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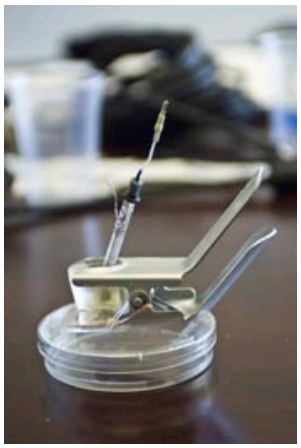
'Self-repairing' photovoltaics not damaged by the Sun

Sep 8, 2010 9 comments

Researchers at the Massachusetts Institute of Technology have fabricated the first synthetic photovoltaic cell capable of repairing itself. The cell mimics the self-repair system naturally found in plants, which capture sunlight and convert it into energy during photosynthesis. The device could be 40% efficient at converting solar power into energy – a value that is two times better than the best commercial photovoltaic cells on the market today.



Test cell

During photosynthesis, plants harness solar radiation and convert it into energy. Scientists have been trying to mimic this process in synthetic materials, but this has proved difficult because the Sun's rays damage and gradually destroy solar-cell components over time. Naturally occurring plants have developed a highly elaborate self-repair mechanism to overcome this problem that involves constantly breaking down and reassembling photodamaged light-harvesting proteins. The process ensures that these molecules are continually being refreshed, and so always work like "new".

Michael Strano and colleagues have now succeeded in mimicking this process for the first time by creating self-assembling complexes that convert light into electricity. The complexes can be repeatedly broken down and reassembled by simply adding a surfactant (a solution of soap molecules). The researchers found that they can indefinitely cycle between assembled and disassembled states by adding and removing the surfactant, but the complexes are only photoactive in the assembled state.

Light reaction centre

The complexes are made up of light-harvesting proteins, single-walled nanotubes and disc-shaped lipids. The proteins (which are isolated from a purple bacterium, *Rhodobacter sphaeroides*) contain a light reaction centre (carried by the lipids) comprising bacteriochlorophylls and other molecules. When the centre is exposed to solar radiation, it converts the sunlight into electron-hole pairs (excitons).

The excitons then shuttle across the reaction centre and subsequently separate back out again into electrons and holes. The nanotubes – which act as wires – channel the electrons, so producing a current. The nanotubes also serve to align the lipid discs in neat rows, ensuring that the reaction centres are uniformly exposed to sunlight.

"The beauty of this system is that a jumbled solution of components can spontaneously arrange itself into highly organized structures, containing thousands of molecules in a specific arrangement, by simply removing the surfactant," team member Ardemis Boghossian explained.

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Nature Chemistry
doi:10.1038/nchem.822

Apples and oranges

"Using the regeneration process, we are able to prolong the lifetime of our solar cell indefinitely, increasing our efficiencies by more than 300% over 164 hours of continuous illumination compared to a non-regenerated cell," added Boghossian. "If we were to increase the concentration of these complexes to make a completely stacked, highly packed formation, we could approach the theoretical limit of 40% – which is well beyond the efficiencies we see in commercial solar cells on the market today."

Comparing the MIT complexes to existing solar cells is like "comparing apples to oranges" though, she insists. "Most solar cells are static because they are made of solid slabs of silicon or thin films. Our solar cells are dynamic, just like plant leaves that can recycle their proteins as often as every 45 minutes on a really sunny day."

"We're basically imitating tricks that nature has discovered over millions of years – in particular 'reversibility', the ability to break apart and reassemble," added Strano.

The work was reported in *Nature Chemistry*.

About the author

Belle Dumé is a contributing editor to *nanotechweb.org*

9 comments

Comments on this article are now closed.

1 **Oliver K. Manuel**
Sep 8, 2010 5:21 PM
United States

Great!

Congratulations!

This sounds like a major breakthrough in the road toward better utilization of the energy that is abundantly supplied to all of us riding on the third little ball of dirt orbiting the Sun.

Again, congratulations!

With kind regards,
Oliver K. Manuel

Offensive? Unsuitable? Notify Editor

2 **lixo35**
Sep 8, 2010 10:42 PM
Braga, Portugal

Nice

This article is very well written and the subject is exciting

Offensive? Unsuitable? Notify Editor

3 **reader01**
Sep 9, 2010 1:40 PM

přírodovědný přístup

Vámi vymyšlený postup je v souladu s přírodními procesy a dovoluje tak ekologický způsob výroby elektřiny. Díky.

Offensive? Unsuitable? Notify Editor

4 **gunslingor**
Sep 9, 2010 5:15 PM
United States

nice but

Yet another great breakthrough.... Now how many decades do we have to wait for rollout?

Really guys... there have been massive advances in solar cells... put everything together in a workable product and roll them out everywhere!

Enough studies... there come a time for implementation and it was last year.

Keep studying for the next generation of cells, but you gotta roll something out already! You can study forever guys... we need products now!

Offensive? Unsuitable? Notify Editor

5 **saleemawan**
Sep 10, 2010 10:02 AM

Really Great Advancement

This is really great great advancement regarding achieving sustainable energy sources... We are in bad need of renewable and sustainable energy. Self repairing photovoltaics will help to produce more solar energy ever used before. It will also make it cheap and wide spread all over the world...

Offensive? Unsuitable? Notify Editor

6 **m.a.king**
Sep 11, 2010 7:06 AM
Toronto, Canada

Self-repair

At first glance, the simple repair method described looks like a bad fit for out-in-the-field installation. However (the researchers probably thought of this already...) one method of continual regeneration would be to have a conveyor belt of cells that pass through a surfactant bath at one end - a sort of re-assembly line. They would emerge at the other end refreshed and the overall system never has to go off-line. Long strips of this type could conceivably be arrayed with compound parabolic trough light collectors. If they're up to high intensity!
mk

Offensive? Unsuitable? Notify Editor

7 **analog**
Sep 11, 2010 11:27 AM

Quote:

> *Originally posted by* ***m.a.king***
> At first glance,
> mk

this is exciting. Perhaps something like a transparent sponge?

and a gycol liquid for freezing climate?

old jim

Offensive? Unsuitable? Notify Editor

8 **GuyGordon**
Sep 15, 2010 5:36 PM
Roswell, United States

Ho Hum...

MIT has been putting out so many Press Releases touting research as "major breakthroughs" that I just ignore them anymore.

I think they must have a PR department whose job is to keep MIT in the news at least every three months -- breakthrough or not.

Sorry guys. I'll believe it's a breakthrough when I see it published in Science or Nature. Till then, knock off the science PR. You're just cheapening the name of MIT.

Offensive? Unsuitable? Notify Editor

9 **inthend9**
Sep 17, 2010 5:29 AM
Lenexa, United States

Economics

Sounds great, but I feel like some important data is being left out of this article:

Is it economical?

Offensive? Unsuitable? Notify Editor