SOLAR ENERGY

Outlook Brightens for Plastic Solar Cells

The global market for solar cells has been growing at more than 30% a year for much of the past decade. But to match the scale of coal or nuclear power anytime soon, the technology will have to do much better. Silicon cells, the premier solar technology, convert 15% to 20% of the energy in sunlight to electricity, and their price has been dropping steadily. But many industry observers worry that a price floor could be near, because the cells require expensive clean-room technology to manufacture. Thin films of copper, indium, gallium, and selenium are 15% efficient and cheap, but indium is in short supply. Cadmium-telluride thin films, which rely on rare tellurium, are in much the same boat.

"The door is still open for a technology that gives you 15%, is cheap, and uses abundant materials," says Michael McGehee, a materials scientist at Stanford University in Palo Alto, California. It's an opening that makers of plastic solar cells hope to fill.

For years the efficiency of polymer-based cells scraped along at a feeble 3% to 5%. But things have improved markedly over the past 2 years. In early April, Mitsubishi Chemical reportedly set a new efficiency record, producing organic solar cells with a 9.2% conversion efficiency, according to *The Nikkei*, a Japanese business daily. Meanwhile, three other companies—Konarka Technologies in Lowell, Massachusetts; Solarmer Energy Inc. in El Monte, California; and Heliatek in Dresden, Germany—are now reporting cells with efficiencies greater than 8%. Many researchers in the field are confident that the figure could soon top 10% and possibly reach 15%.

"The efficiency of organics is lower than other technologies," says Bernard Kippelen, an optics expert at the Georgia Institute of Technology in Atlanta. "But they are catching up at a fast pace."

Just what lies behind the efficiency gains in the companies' cells is hard to determine, as they have released few details about how they are made. But progress has been coming in areas beyond efficiency as well. For example, researchers led by Wei You, a chemist at the University of North Carolina, Chapel Hill, reported online 4 March in the *Journal of the American Chemical Society* devising two novel polymer-based light absorbers that catch less light than some polymers but are better at converting what they do catch to electricity. In recent years, most makers of polymer solar cells have focused on designing polymers that absorb all visible light down into the reds, the low-energy end of the spectrum. The hope has been that maximizing the amount of light absorbed would improve the cells' energy conversion. Although that approach has been somewhat successful, the red absorbers are less successful than higher-energy light-absorbing polymers at converting absorbed light to electricity.

You and his colleagues created two new violet-to-yellow light absorbers, which give up on harvesting the reds but do a better job with what they do catch. The result was single-layer polymer cells with a 7.3% efficiency. "That's impressive work," says Alan Heeger, a physicist at the University of California (UC) Santa Barbara, who won the chemistry Nobel Prize in 2000 for his work on conducting polymers and has pioneered work on polymer solar cells. Heeger notes that the new polymer should be ideally suited to pairing with a second, red-absorbing cell to make higher efficiency "tandem" cells.

RECENT EFFICIENCY GAINS

Company	Date	Efficiency
Solarmer Energy Inc.	July 2010	8.13%
Heliatek	October 2010	8.30%
Konarka	November 2010	8.30%
Mitsubishi Chemical	April 2011	9.2%*

*According to media reports.

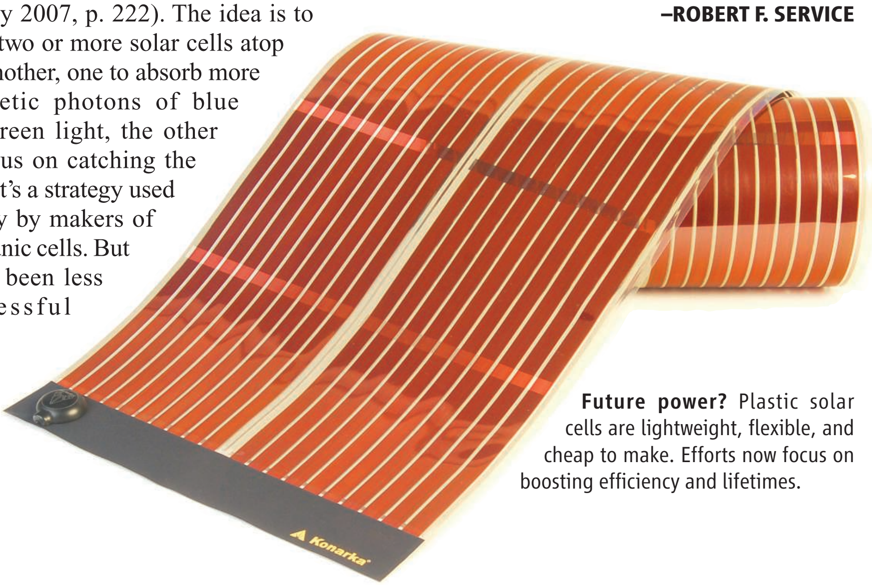
On the rise. Makers of organic solar cells report steady gains in electrical output.

Heeger's group reported the first tandem polymer solar cells 4 years ago (*Science*, 13 July 2007, p. 222). The idea is to stack two or more solar cells atop one another, one to absorb more energetic photons of blue and green light, the other to focus on catching the reds. It's a strategy used widely by makers of inorganic cells. But it has been less successful with organics, in part because the solvents used to print the top solar-cell layers can dissolve those underneath. Polymer tandem makers try to prevent that by laying down a barrier layer between the two cells. But just the right barriers can be hard to make, because they must be not only conductive to collect electrical charges in the cells but also optically transparent. At the American Chemical Society (ACS) meeting 2 weeks ago,* Yang Yang, a physicist at UC Los Angeles, reported that his group had modified a common interlayer material known as PEDOT, making it five orders of magnitude more conductive. That should make it a far better barrier layer and improve the performance of tandem cells, work the group is now trying to carry out.

Another concern for organic solar cells has been lifetime. As anyone who has left children's plastic toys in the backyard over the summer knows, sun can degrade many organic materials. That's of particular concern for solar cells that must hold up under relentless sun exposure. In hopes of addressing this concern, McGehee and colleagues at Stanford have constructed an apparatus to speed up lifetime testing of organic solar cells.

At the ACS meeting, McGehee reported that the first light-absorbing polymer his lab tested, known as PCDTBT, lasted 7 years. That may seem short to someone looking to get decades of power out of the devices, but McGehee says efforts to improve the lifetime of these devices are just beginning. "I think that it's encouraging," he says. Many organic-solar-cell researchers are starting to share his sunny outlook.

–ROBERT F. SERVICE



Future power? Plastic solar cells are lightweight, flexible, and cheap to make. Efforts now focus on boosting efficiency and lifetimes.

*American Chemical Society, 27–31 March, Anaheim, California.

SOURCE: COMPANY DATA; IMAGE CREDIT: KONARKA

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