Q-Cells: Only four horses left in the race

Norbert Michalke / photon-pictures.com

Sontor GmbH

▲▲Sontor, Solibro or Calyxo: Somehow, all the modules look the same – rectangular, black and reflective. Even parent company Q-Cells can't quite choose which is the technology of the future.

▲ Turnkey-based: Sontor GmbH will expand using turnkey production lines – here, a peek at the current production facility. Naturally, research is continuing, with support from experts at Research Center Jülich (FZJ), among others.

Q-Cells SE holds shares in five different thin-film manufacturers: Calyxo GmbH, CSG Solar AG, Solibro AB, Sontor GmbH and VHF-Technologies SA (Flexcell). As the reigning world champion in crystalline solar cell production, Q-Cells is betting on five horses in the same race: amorphous, micromorphous and multicrystalline silicon, copper indium gallium diselenide (CIGS), and cadmium telluride (CdTe) – in other words, on all of the common thin-film technologies, as well as an exotic choice in the form of multicrystalline thin-film silicon. Q-Cells CTO Florian Holzapfel still can't say which of the technologies has the best odds: »It's maybe not possible to get a clear winner,« said the CTO in mid-November at a thin-film conference. Michael Bauer, commercial manager at Calyxo and director of the thin-film business development, stated things more specifically at PHOTON's Thin-Film Conference in early December in San Francisco: »It is really hard to say at the moment, I think we have to wait until next year.« However, one thing has already become clear since the end of December: the company has given up its hopes for one of its thin-film technologies.

According to information from the German newspaper Financial Times Deutschland, CSG Solar, the multicrystalline thin-film module producer in which Q-Cells holds 20 percent, ceased production just about a month after Holzapfel's claim that the race between the various technologies was still undecided. As the newspaper reported in its online edition on Dec. 23, the Thalheim-based company is dismissing 124 of its 164 employees, while the remaining quarter will refocus their efforts on research.

The reason can hardly be a »decrease in demand for solar modules,« as the newspaper assumed, and it's certainly not a side effect of any »crisis within the solar energy business.« It's possible that the financial crisis, which forced Q-Cells in mid-December to issue an unexpected profit warning, could be behind the halt in production. But in the recent past, there have been several signs that the future wouldn't shine brightly for CSG's technology: the constant delays and problems with production ramp-up, co-founder and CTO Paul Basore's jumping ship to become co-partner at Renewable Energy Corp. ASA (REC), and an announcement by Q-Cells regarding the next expansion stage for its thin-film subsidiaries that failed to mention CSG.

Apparently, this is the result of »proactive portfolio management,« a strategy that, according to Holzapfel, will ensure that only the company's best thin-film investments move forward. Still, Q-Cells has high hopes for the remaining four technologies.

The break-even point for a 25 MW thin-film factory could be reached with the following efficiencies: 8.5 to 9.5 percent for CIGS, 7.5 percent for micromorphous modules and 6 percent for CdTe modules. CIGS modules today already have efficiencies of 12 percent, whereas micromorphous products have achieved 7.5 percent and CdTe modules 6 percent, says Holzapfel. »This makes us confident that our investments will work,« sums up Q-Cells' head of technology.

The candidates

Sontor: The German company's only 100-percent subsidiary is Sontor GmbH, which produces solar modules based on micromorphous silicon cells – tandem cells with a layer of amorphous and a layer of microcrystalline silicon. The core of the production facility is a plasma-enhanced chemical-vapor deposition (PECVD) system. Sontor developed the process together with Research Center Jülich (FZJ) and Alzenau, Germany-based production system manufacturer Applied Films GmbH & Co. KG, which now belongs to Applied Materials Inc. Michael Bauer says the next expansion stage from 25 MW to 120 MW will make use of a turnkey production line. Module efficiencies for this technology run between 7 and 8 percent. According to Q-Cells' last quarterly report, Sontor GmbH holds 100 percent of operationally inactive Sontor Schweiz AG. But on Sept. 17, 2008, the latter founded Sontor Mèxico SA de CV and Sontor Servicios SA de CV in Mexicali, Mexico. Although Q-Cells hasn't made a final announcement about the location for Sontor's production facility, it appears that the first choice is Mexico.

Calyxo: Q-Cells' second largest investment, holding 93 percent of the shares, is Calyxo GmbH. The remaining 7 percent belongs to technology start-up Solar Fields Inc., which was founded by American glass pioneer Harold McMaster just before his death in 2003. McMaster was the father of the CdTe processes used by market leader First Solar Inc. and had begun working with Solar Fields on the further development of the process that

allows the deposition of CdTe at atmospheric pressure. This would eliminate the need for expensive vacuum systems for depositing absorbers. With a current module efficiency (in terms of active surface) of 6 percent and a laboratory efficiency of 12 percent, there's still much room for improvement. First Solar's commercially available CdTe modules already have efficiencies of around 11 percent.

Solibro: Q-Cells AG also has CIGS modules in its portfolio. The process technology comes from Solibro AB, a spin-off of the Ångström Solar Center at Uppsala University in Sweden. The companies jointly established the German Solibro GmbH, in which Q-Cells holds a 67.5-percent majority share. The present pilot line in Uppsala, Sweden, is located at a development center that is a 100-percent subsidiary of Solibro GmbH. In 18 months, production capacity should increase from 30 MW to 45 MW at the first factory and to 90 MW at the second facility, says Solibro CEO Johannes Segner.

Flexcell: Q-Cells is not only investing in technologies using rigid substrates, but is also interested in flexible solar modules, shown by its joint venture VHF-Technologies SA (Flexcell). Q-Cells holds a 58.1-percent share in the Swiss company, the remainder is owned by luxury goods producer Richemont SA and South African investment company Venfin Ltd. The technology for the modules was developed at the Institute of Microtechnology (IMT) at the University of Neuchâtel, Switzerland, the same laboratory to which Oerlikon Solar owes its knowledge of amorphous and micromorphous process technology.

But the solar modules have a very low efficiency of just 3 percent. Since the modules are very light – just 2 to 7 kg per m^2 – they can be used in applications with less stable substructures such as curved roof tiles or corrugated iron roofs. »Most likely there will be a market for each of the PV technologies,« says Holzapfel.

CSG: German company CSG Solar AG was Q-Cells' first thin-film investment and also its first investment in an external company. Q-Cells holds a 18.63 percent share, the remaining shares belong to Norway's REC, Swiss company Good Energies Inc. and German investment company Apax, among others. CSG is the only company worldwide to use thin layers of multicrystalline silicon for light absorption. Although the process is very expensive, CSG has barely achieved module efficiencies of 6 percent. Similar efficiency levels can be achieved with considerably less effort by using amorphous silicon. Since 2007, the company has manufactured small quantities of modules, but has never been able to use the entire 25 MW capacity of its production line. Whereas its predecessor Pacific Solar, which

text continues on p. 117

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▲ Following in the steps of First Solar: Calyxo GmbH uses the same base material as the thin-film world's market leader. That alone won't be enough, since the company's current module efficiency levels are far too low.

▲ Products for a niche market: With just 3-percent module efficiency, the amorphous thin-film modules from VHF-Technologies SA (Flexcell) aren't well-suited for PV power plants. But the solar plastic foils are flexible and potentially very inexpensive to produce.

Q-Cells' thin-film portfolio

Sontor

Q-Cells' share: 100 percent
Founded: 2007
Location: Thalheim, Germany
Technology: Micromorphous silicon
At first, a transparent conductive oxide (TCO), which serves as the front contact is deposited onto a clean glass substrate. Afterwards the amorphous and micromorphous silicon cells are deposited by plasma-enhanced chemical-vapor deposition (PECVD). Each of these consist of three differently doped layers (pin-structure) and allow the absorption of both visible and near infrared sunlight. The back contact forms a double layer consisting of TCO and a metallic reflector. The solar cells are integrated monolithically by laser scribing during production. The modules are laminated with an encapsulation foil and a second pane of glass.
Production equipment:
Applied Films
Cell efficiency:
Up to 12 percent
Module efficiency:
7 to 8 percent
Costs:
No information
Capacity 2008:
25 MW
Employees: 90
Expansion goal:
120 MW
Certification:
IEC 61646, IEC 61730 (in process)
Finances:
Capital secured for next expansion stage

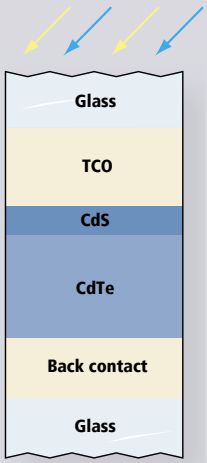
Sontor
module structure

»Second Solar« factor:
Sontor is the only Q-Cells thin-film subsidiary that plans to expand with turnkey production lines. Currently, there are two vendors for the technology Sontor has selected: Oerlikon and Applied Materials. Thus, the company's chances for successfully producing competitive modules are rather high. But that won't give Sontor a competitive edge – the company will likely still compete with the broad masses. Cooperation with the Research Center Jülich (FZJ) could give it the decisive advantage; researchers from FZJ are important players in the world of amorphous and micromorphous technology – and so, perhaps Sontor will become a player, too.

Calyxo

Q-Cells' share: 93 percent
Founded: 2005
Location: Thalheim, Germany
Technology: Cadmium telluride
The module structure in Calyxo's CdTe technology consists of a glass substrate that is equipped with a TCO layer as the front contact. The solar cells' pn-junction is formed between an n-type cadmium sulfide (CdS) layer and a p-type CdTe layer. All of the other process steps, including the formation of the back-side contact and chemical treatment to increase efficiency, are not described in any further detail. The monolithically integrated module is a glass-glass laminate.
Production equipment:
Proprietary development
Cell efficiency:
Up to 16 percent
Module efficiency:
6 percent
Costs:
No information
Capacity 2008:
25 MW
Employees: 80
Expansion goal:
A second line with 60 MW
Certification:
IEC 61646, IEC 61730 (in process)
Finances:
Capital secured for the next expansion stage

Calyxo
module structure

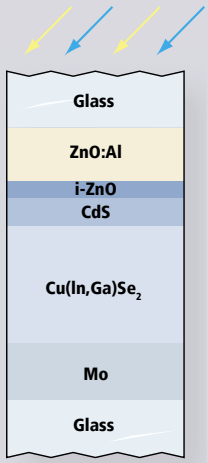


»Second Solar« factor:
One thing is certainly clear: Q-Cells' CdTe technology has a long road ahead of it before it can join First Solar's league. The US manufacturer not only produces CdTe modules with efficiencies almost twice as high, but with production costs of around $1 per W. First Solar is simply years ahead of Q-Cells in regard to costs.

Solibro

Q-Cells' share: 67.5 percent
Founded: End of 2006
Location: Thalheim, Germany
Technology: CIGS on glass
Solar cells are manufactured with typical CIGS production technology. A CIGS layer is applied to a glass sheet sputtered with molybdenum using co-evaporation by thermal physical vapor deposition (PVD). A razor-thin cadmium sulfide layer is formed in a chemical bath (CBD). The transparent conductive zinc-oxide layer has two functions: together with the CIGS absorber, it forms the pn-junction and serves as the front contact. The solar cells are separated in-situ by scribing and the module is laminated with a standard encapsulation foil and a second glass pane.
Production equipment:
Proprietary development
Cell efficiency:
16 percent
Module efficiency:
8 to 12 percent
Costs:
No information
Capacity 2008:
30 MW
Employees: 150
Expansion goal:
First line with 45 MW, additional lines with 90 MW
Certification:
IEC 61646, IEC 61730 (in process)
Finances:
Capital secured for the next expansion stage

Solibro
module structure

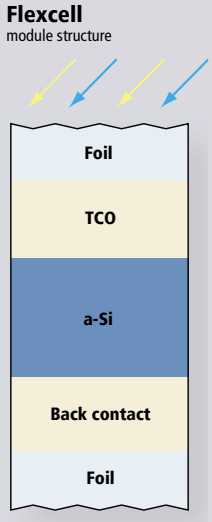


»Second Solar« factor:
The efficiency of Solibro's modules runs between 8 and 12 percent, which, while high, is still far from the world record for CIGS mini-modules. The Ångström Solar Center achieved 16.6 percent on a surface area of 4 × 4 cm with a similar technology. Efficiencies of around 12 percent will suffice for the production of competitive modules – if production costs are adequately low. Q-Cells didn't supply any information about costs, but certainly they are nowhere near the €1 ($1.27) hurdle set by First Solar. Still: among all the CIS and CIGS start-ups currently active, Solibro has the best prospects due to the excellent technological support from the Ångström Solar Center.

Flexcell

Q-Cells' share: 57.1 percent
Founded: 2000 (Q-Cells' involvement started in 2007)
Location: Yverdon-les-Bains, Switzerland
Technology: Amorphous silicon
Flexcell is one of a few module manufacturers that deposits its solar cells onto plastic foil. Most manufacturers of flexible modules use a metal foil substrate, like United Solar, the amorphous module market leader. Flexcell also chooses to produce solar cells made of amorphous silicon and has achieved deposition rates much higher than that offered by commercially available machinery. While Flexcell operates with an excitation frequency of 80 MHz, most of its competitors use frequencies of 13.56 MHz, as is the case with the machinery from Applied Materials or Ulvac. Even systems from Oerlikon have a excitation frequency of just 40.68 MHz – half that of Flexcell.
Production equipment: Proprietary development
Cell efficiency: 10.9 percent
Module efficiency: 3 percent
Costs: 60 euro cents (76.2¢) per W possible
Capacity 2008: 25 MW
Employees: 120
Expansion goal: Second line with another 25 MW
Certification: IEC 61646, IEC 61730
Finances: Capital secured for the next expansion stage

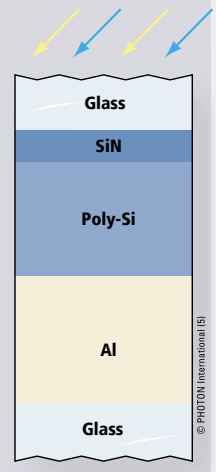
»Second Solar« factor:
Admittedly, a module efficiency of 3 percent is out of the question. But Flexcell's technology has considerable potential for development. Last year, a micromorphous tandem cell made of plastic with an efficiency of 10.9 percent was developed at the Institute of Microtechnology at the University of Neuchâtel, Switzerland. With this as a basis and an efficiency of 10 percent in production, the company could achieve costs of less than 60 euro cents (76.2¢) per W.



CSG

Q-Cells' share: 18.63 percent
Founded: 1995 as Pacific Solar
Location: Thalheim, Germany
Technology: Crystalline thin-film silicon on glass
At first, the heat-resistant borosilicate substrate-glass is textured using etching technology. A silicon nitride anti-reflection coating is applied by PECVD. Using one of Oerlikon's KAI-PECVD systems, the silicon layer is deposited as an amorphous layer first and then crystallized at temperatures of around 600 °C. Since silicon oxidizes at such temperatures, an hydrogen chloride (HCl) etching step is required. The high crystallization temperature is also the reason why CSG doesn't use TCO as a front contact like all other thin-film module manufacturers, but rather uses an elaborate rear contact with »aluminum point contacts.«
Production equipment: Proprietary development
Cell efficiency: 10.4 percent
Module efficiency: 6.1 percent
Costs: No information
Capacity 2008: 20 MW
Employees: 164
Expansion goal: No plans
Certification: IEC 61646, IEC 61730
Finances: Not applicable

»Second Solar« factor:
Nonexistent.




Solibro GmbH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▲▲ Swedish know-how: Solibro GmbH obtained the process technology for its CIGS modules from Ångström Solar Center at Uppsala University, Sweden. The company's cells are manufactured using a process typical for most CIGS manufacturers, but its efficiencies are higher than for many other start-ups.

▲ At the end of a long journey: The multicrystalline silicon thin-film modules that CSG wanted to commercialize were developed back in 1995 by Australian company Pacific Solar Pty. Ultimately, it seems all hopes placed in this unique technology have gone unfulfilled – here a picture of the production hall in 2006.

was founded in 1995, was saved by investments from Q-Cells and REC, the recent announcement that the company ended production shortly before Christmas was likely the final straw. The production process is simply too complicated and too expensive.

The next round

In an ad-hoc announcement on Dec. 9, Q-Cells lowered its business prognosis for both the current and the next quarter: »Q-Cells SE's investments in 2009 will focus on the expansion of production capacities for crystalline solar cells and majority interests in thin-film companies.« Consequently, it was clear at that point that CSG would no longer expand, while the other four holdings would begin with the expansion of additional production lines. Financing for these expansions could be secured, Michael Bauer confirmed at the PHOTON event. In short: Q-Cells is sending its thin-film division into the next round on the hunt for the best candidate to be Second Solar.

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