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Semiconductor Manufacturing Technique

Holds Promise for Solar Energy

Researchers at University of Illinois at UrbanaChampaign, USA Semprinus, Inc., and Hanyang University, South Korea, described in the present.

Nature materials and fabrication concepts for photonics and optoelectronics, through the use of films of GaAs or AlGaAs grown in thick, multilayer optical assemblies, than 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. Byerly 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 semiconductorcreated wafer is cut up into chips of 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 once,” said Li, a professor of chemical and biomolecular engineering. “If you can do 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 water 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.

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

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