Twin Creeks Unwraps New Tool, Process to Slash Silicon Solar PV Costs

A startup company has emerged from stealth mode with a new technology that promises to radically change the game for silicon solar photovoltaics (PV) manufacturing, by taking out almost all the starting material and up-front process costs.

Progressing further toward the goal of "grid parity" means continually refining all steps along the solar supply chain, from manufacturing to balance-of-systems. For silicon-based solar PV manufacturing, costs on the materials alone (silicon, process gases, silver paste, encapsulants, etc.) can be $0.60/Watt. One dollar per watt for solar, fully installed, is held up as the ultimate grid-parity goal — but that's still a long way off, and costs have to come down a lot more both in manufacturing and balance-of-systems. Some companies have figured the best way to reduce costs is by using less starting material. Today's conventional silicon-based solar PV manufacturing still means sawing silicon ingots into wafers 150 to 200 microns thick. This creates issues of kerf loss (material lost as sawdust) and wafer fragility, and requires the need to prep the new wafer's surface for following solar-cell creation steps. Some efforts (e.g. SiGen and 1366 Technologies) have sought new ways to significantly eliminate more silicon processing and end up with slices tens of microns thick; most are still in pilot or lab stages.

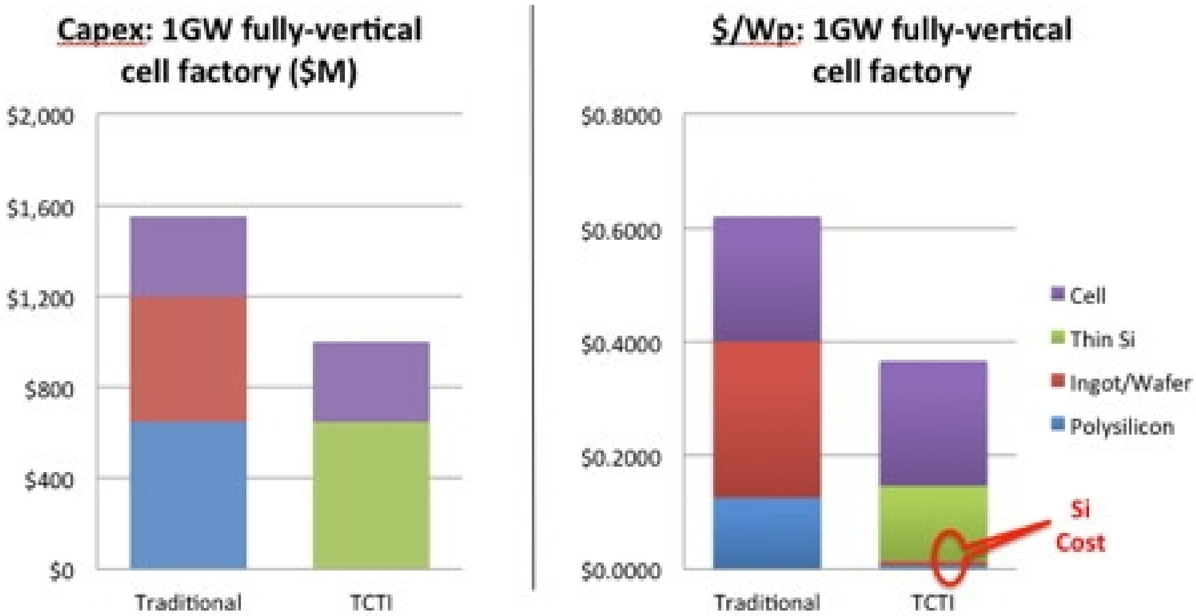
Enter startup Twin Creeks Technologies. The company was formed in 2008 and made headlines in 2010 by announcing plans to build a $175 million, 100-megawatt (MW) plant in Senatobia, Miss., where it would make lower-cost solar panel technology. Then it went back into stealth mode and hasn't been heard from since, except for some tantalizing patent information which revealed a direction into solar photovoltaic (PV) manufacturing equipment. Still, it's managed to raise a total of $93 million in equity from a handful of backers including Crosslink Capital and DAG, and another $50 million from the State of Mississippi to help establish the factory, of which only $30 million has been drawn down, says CEO Siva Sivaram.

Today, the company has decloaked with its technology called "proton induced exfoliation." It's based on a phenomenon first noticed decades ago in Soviet nuclear reactors whose inner walls were peeling away due to bombardment and accumulation of protons just under the surface, according to Sivaram. Twin Creeks' version operates in the same way: their tool, dubbed Hyperion, shoots hydrogen atoms into a thick piece of silicon at high current and high voltage where they embed at a fixed depth and form microbubbles; when heated, a layer of material is cleaved off. (The hydrogen atoms [protons] aren't preserved in the lattice structure of the silicon so there's no damage.) The result is a superthin 20-micron skin of silicon, created with zero kerf loss, and reducing by 90 percent the amount of silicon content processed. "All you really need is under 30 microns" of silicon material for current collection, explains Sivaram; the rest is mainly for mechanical support and no longer necessary.

Meet the Hyperion 3. Note for scale the computer & desk alongside.
The large beams on top of the tool are actually a special crane-lift rig necessary for such a giant piece of equipment. (Source: Twin Creeks Technologies)

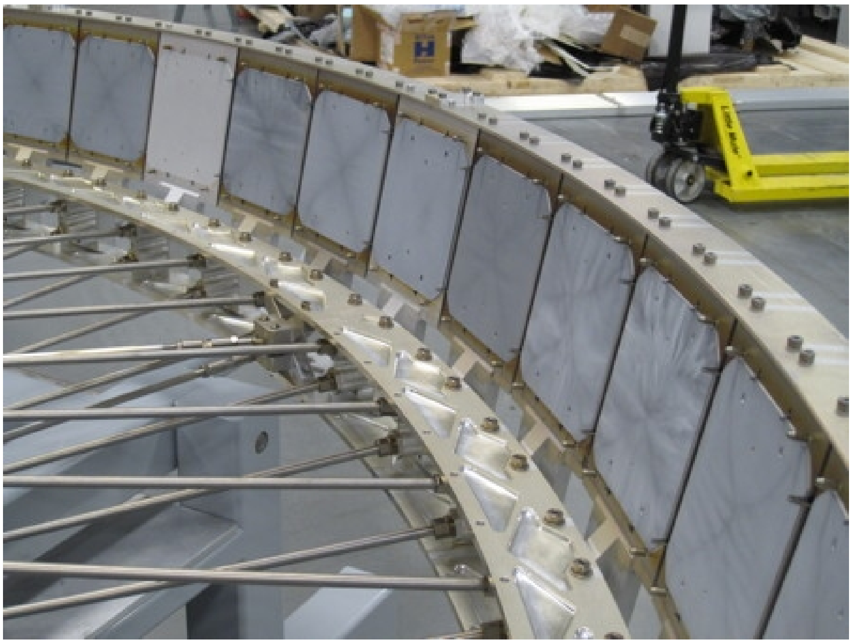
That impressive reduction in silicon usage has a cascading effect on reducing costs all along the solar PV manufacturing process, from other steps that can be dialed back or even eliminated (forming, shaping, resizing and texturing silicon) to reduction in other materials used (e.g. less silver paste). And getting wafer thinness down to around 20 microns has another benefit: the monocrystalline wafer is actually flexible, so all it needs is a good laminate to make modules, without all the rigid glass and EVA encapsulants or other expensive backings. All that adds up to eliminating as much as 50 percent of a cell/module makers' capital spending costs ("capex"), or several dozen pieces of equipment, in a typical 100-MW solar manufacturing line. (That doesn't include possible savings on the balance-of-systems side too. For example, new racking and wiring schemes that don't have to deal with heavy glass-sandwiched modules.)

"We can make less than $0.40/W cells today," Sivaram says, with $0.20/W for silicon and just $0.20/W for processing. Today's rooftop solar PV panels take two years to pay back the power used to create them, he points out; "we can do it in 25 days."



Another benefit of this technology is that it doesn't drastically change how a cell/module manufacturer operates, notes Sam Jaffe, research manager, distributed energy strategies at IDC Energy Insights. "It's a hard sell to convince the major solar cell producers to replace entire manufacturing processes, start from scratch and do things differently," he said. "That's not how mature industries work. You have to come up with a drop-in improvement and innovate that way. That's what this technology has going for it." Sivaram acknowledges that some tools in tangential PV manufacturing steps (wet station, screen printing, PECVD, metallization) will need some minor modifications, such as temporary handlers to be automatically attached and removed, but "it's something the equipment companies know how to do and work with us to make it happen."

The company has stealthily refined two generations of its Hyperion technology, and now a third-gen Hyperion tool offers equivalent output of 6 MW of cells/modules per year (improved from 750 kW and 3 MW in the previous two versions), and the company expects to improve Hyperion's output to 10MW/year within the next 12 months. Two of these monsters — each is 350 sq. ft., the size of a New York City studio apartment — are on the company's factory floor in Mississippi, a 25-MW production line which Sivaram describes as a "living lab" where prospective customers can come kick the proverbial tires, define and run their own solar-cell processes and "see for themselves" how it works, then take the results back to their own factories. A 100MW solar PV line would need ten of these 10-MW tools, and a gigawatt-sized factory would have 100 of them. But even that level of investment would still end up cutting a solar manufacturer's capex in half, the company points out.



Wafers being processed in the Hyperion 3 tool. (Source: Twin Creeks Technologies)

Twin Creeks claims to be "very far into conversations for signing MOUs" (essentially "gentleman's agreement" preliminary to a formal contract) with a number of top-10 solar cell producers both overseas and domestic. "We're not spending any time with non-top-10 customers," Sivaram indicated.

Beyond c-Si solar PV, the company sees opportunities elsewhere in solar, from building-integrated applications where flexible, lightweight solar cells and packaging are key, to gallium arsenide (GaAs) and germanium (Ge) substrates for higher-efficiency and concentrated solar PV applications. The technology also can work with other crystalline substrate materials, which will eventually open up eventual inroads into industries outside of solar: gallium nitride (GaN) for light-emitting diodes (LED), silicon carbide (SiC) for power electronics, and other silicon-based processes for CMOS sensors, 3D packaging and interposers for semiconductors.

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Posted by Janine E. Mooney, Editor

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