Perfecting a solar cell by adding imperfections

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Nanotechnology is paving the way toward improved solar cells. New research shows that a film of carbon nanotubes may be able to replace two of the layers normally used in a solar cell, with improved performance at a lower cost. Researchers have found a surprising way to give the nanotubes the properties they need: add defects.

Currently, these solar cells, called dye-sensitized solar cells, have a transparent film made of an oxide that is applied to glass and conducts electricity. In addition, a separate film made of platinum acts as a catalyst to speed the chemical reactions involved.

Both of these materials have disadvantages, though. The oxide films can't easily be applied to flexible materials: they perform much better on a rigid and heat resistant substrate like glass. This increases costs and limits the kinds of products that can be made. And expensive equipment is necessary to create the platinum films.

Jessika Trancik of the Santa Fe Institute, Scott Calabrese Barton of Michigan State University and James Hone of Columbia University decided to use carbon nanotubes to create a single layer that could perform the functions of both the oxide and platinum layers. They needed it to have three properties: transparency, conductivity, and catalytic activity.

Ordinary carbon nanotubes films are so-so in each of these properties. The obvious ways of improving one, though, sacrifice one of the others.

For example, making the film thicker makes it a better catalyst, but then it's less transparent.

Previous theory had suggested that materials may function better as catalysts when they have tiny defects, providing sites for chemicals to attach. So the researchers tried exposing the carbon nanotubes to ozone, which roughs them up a bit. Very thin films, they found, became dramatically better catalysts, with more than ten-fold improvement.

In order to address the trade-off between transparency and conductivity, the researchers tried another trick on a bottom layer of tubes: they created carbon nanotubes that were longer. This improved both conductivity and transparency.

The carbon nanotube films might be used in fuel cells and batteries as well.

"This study is an example of using nanostructuring of materials – changing things like defect density and tube length at very small scales – to shift trade-offs between materials properties and get more performance out of a given material," Trancik says. "Making inexpensive materials behave in advanced ways is critical for achieving low-carbon emissions and low cost energy technologies."

The researchers published their results recently in *Nano Letters*. They are currently in the process of filing a patent application for their techniques.

Source: Santa Fe Institute