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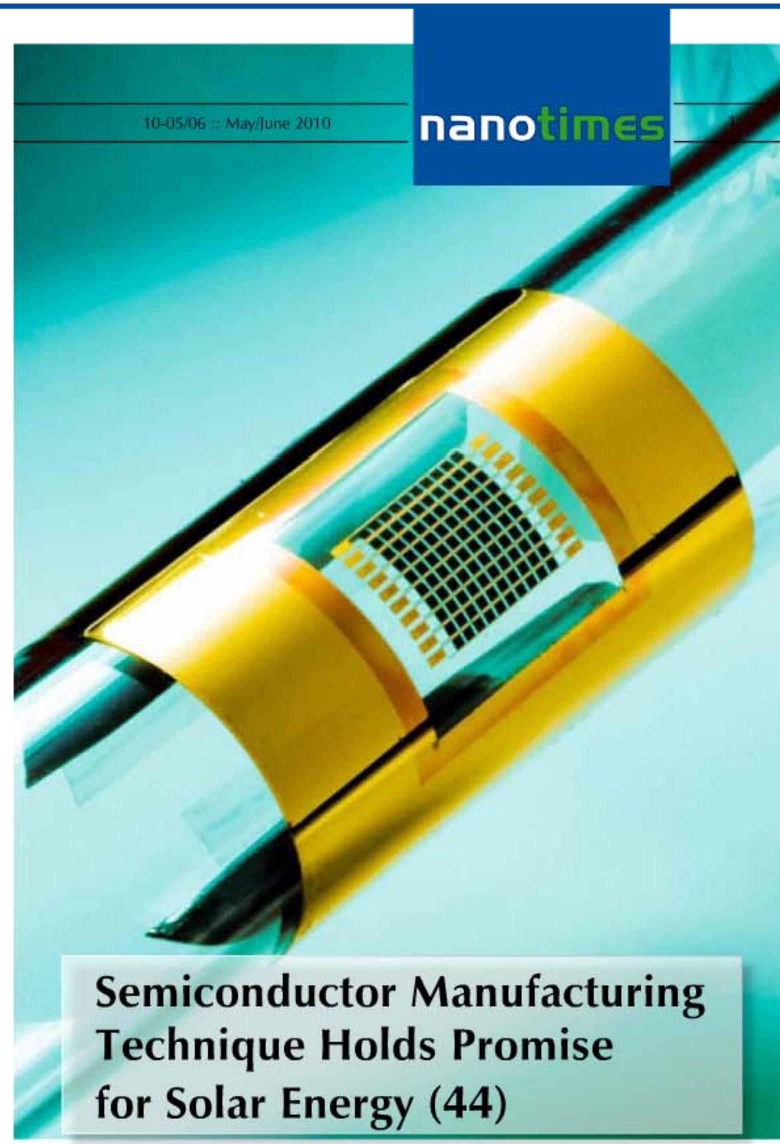

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Solar Energy //

Semiconductor Manufacturing Technique Holds Promise for Solar Energy

Researchers at **University of Illinois at Urbana-Champaign, USA**, **Semprius, Inc.**, and **Hanyang University, South Korea**, describe in the journal *Nature* materials and fabrication concepts for photovoltaics and optoelectronics, through the use of films of GaAs or AlGaAs grown in thick, multilayer epitaxial assemblies, then separated from each other and distributed on foreign substrates by printing.

University of Illinois professors **John Rogers** and **Xiuling Li** explored lower-cost ways to manufacture thin films of gallium arsenide that also allowed versatility in the types of devices they could be incorporated into.

"If you can reduce substantially the cost of gallium arsenide and other compound semiconductors, then you could expand their range of applications," said Rogers, the Lee J. Flory Founder Chair in Engineering Innovation, and a professor of materials science and engineering and of chemistry.

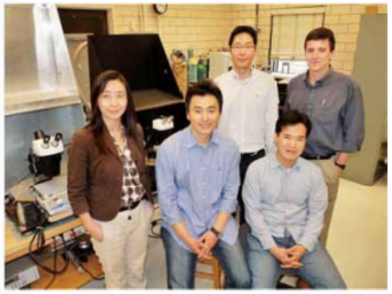
Typically, gallium arsenide is deposited in a single thin layer on a small wafer. Either the desired device is made directly on the wafer, or the semiconductor-coated wafer is cut up into chips of the desired size. The Illinois group decided to deposit multiple layers of the material on a single wafer, creating a layered, "pancake" stack of gallium arsenide thin films.

"If you grow 10 layers in one growth, you only have to load the wafer one time," said Li, a professor of electrical and computer engineering. "If you do this in 10 growths, loading and unloading with temperature ramp-up and ramp-down take a lot of time. If you consider what is required for each growth – the machine, the preparation, the time, the people – the overhead saving our approach offers is a significant cost reduction."

Next the researchers individually peel off the layers and transfer them. To accomplish this, the stacks alternate layers of aluminum arsenide with the gallium arsenide. Bathing the stacks in a solution of acid and an oxidizing agent dissolves the layers of aluminum arsenide, freeing the individual thin sheets of gallium arsenide. A soft stamp-like device picks up the layers, one at a time from the top down, for transfer to another substrate – glass, plastic or silicon, depending on the application. Then the wafer can be reused for another growth.

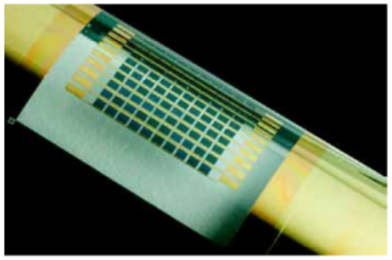
"By doing this we can generate much more material more rapidly and more cost effectively," Rogers said. "We're creating bulk quantities of material, as opposed to just the thin single-layer manner in which it is typically grown."

The group describes its methods and demonstrates three types of devices using gallium arsenide chips manufactured in multilayer stacks: **light sensors**, **high-speed transistors** and **solar cells**. The authors also provide a detailed cost comparison.



Illinois researchers have developed a more efficient, lower-cost method of manufacturing compound semiconductors such as gallium arsenide for many electronic device applications, including solar cells. The research team, from the left: professor Xiuling Li, student Ik Su Chun, postdoctoral researchers Sungjin Jo and Jongseung Yoon, and professor John Rogers. © Liz Ahlberg

A pile of gallium arsenide solar cells manufactured in stacks and then peeled apart layer by layer. They can be integrated into a number of electronic devices. © John Rogers



Bottom: A flexible array of gallium arsenide solar cells. Gallium arsenide and other compound semiconductors are more efficient than the more commonly used silicon. © John Rogers

Jongseung Yoon, Sungjin Jo, Ik Su Chun, Inhwa Jung, Hoon-Sik Kim, Matthew Meitl, Etienne Menard, Xiuling Li, James J. Coleman, Ungyu Paik & John A. Rogers: GaAs photovoltaics and optoelectronics using releasable multilayer epitaxial assemblies, In: *Nature*, Vol. 465(2010), Number 7296, May 20, 2010, Pages 329-333, DOI:10.1038/nature09054:
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