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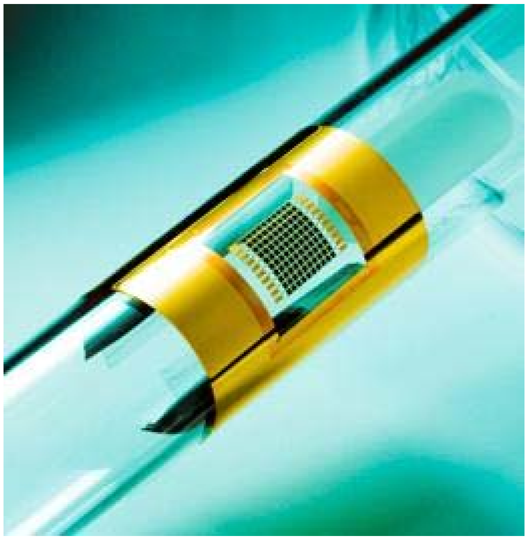
News

Solar cells sliced and diced

Peel-and-stamp technique could pave the way for more efficient semiconductors.

Geoff Brumfiel

An alternative method of making light-sensitive semiconductors could lead to high-efficiency solar cells, better night-vision cameras and a host of other applications, according to research published in this week's issue of *Nature*[1].



Gallium arsenide solar cells can be produced using a peel-and-stamp technique.

A team led by John Rogers, a materials scientist at the University of Illinois at Urbana-Champaign, has developed a potentially cost-effective technique to produce microchips made of the semiconductor gallium arsenide, which responds well to light. A transfer-printing technique is used to peel and print thin layers of the semiconductor onto glass or plastic, which by overcoming a long-standing problem in gallium arsenide manufacturing could transform the solar-cell industry.

Silicon is the workhorse of the modern semiconductor industry and is used in everything from solar cells to digital cameras. But for decades, scientists have known that when it comes to capturing light, there are better materials out there. Certain types of semiconductors can absorb light much better than silicon, so make better solar cells and infrared-detection devices.

Gallium arsenide is one of the most studied silicon alternatives. It can theoretically convert about 40% of incident solar radiation to electricity, making it twice as effective as silicon. Its efficiency makes gallium arsenide the material of choice for building solar cells for spacecraft.

But like its best applications, the price of gallium arsenide is sky-high. According to Rogers, this is partly because high-quality wafers of gallium arsenide must be grown in carefully controlled chambers. Once grown, the thick wafers are typically sliced up, but only their surfaces are used. Much of the costly material is essentially wasted, says Rogers.

Semiconductor pancake

Now Rogers and his colleagues have found another way[1]. Rather than growing a single gallium arsenide layer, the team grew a 'pancake' of alternating layers of gallium arsenide and aluminium arsenide. Then, using careful sequence of chemicals the team was able to loosen the individual gallium arsenide layers and peel them off with a silicon-based rubber stamp. They stamped the wafers onto another surface, such as glass or plastic, and then etched the thin slices into circuits using more established techniques.

The team was able to mass-produce very small solar cells, each around 500 micrometres wide, infrared-imaging devices and certain components for mobile phones. Several co-authors on the paper are involved in the start-up company Semprius that aims to use the technique to make gallium arsenide electronics more affordable. "We believe that this kind of approach can be competitive on a cost basis with anything out there," says Rogers, who sits on the company's board of directors.

The researchers were able to mass produce very small solar cells.

"What they've done is very impressive," says Gerard Bauhuis, a materials scientist at Radboud University in Nijmegen, the Netherlands. But Bauhuis says that the team's technique can't make circuits that are more than a few-hundred micrometres in size — too small for typical solar cells. More work will need to be done to see whether the peel-and-stamp system can be used to make large sheets, several centimetres square, he says.

Bauhuis, whose lab has its own start-up company called tf2 devices that also aims to produce high-efficiency solar cells, says that gallium arsenide electronics are close to becoming competitive. "In the coming two to five years, it will be decided if this is a feasible route," he says.

Rogers agrees that gallium arsenide shows great potential. His lab is now working on developing solar cells that can generate electricity at around US$1 per watt, which would make it commercially attractive. "We think we can get there," he says, "But it's not really proven until you actually go and do it."

References

1. Yoon, J. *et al. Nature* **465,** 329-333 (2010).

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The production of Gallium arsenide solar cells with peel and stamp technology is quite interesting as roger reports but still cost and production of large cells is still challenging.
I think if we do something in computer based technology where drawing of circuits can be printed using gallium arsenide as ink on plastic sheet. **#10666**

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This is indeed a breakthrough Technology for wider utilisation of Solar Energy. The main drawback with present PV of silicon and Amorphous is its low efficiency. As such it requires large area of solar panels. Gallium arsenide,gallium phosphide,tandem,organic,polymer cells come into market then PV utilisation will pickup. There are two ways to make systems cost effective. One is large production and another is increasing the efficiency. **#10715**

Gallium arsenide (GaAs) is a compound of the elements gallium and arsenic. It is a III/V semiconductor, and is used in the manufacture of devices such as microwave frequency integrated circuits, monolithic microwave integrated circuits, infrared light-emitting diodes, laser diodes, solar cells, and optical windows. The IUPAC name "Gallium arsenide" is only applicable as a structurally descriptive name when gallium arsenide is in the gaseous phase; in the solid phase it polymerises into a macromolecule similar to silicon dioxide.

GaAs advantages
GaAs has some electronic properties which are superior to those of silicon. It has a higher saturated electron velocity and higher electron mobility, allowing transistors made from it to function at frequencies in excess of 250 GHz. Unlike silicon junctions, GaAs devices are relatively insensitive to heat. Also, GaAs devices generate less noise than silicon devices when operated at high frequencies. They can also be operated at higher power levels than the equivalent silicon device because they have higher breakdown voltages. These properties recommend GaAs circuitry in mobile phones, satellite communications, microwave point-to-point links, and some radar systems. It is used in the manufacture of Gunn diodes for generation of microwaves.
Another advantage of GaAs is that it has a direct band gap, which means that it can be used to emit light efficiently. Silicon has an indirect bandgap and so is very poor at emitting light. Nonetheless, recent advances may make silicon LEDs and lasers possible. As a wide direct band gap material with high breakdown voltage, and resulting resistance to radiation damage, GaAs is an excellent material for space and optical windows in high power applications.
Because of its wide bandgap, pure GaAs is highly resistive. Combined with the high dielectric constant, this property makes GaAs a very good electrical substrate and unlike Si provides natural isolation between devices and circuits. This has made it an ideal material for microwave and millimeter wave integrated circuits, MMICs, where active and essential passive components can readily be produced on a single slice of GaAs.

Dr.A.Jagadeesh Nellore(AP),India

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