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Solar Cells: The New Light Fantastic

A novel and inexpensive material that ekes current from even the weakest rays could someday make the world a cleaner, greener place

One day last July, Ted Sargent was typing away in his office at the University of Toronto when a graduate student rushed in. His excited visitor explained that he had just shone infrared light -- invisible to the human eye -- onto a tiny sample of a special material Sargent and his researchers had developed, and the sample actually converted the light into energy. Always the skeptic, Sargent asked, "Did you turn the [overhead] lights off?"

Soon, however, it became clear that this research group had stumbled onto something big. Sargent and his team describe their discovery -- the world's first plastic solar cell able to absorb infrared light -- in the February issue of the prestigious industry journal *Nature Materials*. Their little sample could bring about a sea change in the energy industry, perhaps making solar energy so cheap that it becomes a viable alternative to fossil fuels.

Solar cells in commercial production today are expensive, around $6 per watt. To understand what that means, consider this: If you install $600 worth of solar cells, you can power a typical light bulb for 25 years, figures Ron Pernick, co-founder of renewable-energy consultancy Clean Edge in San Francisco. That's about twice the cost of coal-based electricity.

Through various technological improvements, solar-cell prices have typically fallen by 5% to 6% a year -- but no more, because cells are manufactured through complex processes similar to those employed for making PC processors and memory cards.

NARROWING THE GAP. To bridge that price gap, scientists have long attempted to develop so-called plastic solar cells. Essentially, they're a thin film that can be manufactured through a much cheaper process, one analogous to a newspaper printing press. They can be flexible and light. Plastic solar cells can also, potentially, be simply sprayed onto any surface -- and, voila! -- that wall, roof, or consumer electronics case becomes a solar-energy collector. Goodbye, ugly solar-panel roofs. Goodbye, lead storage batteries. Welcome, walls, cars, MP3 players, even shirts doubling as electricity generators.

A person could, potentially, unfurl a roll of such plastic solar cells in a field and create a huge solar farm in a matter of minutes, says Sargent. The beauty of plastic solar cells is that they do away with the costly installation required for traditional, heavy solar panels.

On the downside, today's plastic solar cells are highly inefficient. They only convert about 6% of the sunlight that hits them into energy. Standard solar cells can have 30%-plus efficiency. That's why no company produces plastic solar cells today, though one, startup Konarka in Lowell, Mass., plans to begin selling its cells for use as a supplemental energy sources for consumer electronics later this year, says Daniel McGahn, the outfit's executive vice-president and chief marketing officer. Konarka is mum on its product's features, but McGahn admits that even under optimal conditions, the cells are only 7% efficient.

Plastic solar cells are also terribly expensive. They can cost 10 times more than the traditional, semiconductor solar cells.

EXCITED ELECTRONS. Sargent's discovery could drastically increase plastic solar cells' light absorption -- and tip the cost-benefit scale in favor of the cells. A plastic solar cell that captures both visible and infrared light might be able to reach 30% efficiency, figures Peter Peumans, an organic-electronics expert at Stanford University.

The main principle of Sargent's solar-cell operation is nothing out of the ordinary. Light hits the cell's material, which absorbs a portion of its energy. The energy knocks tiny electrons that are part of the material loose, and they start flowing in a certain direction. That creates an electrical current.

Sargent's knowhow is in the material from which electrons are generated. Semiconductor material used in regular solar cells requires particularly intense solar power, found in visible sunlight but not infrared light, for electrons to be knocked out of place.

But electrons in Sargent's material "get excited" under the influence of infrared light. The material is made with so-called quantum dots. These are particles of semiconductor material so small they're invisible to the human eye. To those, Sargent attaches nanosize organic molecules sometimes found in skin moisturizers. They're about 100,00 times smaller than the diameter of a human hair. This unique combination is superresponsive to infrared light.

LONG ROAD. The work is far from done, of course. Sargent's still-unnamed material will have to be improved before it's used in commercial products. So far, it can convert only a very small amount of infrared light into energy -- about 1,000 times less than what's needed for commercial use. "We have a hint of a solution, maybe," says Stanford's Peumans.

What's more, materials containing organic molecules decompose when heated. So, theoretically, such organic-based plastic solar cells will have a life span that's a lot shorter than today's mainstream solar cells, which are guaranteed to function for more than 25 years. Still, Sargent says his material has withstood being heated to 200 degrees Celsius (392 degrees Fahrenheit) without disintegrating. Plus, a dirt-cheap plastic solar cell that can last for, say, three to five years, will find its uses -- particularly in consumer-electronics devices, which typically arn't designed to last longer, anyway.

It will probably take Sargent and the industry up to 10 years to get this technology to become a significant commercial product. But many venture capitalists and solar-cell companies believe it's worth the wait. "I view this work to be groundbreaking," says Josh Wolfe, managing partner at New York-based venture-capital firm Lux Partners. "There's an opportunity for a disruptive breakthrough technology with major social implications."

Indeed, with its potential to be used in power-generating garments, the day may not be that far off when the term "power suit" takes on a whole new meaning.