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Cheap Nano Solar Cells

Carbon nanotubes could help make nanoparticle-based solar cells more efficient and practical.

By Kevin Bullis

Researchers at University of Notre Dame, in Indiana, have demonstrated a way to significantly improve the efficiency of solar cells made using low-cost, readily available materials, including a chemical commonly used in paints.

The researchers added single-walled carbon nanotubes to a film made of titanium-dioxide nanoparticles, doubling the efficiency of converting ultraviolet light into electrons when compared with the performance of the nanoparticles alone. The solar cells could be used to make hydrogen for fuel cells directly from water or for producing electricity. Titanium oxide is a main ingredient in white paint.

The approach, developed by Notre Dame professor of chemistry and biochemistry Prashant Kamat and his colleagues, addresses one of the most significant limitations of solar cells based on nanoparticles. (See "Silicon and Sun.") Such cells are appealing because nanoparticles have a great potential for absorbing light and generating electrons. But so far, the efficiency of actual devices made of such nanoparticles has been considerably lower than that of conventional silicon solar cells. That's largely because it has proved difficult to harness the electrons that are generated to create a current.

Indeed, without the carbon nanotubes, electrons generated when light is absorbed by titanium-oxide particles have to jump from particle to particle to reach an electrode. Many never make it out to generate an electrical current. The carbon nanotubes "collect" the electrons and provide a more direct route to the electrode, improving the efficiency of the solar cells.

As they wrote online in the journal *Nano Letters*, the Notre Dame researchers form a mat of carbon nanotubes on an electrode. The nanotubes serve as a scaffold on which the titanium-oxide particles are deposited. "This is a very simple approach for bringing order into a disordered structure," Kamat says.

The new carbon-nanotube and nanoparticle system is not yet a practical solar cell. That's because titanium oxide only absorbs ultraviolet light; most of the visible spectrum of light is reflected rather than absorbed. But researchers have already demonstrated ways to modify the nanoparticles to absorb the visible spectrum. In one strategy, a one-molecule-thick layer of light-absorbing dye is applied to the titanium-dioxide nanoparticles. Another approach, which has been demonstrated experimentally by Kamat, is to coat the nanoparticles with quantum dots--tiny semiconductor crystals. Unlike conventional materials in which one photon generates just one electron, quantum dots have the potential to convert high-energy photons into multiple electrons.

Several other groups are exploring approaches to improve the collection of electrons within a cell, including forming titanium-oxide nanotubes or complex branching structures made of various semiconductors. But experts say that Kamat's work could be a significant step in creating cheaper, more-efficient solar cells. "This is very important work," says Gerald Meyer, professor of chemistry at Johns Hopkins University. "Using carbon nanotubes as a conduit for electrons from titanium oxide is a novel idea, and this is a beautiful proof-of-principle experiment."
