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Alta Devices Breaks Solar-Cell Record

Silicon Valley startup gives details about its technology for making highly efficient yet inexpensive solar cells.

By Kevin Bullis

A startup that has been working in stealth mode for several years says it has achieved a record solar-cell efficiency of 28.2 percent, nearing the theoretical maximum of 33.5 percent. The mark is roughly 2 percentage points higher than a record set last year—a major advance in an industry that typically measures improvements in tenths of a percent. Alta Devices, founded in 2007 and based in Santa Clara, California, says its innovative techniques lend themselves to large-scale manufacturing.

Improving efficiency is essential if solar power is to be competitive with fossil fuels. Increasing the power output of individual solar cells reduces the number of cells needed per installation and also cuts the cost of things such as installation, wiring, and electronics for connecting the panels to the grid.

Alta Devices researchers worked with gallium arsenide to improve inherent properties that make it "almost an ideal solar-cell material," says Harry Atwater, a professor of applied physics at Caltech and cofounder of the company. When a solar cell absorbs sunlight, some of the energy in the sunlight generates electrons that are quickly extracted from the cell to make electricity. If the electrons are not extracted fast enough, they decay, releasing their energy as either heat or light. Losing the energy as heat reduces both the voltage and the amount of current the cell can make, reducing power output. But if the electron instead produces light, the light can be reabsorbed by the solar cell to generate another electron, providing another chance for the energy in sunlight to become electricity.

In gallium arsenide, almost all of the electrons produce light rather than heat. In the highest-quality examples of the material, the cycle of light production and reabsorption can happen 100 times per incoming photon, providing a high probability that an electron produced will eventually be extracted to generate electricity. To achieve its record solar-cell efficiency, Alta Devices researchers developed chemical treatments for cracks in the material, which otherwise have a tendency to trap electrons and cause them to release their energy as heat. They also worked to improve a surface at the back of the cell to ensure that photons generated are reflected back into the material, thereby increasing the probability that they will generate electricity.

Significantly, the researchers were able to achieve high efficiency with techniques that Atwater says could be used in inexpensive manufacturing. Gallium-arsenide solar cells have been expensive to produce because they are made of very high quality wafers of the semiconductor, similar to those used in computer chips. To cut costs, Alta Devices is using a technique called epitaxial liftoff, an early version of which was pioneered by Alta Devices cofounder Eli Yablonovitch in the

1980s. In the current version of the technique, the wafer is used as a template for growing very thin layers of crystalline material to form a solar cell. These layers are then freed from the wafer with chemical etching and lifted off, allowing the wafer to be used again.

Atwater says the company is working to improve epitaxial liftoff and to develop better ways to grow the crystalline layers on the wafer. The current method, called chemical vapor deposition, is too slow to make cheap solar cells.

The high-efficiency cells Alta Devices has produced are small, one-off devices. The company's larger solar modules have lower efficiency—about 21 percent. Typically as companies switch to high-throughput production, efficiencies drop by several points. Alta Devices also needs to demonstrate that the high-efficiency cells will last for decades when exposed to the elements without a significant degradation of their performance.