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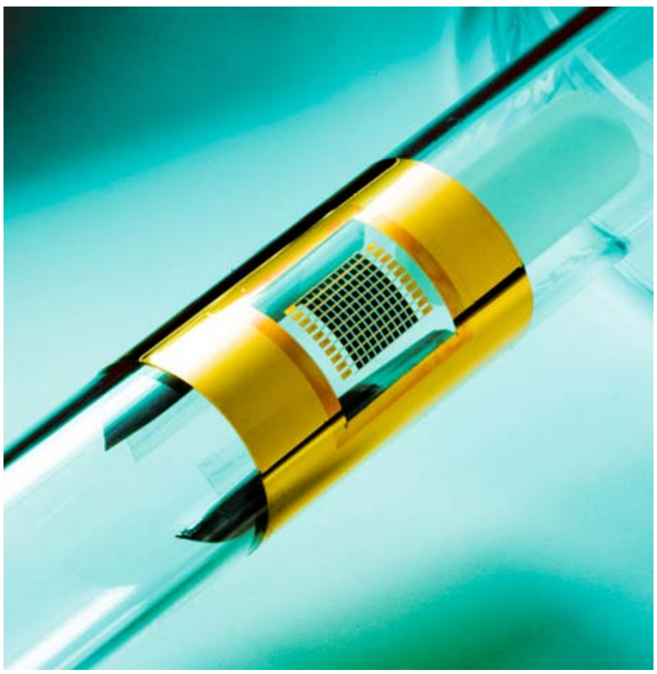

Photo: John Rogers/University of Illinois at Urbana-Champaign

FLEXIBLE PHOTOVOLTAIC: Transfer printing makes a 10-by-10 array of gallium arsenide solar cells on flexible plastic possible.

BY ARIEL BLEICHER // MAY 2010

19 May 2010—Researchers led by John Rogers at the University of Illinois at Urbana-Champaign have invented a cheaper way to build devices—including solar cells and infrared cameras—using highly efficient but notoriously pricey compound semiconductors. Their method, reported in the journal *Nature*, involves growing stacks of thin films of semiconductor, peeling off the films one by one, and printing them onto cheaper substrates, such as silicon or glass.

Silicon is the stuff of computer chips, but if you want to build the fastest transistor or the most efficient LED, compound semiconductors—such as gallium arsenide (GaAs) or gallium nitride—are your best bet. In solar cells, for instance, "gallium arsenide is more efficient than anything known to man," says Rogers, a materials engineer. Some GaAs solar cells can convert about 40 percent of the sun's energy into electricity, while silicon cells max out at about 20 percent efficiency.

The problem is that compound semiconductors are much more expensive than silicon. A 6-inch wafer of gallium arsenide costs about US $200, whereas a 200-millimeter wafer of silicon goes for roughly $40. So Rogers and his colleagues

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researched a new way to manufacture compound semiconductors and came up with a process that he says could make GaAs-based solar panels commercially competitive for utilities.

The process began with a wafer of GaAs, which the researchers placed in a chamber for growing films. But rather than grow a single layer on top of the wafer, they grew a multilayer tower, "like a stack of pancakes," Rogers says. The stack alternated between GaAs layers and aluminum arsenide (AlAs) layers. Later they etched away the AlAs layers using hydrofluoric acid, unbinding the GaAs films and making them easier to pick off and transfer to another substrate.

But handling these films—whose thicknesses range from a couple of hundred nanometers to a few micrometers—is no easy feat. "There's no good way to manipulate the material once you release it from the wafer," Rogers says. "If you try to manipulate the pancakes with tweezers or a robotic system, it's almost impossible to do without breaking them." So engineers typically avoid removing the film and build devices directly on the wafers.

Using the whole wafer rather than just the thin film on top poses two problems. First, because it's difficult to grow large high-quality wafers of compound semiconductors in a way that's cost-effective, they aren't manufactured bigger than six inches (15.25 centimeters) in diameter. This limits, for example, how big you can make solar cells. Second, wafers of compound semiconductors are much more expensive than the thin films needed to build the devices. Using a new wafer for each new set of devices quickly multiplies the cost of building them.

TAGS: GALLIUM ARSENIDE // SOFT LITHOGRAPHY // THIN FILMS

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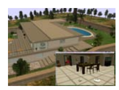

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Photo: John Rogers/University of Illinois at Urbana-Champaign

SCATTERED SOLAR CELLS: A new trick for forming thin films peels off piles of gallium arsenide solar cell chips.

BY ARIEL BLEICHER // MAY 2010

Rogers and his coworkers figured that if they could reuse the wafer to make subsequent stacks of films, they could drastically reduce material costs. They just needed a way to remove the films from the wafer without damaging them.

To do this, they used a printing technique Rogers calls "transfer printing," which he and his colleagues have been perfecting for about a decade. They took a specialized stamp made of soft rubber, which, when pressed onto a stack of GaAs films and quickly lifted, picks up only the top layer. They could then deposit the film onto any substrate, such as a sheet of plastic, by stamping the film onto the surface and peeling the rubber back very slowly, or sometimes by adding a little adhesive. They were then able to build devices—including transistors, solar cells, and infrared cameras—on the substrates, leaving the wafer intact and ready for a new batch of film.

"This is beautiful work," says Ali Javey, an assistant professor of electrical engineering at the University of California, Berkeley, who was not involved in the research. "It represents an important breakthrough for photovoltaics and optoelectronics." From a cost perspective, Javey says, "it makes gallium arsenide look very attractive for photovoltaics."

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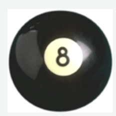
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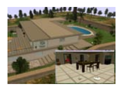

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