

New solar cell self-repairs like natural plant systems

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Jong Hyun Choi, an assistant professor of mechanical engineering at Purdue, and doctoral student Benjamin Baker use fluorescent imaging to view a carbon nanotube. Their research is aimed at creating a new type of solar cell designed to self-repair like natural photosynthetic systems. The approach might enable researchers to increase the service life and reduce costs for photoelectrochemical cells, which convert sunlight into electricity. Credit: Purdue University photo/Mark Simons

(PhysOrg.com) -- Researchers are creating a new type of solar cell designed to self-repair like natural photosynthetic systems in plants by using carbon nanotubes and DNA, an approach aimed at increasing service life and reducing cost.

"We've created artificial photosystems using optical [nanomaterials](#) to

harvest [solar energy](#) that is converted to electrical power," said Jong Hyun Choi, an assistant professor of mechanical engineering at Purdue University.

The design exploits the unusual [electrical properties](#) of structures called single-wall carbon nanotubes, using them as "molecular wires in light harvesting cells," said Choi, whose research group is based at the Birck Nanotechnology and Bindley Bioscience centers at Purdue's Discovery Park.

"I think our approach offers promise for industrialization, but we're still in the basic research stage," he said.

Photoelectrochemical cells convert sunlight into electricity and use an [electrolyte](#) - a liquid that conducts electricity - to transport electrons and create the current. The cells contain light-absorbing dyes called chromophores, chlorophyll-like molecules that degrade due to exposure to sunlight.

"The critical disadvantage of conventional [photoelectrochemical cells](#) is this degradation," Choi said.

The new technology overcomes this problem just as nature does: by continuously replacing the photo-damaged dyes with new ones.

"This sort of self-regeneration is done in plants every hour," Choi said.

The new concept could make possible an innovative type of photoelectrochemical cell that continues operating at full capacity indefinitely, as long as new chromophores are added.

Findings were detailed in a November presentation during the International Mechanical Engineering Congress and Exhibition in

Vancouver. The concept also was unveiled in an [online article](#) featured on the Web site for SPIE, an international society for optics and [photonics](#).

The talk and article were written by Choi, doctoral students Benjamin A. Baker and Tae-Gon Cha, and undergraduate students M. Dane Sauffer and Yujun Wu.

The carbon nanotubes work as a platform to anchor strands of DNA. The DNA is engineered to have specific sequences of building blocks called nucleotides, enabling them to recognize and attach to the chromophores.

"The DNA recognizes the dye molecules, and then the system spontaneously self-assembles," Choi said

When the chromophores are ready to be replaced, they might be removed by using chemical processes or by adding new DNA strands with different nucleotide sequences, kicking off the damaged dye molecules. New chromophores would then be added.

Two elements are critical for the technology to mimic nature's self-repair mechanism: molecular recognition and thermodynamic metastability, or the ability of the system to continuously be dissolved and reassembled.

The research is an extension of work that Choi collaborated on with researchers at the Massachusetts Institute of Technology and the University of Illinois. The earlier work used biological chromophores taken from bacteria, and findings were detailed in a research [paper published](#) in November in the journal *Nature Chemistry*.

However, using natural chromophores is difficult, and they must be

harvested and isolated from bacteria, a process that would be expensive to reproduce on an industrial scale, Choi said.

"So instead of using biological chromophores, we want to use synthetic ones made of dyes called porphyrins," he said.

Provided by Purdue University

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