

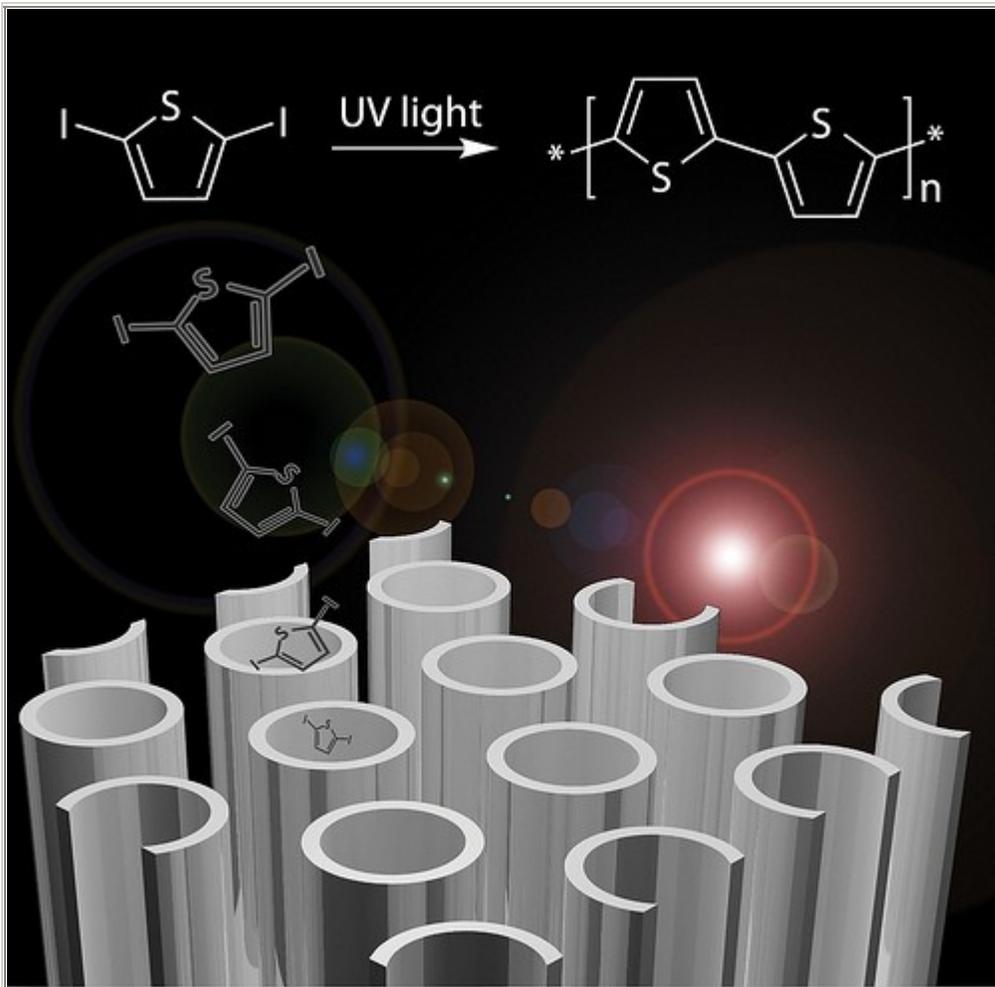
http://www.electroiq.com/index/display/photovoltaics-article-display/6823434960/articles/Photovoltaics-World/industry-news/2009/november-2009/argonne-touts_hybrid.html

Argonne touts hybrid PV cell with "homegrown" polymer

November 12, 2009 - Researchers at the US Department of Energy's Argonne National Labs say they have refined a technique to make solar cells by growing polymers inside tubes of semiconducting material, a method potentially much cheaper than conventional [crystalline silicon](#) or thin-film commercial processes.

Organic/inorganic "hybrid" cells that combine two semiconducting materials (conducting electrons and holes); at the junction between the two, the electron-hole pair is pulled apart, creating a current, [they explain](#). But if they're too close the charges won't make it out of the cell; if they're too far apart the pair will die in transit.

One way to make inexpensive hybrid cells is pairing a solid organic hole conductor with an electron acceptor. In their work, they grew rows of TiO₂ nanotube arrays across a Ti film submerged in an electrochemical bath, then filled the tubes with conjugated polymers -- a tricky step akin to "trying to stuff wet spaghetti into a table full of tiny holes," according to Argonne nanoscientist Seth Darling. As the polymer bends and twists it leads to inefficiencies due to reduced charge conduction and trapped air pockets. Furthermore, the polymer tends to pull away from the Ti interface.



A computer-generated image showing the TiO₂ nanotubes which comprise the new technique developed at Argonne for "growing" solar cells. (Image courtesy Seth Darling/[Center for Nanoscale Materials](#) and [Argonne National Laboratory](#))

To solve these problems, the team decided to grow the polymer on the inside of the TiO₂ tubes, by filling the tubes with a polymer precursor and applying UV light. Tests suggested that the two materials thus are more molecularly compatible, and together capture light at wavelengths otherwise inaccessible to either alone. Furthermore, the process, they say, is "much less expensive" than today's energy-intensive silicon PV cell manufacturing processes.

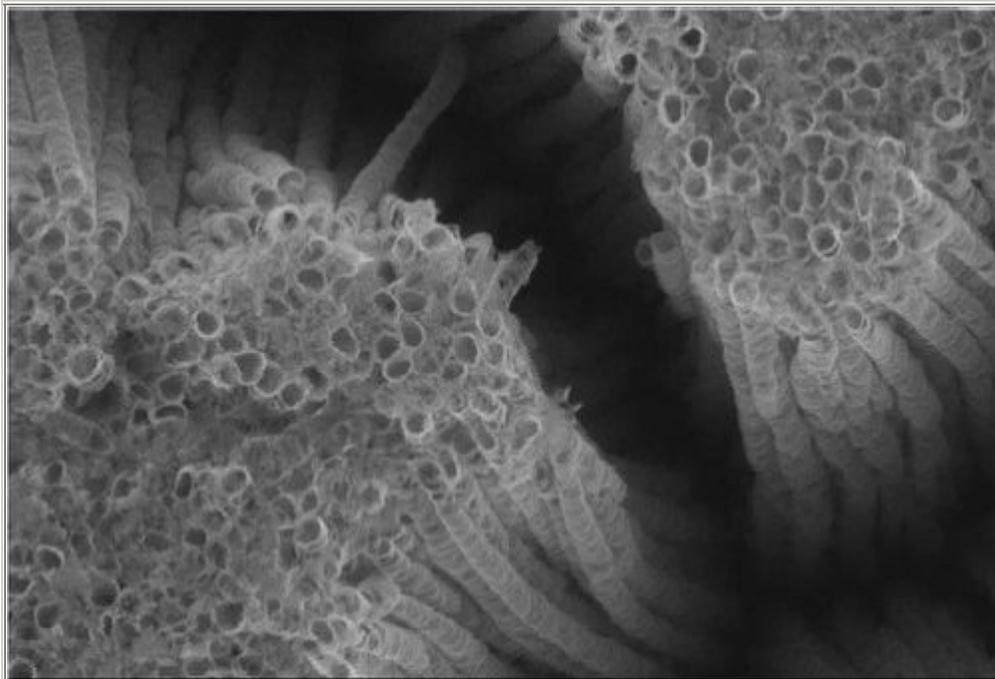
From their paper, published in the journal [Small](#):

A nanotubular TiO₂ substrate is immersed in a 2,5-diiodothiophene (DIT) monomer precursor solution and then irradiated with UV light. The selective UV photodissociation of the C-I bond produces monomer radicals with intact π-ring structure that further produce longer oligothiophene/PT

molecules. Complete photoluminescence quenching upon UV irradiation suggests coupling between radicals created from DIT and at the TiO₂ surface via a charge transfer complex. Coupling with the TiO₂ surface improves UV-PT crystallinity and π - π stacking; flat photocurrent values show that charge recombination during hole transport through the polymer is negligible. A non-ideal, backside-illuminated setup under illumination of 620nm light yields a photocurrent density of $\approx 5 \mu A cm^2$ -- surprisingly much stronger than with comparable devices fabricated with polymer synthesized ex situ.

The new hybrid cells' conversion efficiency was determined to be about 10× better than hybrid tubes stuffed with premade polymer, though performance is still below that of conventional c-Si. They add that they used an Ag top electrode to illuminate the cell, so an Ag plasmon-enhanced solar energy conversion might also work for such a backside architecture.

The work was funded by the DoE's Office of Basic Energy Sciences and the NSF-Materials Research Science and Engineering Center at the U. of Chicago.



An electron microscope image of electrochemically grown TiO₂ nanotubes. (Image courtesy Seth Darling/[Center for Nanoscale Materials](#) and [Argonne National Laboratory](#))