanostructure synthesis. The resulting nanotubes and nanowires were shown to be chemically pure and structurally well-defined.

A key point in this method is that the nanostructures could be transferred onto any substrate, which the researchers demonstrated by placing them on a flat silicon substrate and on a curved glass rod. The authors note that this is a general strategy for the generation of arrays of these and other nanostructures on a variety of rigid and flexible substrates, which could have applications in future portable electronic or sensor devices.



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