Researchers use carbon nanotubes to make solar cells affordable, flexible

September 27 2011

Researchers from Northwestern University have developed a carbon-based material that could revolutionize the way solar power is harvested. The new solar cell material – a transparent conductor made of carbon nanotubes – provides an alternative to current technology, which is mechanically brittle and reliant on a relatively rare mineral.

Due to the earth abundance of carbon, carbon nanotubes have the potential to boost the long-term viability of solar power by providing a cost-efficient option as demand for the technology increases. In addition, the material's mechanical flexibility could allow solar cells to be integrated into fabrics and clothing, enabling portable energy supplies that could impact everything from personal electronics to military operations.

The research, headed by Mark C. Hersam, professor of materials science and engineering and professor of chemistry, and Tobin J. Marks, Vladimir N. Ipatieff Professor of Catalytic Chemistry and professor of materials science and engineering, is featured on the cover of the October 2011 issue of *Advanced Energy Materials*, a new journal that specializes in science about materials used in energy applications.

Solar cells are comprised of several layers, including a transparent conductor layer that allows light to pass into the cell and electricity to pass out; for both these actions to occur, the conductor must be both electrically conductive and also optically transparent. Few materials concurrently possess both of these properties.

Currently, indium tin oxide is the dominant material used in transparent conductor applications, but the material has two potential limitations. Indium tin oxide is mechanically brittle, which precludes its use in applications that require mechanical flexibility. In addition, Indium tin oxide relies on the relatively rare element indium, so the projected increased demand for solar cells could push the price of indium to problematically high levels.

"If solar technology really becomes widespread, as everyone hopes it will, we will likely have a crisis in the supply of indium," Hersam said. "There's a great desire to identify materials – especially earth-abundant elements like carbon – that can take indium's place in solar technology."

Hersam and Marks' team has created an alternative to indium tin oxide using single-walled carbon nanotubes, tiny, hollow cylinders of carbon just one nanometer in diameter.

The researchers have gone further to determine the type of nanotube that is most effective in transparent conductors. Nanotubes' properties vary depending on their diameter and their chiral angle, the angle that describes the arrangement of carbon atoms along the length of the nanotube. These properties determine two types of nanotubes: metallic and semiconducting.

Metallic nanotubes, the researchers found, are 50 times more effective than semiconducting ones when used as transparent conductors in organic solar cells.

"We have now identified precisely the type of carbon nanotube that should be used in this application," Hersam said.

Because carbon nanotubes are flexible, as opposed to the brittle indium tin oxide, the researchers' findings could pave the way for many new applications in solar cells. For example, the military could incorporate the flexible solar cells into tent material to provide solar power directly to soldiers in the field, or the cells could be integrated into clothing, backpacks, or purses for wearable electronics.

"With this mechanically flexible technology, it's much easier to imagine integrating solar technology into everyday life, rather than carrying around a large, inflexible solar cell," Hersam said.

Researchers are now examining other layers of the solar cell to explore also replacing these with carbon-based nanomaterials.

Provided by Northwestern University

Citation: Researchers use carbon nanotubes to make solar cells affordable, flexible (2011, September 27) retrieved 10 April 2024 from https://phys.org/news/2011-09-carbon-nanotubes-solar-cells-flexible.html