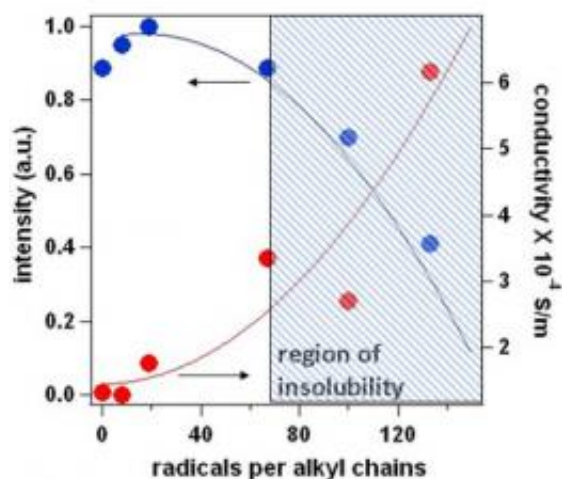


A Straightforward Solution for Increasing Solar Cell Performance

April 29 2010, by Tianna Hicklin



Properties of polythiophene polymer after crosslinking with radical initiator ditert butyl peroxide. The intensity of light absorption (blue circles) is unchanged with up to 70 radicals per alkyl chain of crosslinker. Conductivity (red circles) increases, up to five times, as increasing concentrations of crosslinker is added. The addition of 70 radicals per alkyl chain of crosslinker immobilizes the polymer, preserves its absorption properties, and increases conductivity by three times (shown by solid line).

(PhysOrg.com) -- Brookhaven National Laboratory researchers recently demonstrated improved stability and efficiency of a certain type of solar cell by incorporating a commercially available additive into the fabrication process.

"The energy that the earth receives from one hour of sunlight is enough to accommodate the world's energy needs for an entire year," said Ioana Gearba, the lead author of the study, formerly a researcher at Brookhaven's Center for Functional Nanomaterials (CFN) and presently at the University of Texas at Austin. "Efficient methods for converting sunlight to usable energy, such as solar cells, can contribute significantly to society's future energy needs. But commercial solar cells made with silicon do not produce cost-competitive electricity due, in part, to high manufacturing costs. An exciting development in the field has been the discovery of organic semiconductors, which can, in principle, lower the manufacturing costs of large-area solar devices."

But solar cells made from semiconducting organic materials, based on carbon, have their own drawbacks. Although this class of solar cells may provide a more cost-effective manufacturing route, they also are less efficient.

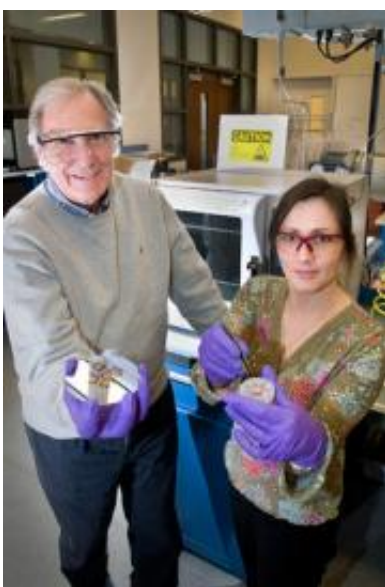
"Solar cells made from organic plastic materials are both attractive and unattractive at the same time," said Chuck Black, the Electronic Materials Group Leader at the CFN. "For example, they may deform a little bit when put out in the hot sun, and their [electrical properties](#) may change as they move. For solar cells made out of such materials to really work, they will need to withstand significant changes in conditions."

In the October 26, 2009, edition of *Applied Physics Letters*, the Brookhaven researchers report that one way to increase the stability of [organic solar cells](#) is "locking" the semiconducting base layer, the first layer upon which the solar cell is built, in place. To do this, a chemical crosslinker, which interconnects the polymer chains in the material's base layer, was added to the solution-based starting materials. This high degree of interconnection immobilizes the polymer structure and helps preserve its properties during changes in temperature, for example.

"We wanted to find a chemical way to freeze, or immobilize, the organic polymer in order to make it more stable," said Black. "We found a straightforward and elegant way to do that, and the method has an added benefit of making the material convert sunlight to electricity slightly more efficiently."

"Adding the crosslinker only takes an extra 10 minutes," said Gearba. "Our work is the first time that anyone has used a commercially available crosslinker to interconnect solution-based semiconducting polymers. Other groups have done something similar, but used an approach that may not work for all polymers."

The crosslinker mechanically stabilizes the polymer and increases its conductivity by as much as five times. The efficiency of model solar cells made from the crosslinked polymer also increased, up to three fold. The solution-based process is cost-effective and allows for large-scale uses, such as in spray-on or roll-to-roll manufacturing methods.



Ioana Gearba (right), a former researcher at the CFN, and Ron Pindak, Physical and Chemical Sciences Division Head at the NSLS, display the enhanced

polythiophene blended solar cells.

Using x-ray diffraction at NSLS beamline X6B, the group investigated whether structural changes in the polymer film induced by crosslinking were related to the observed improvements in conductivity and device efficiency.

"The x-ray scattering measurements showed that the [polymer chains](#) orient in such a way that electronic charge follows a more direct pathway through the film," said Gearba.

The new technique provides a way to create a stable [polymer](#) foundation upon which additional semiconducting materials can be layered - a necessary component of realizing more complex solar cell designs.

"The project has provided us with a new tool that we believe is more broadly applicable to other materials," said Black. "This is an exciting capability that could serve as a base for many new projects."

"This was a great example of the synergy between the CFN and the NSLS," said Ron Pindak, the Physical and Chemical Sciences Division Head at the NSLS. "These adjacent user facilities allow us to make model devices, such as [solar cells](#), in the CFN and then use complementary tools in both facilities for their analysis."

More information: I.R. Gearba, C-Y Nam, R. Pindak, C.T. Black, "Thermal Crosslinking of Organic Semiconducting Polythiophene Improves Transverse Hole Conductivity," Appl. Phys. Lett., 95, 173307 (2009).

Provided by Brookhaven National Laboratory

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