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CURRENT NEWS

Sandwich Solar Cells May See Off Silicon

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A new manufacturing technique which involves growing alternate layers of gallium arsenide (GaAs) and aluminium arsenide (AlAs) will provide low-cost manufacturing of compound semiconductors used in many electronic devices.

Illinois researchers have developed an efficient, low cost method of manufacturing compound semiconductors such as gallium arsenide (GaAs).

The current industry standard used in most electronic devices, including the photovoltaic (PV) cells are based on silicon. However, alternatives such as GaAs and other compound semiconductors offer nearly twice as much efficiency when converting sunlight into energy, but with substantial manufacturing costs.

University of Illinois professors John Rogers and Xiuling Li explored low cost ways to manufacture thin films of GaAs that also allowed versatility in the types of devices they could be incorporated into. “If you can reduce substantially the cost of GaAs and other compound semiconductors, then you could expand their range of applications,” said Rogers.

Typically, GaAs 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 GaAs 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 aluminium arsenide (AlAs) with the GaAs. Bathing the stacks in a solution of acid and an oxidizing agent dissolves the layers of aluminum arsenide, freeing the individual thin sheets of GaAs. 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.”

Freeing the material from the **wafer** also opens the possibility of flexible, thin-film electronics made with gallium arsenide or other high-speed semiconductors. “To make devices that can conform but still retain high performance, that’s significant,” Li said.

In a paper published online in the journal Nature, the group describes its methods and demonstrates three types of devices using GaAs chips manufactured in multilayer stacks: light sensors, high-speed transistors and solar cells. The authors also provide a detailed cost comparison.

Another advantage of the multilayer technique is the release from area constraints, especially important for solar cells. As the layers are removed from the stack, they can be laid out side-by-side on another substrate to produce a much larger surface area, whereas the typical single-layer process limits area to **wafer** size.

“For photovoltaics, you want large area coverage to catch as much sunlight as possible. In an extreme case we might grow enough layers to have 10 times the area of the conventional route,” Rogers said.

“You really multiply the area coverage, and by a similar multiplier you reduce the cost, while at the same time eliminating the consumption of the **wafer**,” he said.

Among the paper’s co-authors are two scientists from Semprius, a North Carolina-based startup company that is beginning to use this technique to manufacture solar cells. A shift from silicon-based panels to more efficient GaAs models could make solar power a more cost-effective form of alternative energy.

The group now plans to explore more potential device applications and other semiconductor materials that could adapt to multilayer growth.

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