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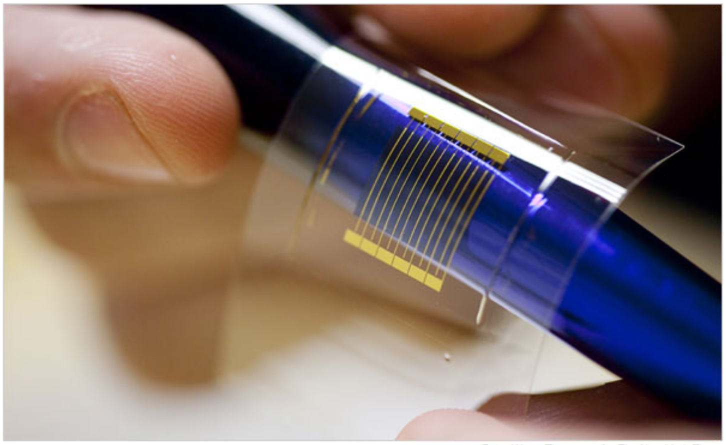

Peter Wynn Thompson for The New York Times

SMALL WONDERS Flexible photovoltaic cells created by John Rogers, below, of the University of Illinois, can be printed on many materials. More Photos >

By ANNE EISENBERG
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PHOTOVOLTAIC cells are already a familiar sight on rooftops. But one day, miniature cells may also be found in more unconventional places: power-generating windows, car sunroofs or even awnings.

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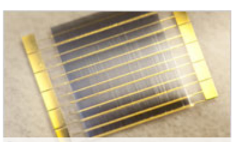

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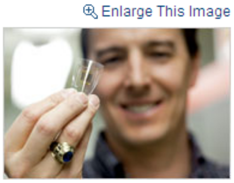

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John Rogers of the University of Illinois. More Photos »

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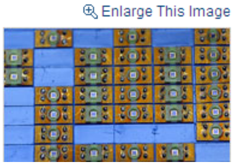

The new technology is the work of a researcher and his colleagues who developed a way to print ultrathin, semitransparent and flexible cells on plastic, cloth and other materials. If the technology succeeds, it may provide the solar industry with alternatives to the fixed installations that are common today: cells may be printed on plastic rolls that could be unfurled for dozens of uses, or stamped onto fabric for T-shirts or other clothes that collect energy while worn.

The researcher, John A. Rogers, a professor of materials science and engineering at the University of Illinois, Urbana-Champaign, and his team use a standard printing technique to create solar cells that are a tenth the thickness of conventional semiconductor cells, or even thinner. The cells are so flexible that dense arrays of them can be rolled tightly around a pencil. The technology has been licensed to Semprius, a semiconductor company in Durham, N.C., that expects to begin a pilot project making solar modules in about a year. Dr. Rogers's approach offers a unique strategy for making highly efficient, flexible solar cells for large-scale production, said Ali Javey, an electrical engineer and assistant professor at the University of California, Berkeley, who co-wrote a review of the work for the journal Nature Materials.

Traditional silicon solar cells are rigid, heavy and opaque,

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Sara D. Davis for The New York Times (Semprius)

The flexible photovoltaic cell technology is being developed by Semprius, in Durham, N.C. More Photos >

but they dominate the technology because they are very reliable and efficient, he said, and because silicon is abundant. Still, the brittleness of silicon limits its uses. Dr. Rogers "has figured out how to grab thin layers of silicon or other inorganics, and put them on whatever substrates you want," Dr. Javey said.

Dr. Rogers's work is an extension of techniques that he and his collaborators have developed for making flexible electronics over the past five years. The thin solar cells are first fabricated on semiconductor wafers using standard lithographic techniques and then transferred by a soft rubber stamp onto another material, Dr. Rogers said.

The sticky surface of the stamp "picks up the cells," he said, "and now your stamp is inked with these silicon cells. Then we use the stamp to print them on, for instance, a sheet of plastic."

George M. Whitesides, a renowned chemist and professor in the department of chemistry and chemical biology at Harvard University, said that Dr. Rogers's research took advantage of years of progress in silicon fabrication, while at the same time overcoming a basic restriction. "Silicon does work well, but it's always been the limitation that you make silicon devices on hard, rigid, planal surfaces," Dr. Whitesides said.

Dr. Rogers has retained the technology for creating silicon devices but developed new forms that were previously off-limits because of silicon's lack of flexibility. "He's extended an important technology in directions that will certainly open new applications," Dr. Whitesides said.

And the ability to make the cells semitransparent may lead to novel uses, for example, in tinted window coatings that also produce energy, Dr. Javey said. The transparency in the cells can be adjusted by controlling their density by printing sheets with fewer cells to enable more light to come though. "Then you can see through the cells as you could through tinted film," he said.

At its plant in Durham, N.C., where Semprius is developing technology for solar cell arrays, Joe Carr, the company's chief executive, said, "We almost can't keep up with all of the opportunities that have been presented to us." Semprius is working on photovoltaic modules for potential customers including automotive companies interested in the new cells for car roofs, he said.

Dr. Rogers said he was pleased with the new cells' flexibility and thinness but said that they offered another even more critical advantage. "That the technology is rollable and transparent is important," he said. "But cost is the paramount consideration for a lot of solar applications, which have to be low-cost per watt generated." The technology is producing cells that are often only two microns thick (a micron is one-millionth of a meter). "Thinner allows cheaper," he said.

A version of this article appeared in print on April 30, 2009, on page F2 of the New York edition.

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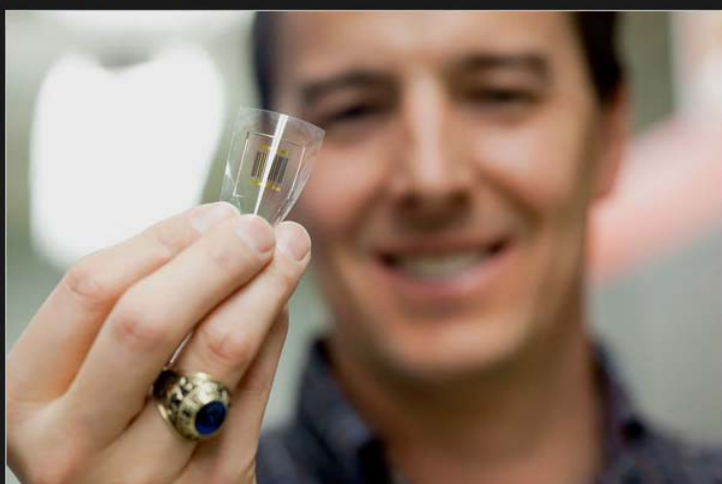

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John A. Rogers, a professor at the University of Illinois, Urbana-Champaign, and his team have developed a technology that allows photovoltaic cells used to collect solar energy to be printed on flexible materials.

Photo: Peter Wynn Thompson for The New York Times

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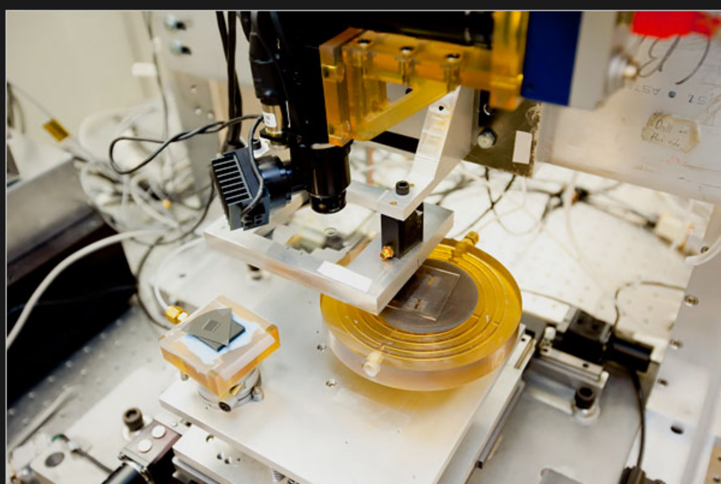

Traditional silicon solar cells are rigid, heavy and opaque, and widely used because they are reliable and efficient and silicon is abundant. But the brittleness of silicon limits its uses. Dr. Rogers has figured out how to grab thin layers of silicon or other semiconductors and print them on many kinds of materials.

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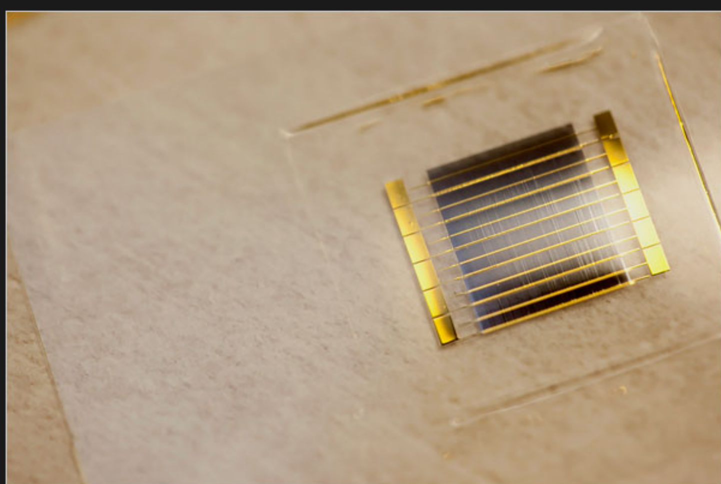

The flexible cells are a tenth of the thickness of standard cells, semi-transparent and might be printed on garments or affixed to automobile roofs or windows.

Photo: Peter Wynn Thompson for The New York Times

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The cells are so flexible that dense arrays of them can be wrapped tightly around a pencil or pen.

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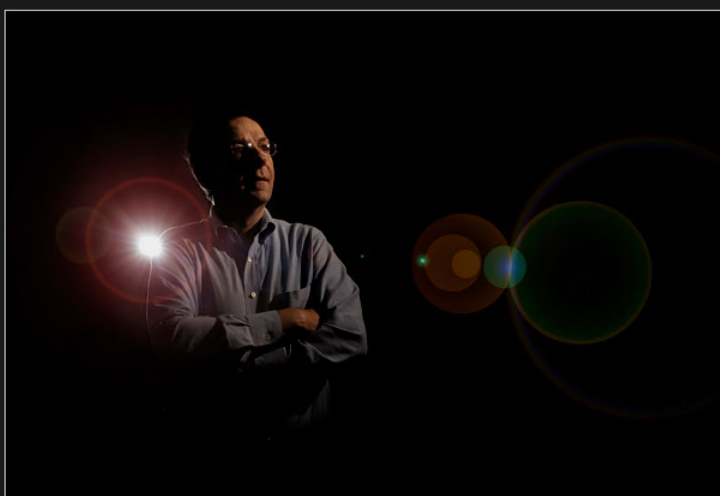

Joe Carr is the chief executive of Semprius, in Durham, N.C., which has licensed the printing technology developed by the team in Illinois.

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At Semprius, the solar cell printer is monitored by Tanya Moore.

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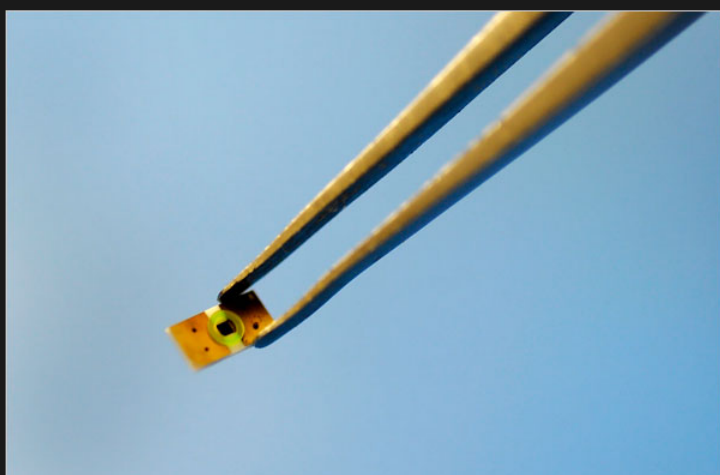

The printing technology at Semprius uses gallium arsenide as a semiconductor. It absorbs light energy more efficiently than silicon.

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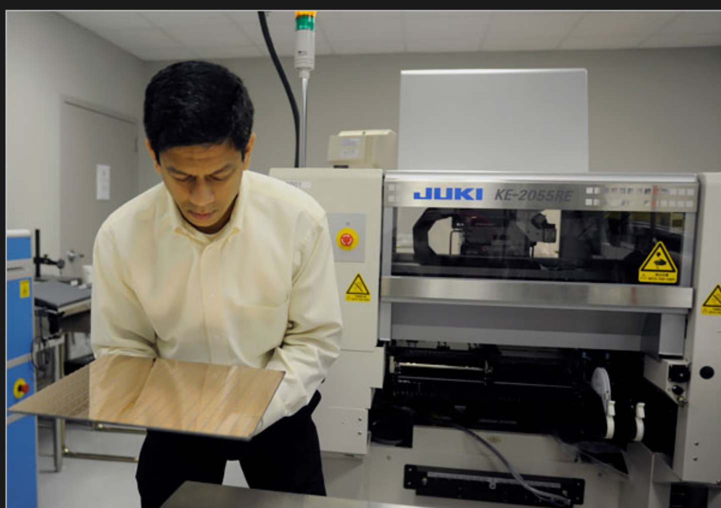

Kanchan Ghusal, a senior scientist at Semprius, inspects a copper-coated glass module arrayed with the tiny solar cells. The rigid collectors are intended for large installations.

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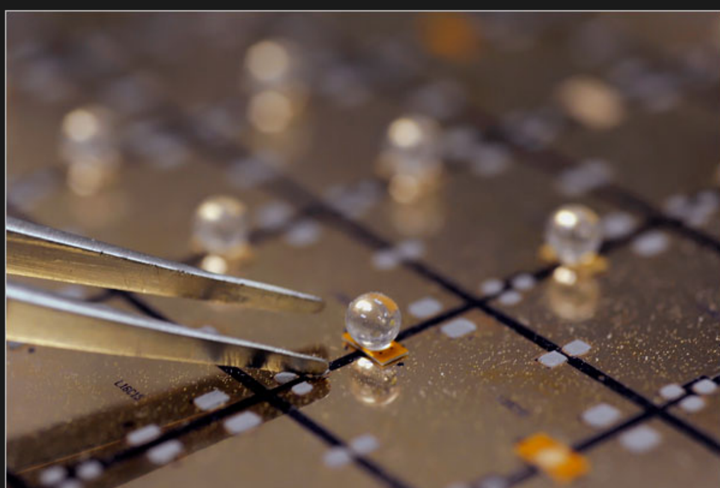

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Circular pieces of glass distribute the sunlight uniformly across the solar cell.

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