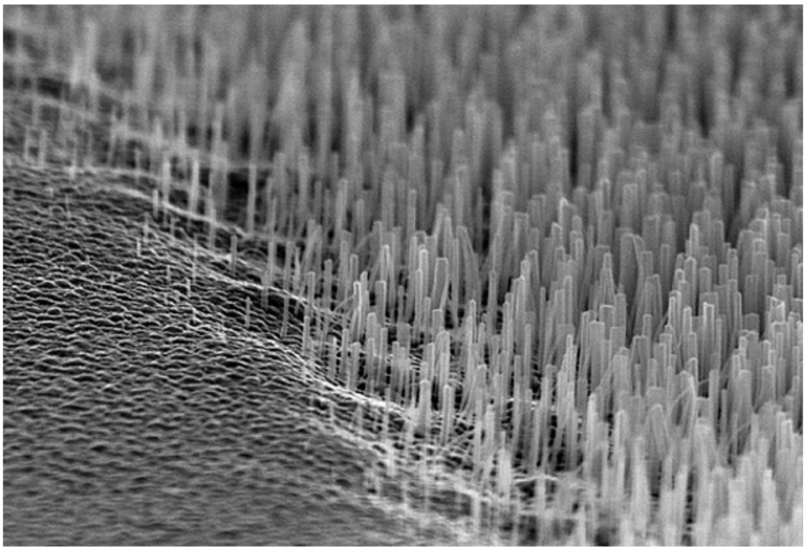
How to Double the Power of Solar Panels



In an attempt to further drop the cost of solar power, Bandgap Engineering [1], a startup in Woburn, Mass., is developing a nanowire-based solar cell that could eventually generate twice as much power as conventional solar cells.

That's a long-term project, but meanwhile the company is about to start selling a simpler version of the technology, using silicon nanowires that can improve the performance and lower the cost of conventional silicon solar cells. Bandgap says its nanowires, which can be built using existing manufacturing tools, boost the power output of solar cells by increasing the amount of light the cells can absorb.

Right now most solar-panel manufacturers aren't building new factories because the market for their product is glutted. But if market conditions improve and manufacturers do start building, they'll be able to introduce larger changes to production lines. In that case the Bandgap technology could make it possible to change solar cells more significantly.

For example, by increasing light absorption, it could allow manufacturers to use far thinner wafers of silicon, reducing the largest part of a solar cell's cost. It could also enable manufacturers to use copper wires instead of more expensive silver wires to collect charge from the solar panels.

These changes could lead to solar panels that convert more than 20% of the energy in sunlight into electricity (compared with about 15% for most solar cells now) yet cost only $1 per watt to produce and install, says Richard Chleboski, Bandgap's CEO. (Solar installations cost a few dollars per watt now, depending on their size and type.) Over the operating lifetime of the system, costs would come to $0.06-0.10 per kilowatt-hour.

That's still higher than the current cost of natural-gas power in the United States, which is about $0.04 per kilowatt-hour. But it's low enough to secure solar power a substantial market in many parts of the world where energy costs can be higher, or in certain niche markets in the United States.

Meanwhile, Bandgap is pursuing technology that could someday improve efficiency enough to allow solar power to compete widely with fossil fuels. Double the efficiency of solar cells without greatly increasing manufacturing costs, and you substantially lower the cost per watt of solar panels and halve the cost of installation — currently the biggest expense in solar power — by making it possible to get the same amount of power out of half as many cells.

Both the cells Bandgap is about to introduce and the cells it hopes to produce in the long term are based on the idea of minimizing the energy loss that typically occurs when light passes through a solar cell unabsorbed or when certain wavelengths of light are absorbed but don't have enough energy to dislodge electrons to create electricity. (That energy is wasted as heat.) In a conventional solar cell, at least two-thirds of the energy in sunlight is wasted — usually much more.

The company's existing technology makes use of the fact that when light encounters the nanowires, it's refracted in a way that causes it to bounce around in the solar cell rather than simply moving through it or bouncing off it. That increases its chances of being absorbed.

But what Bandgap ultimately wants to do is to change the way light is converted to electricity inside the cell. If the nanowires can be made uniformly enough, and if they can be formed in such a way that their atoms line up along certain planes, the tiny structures could change the electronic properties of silicon.

These changes could allow solar cells to generate electricity from low-energy light that normally produces only heat, says Marcie Black, the company's founder and chief technology officer. It does this in part by providing a way to combine energy from more than one photon of low-energy light.

The technology could take many years to develop. For one thing, it requires very precise control over the properties of each of millions of nanowires. Also, the techniques needed to make the solar cells might not be cheap or reliable enough to produce them on a large scale. But such solar cells could theoretically convert 60% of the energy in sunlight into electricity. That will be hard to achieve in practice, so the company is aiming at a more modest 38% efficiency, which is still more than twice that of typical silicon solar cells made now.

Researchers are taking several other approaches [2] to producing very high-efficiency solar cells, such as using quantum dots or combining several kinds of materials [3].

The nanowire technology could be simpler, however. "In theory, the approach has many potential advantages, but you've got to get it to work," says Andrew Norman, a senior researcher at the National Renewable Energy Laboratory in Golden, Colo.

Bandgap hasn’t yet built solar cells using the approach it hopes to pursue in the long term, but it’s made indirect measurements showing that its nanowires can change the electronic properties of silicon. “This is still in the research phase,” Black says. “We’re being very honest with investors — there’s still a lot of work to do.”

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