# A declaration of war from Switzerland

## Oerlikon sues thin-film manufacturer Sunfilm – to hurt its competitor Applied Materials

dpa Picture-Alliance GmbH

**Attack!: This is how it probably looks when the Swiss army mobilizes. Switzerland/Lichtenstein-based company Oerlikon is taking on its US competitor Applied Materials by different means – still, it's unlikely Oerlikon's litigious approach will fair any better.**

**A patent dispute has been smoldering for more than a year now between Swiss system manufacturer Oerlikon and several PV companies over the rights to a very promising thin-film technology. Now, Oerlikon has taken legal action against Germany's Sunfilm AG for alleged patent infringement. The real target in this fight is Oerlikon's US competitor, Applied Materials, which offers a similar technology, but for module sizes four times larger. An aggravated PV industry is following the case from the sidelines.**

Neutrality is a valuable commodity in Switzerland. The tiny mountainous country has adroitly kept itself out of the last century's major military conflicts. But that doesn't keep Swiss companies from profiting from the belligerence of other nations: that included armaments company Oerlikon from the Zurich district of the same name. The company's product's – for instance, antiaircraft canons – have been used on frontlines for decades.

But this chapter in the company's history is over. Oerlikon sold its less than popular weapons division to Dusseldorf, Germany-based Rheinmetall AG about a decade ago, in order to focus more on the production of coating and vacuum technologies. It's no wonder the company started to seek its fortune in the very promising field of thin-film PV as well. In early 2003, the company, then renamed

to Unaxis Balzers AG, announced that it would produce coating systems for thin-film modules made of amorphous silicon (a-Si) and micromorphous silicon (a-Si/µc-Si). The PV sector embraced the news enthusiastically. »It's a big step forward,« commented Arvind Shah at the time (see PI 5/2003, p. 28). Shah is a professor at the Institute for Microtechnology (IMT) at the University of Neuchâtel, where the cell technology for Unaxis' new machines was developed.

The industry hoped that Unaxis would provide standardized production machinery and a rapid, significant reduction in costs. After all, amorphous silicon thin films were considered one of the leading lights among the various cell technologies. The reason for these high hopes: a company that is capable of manufacturing highly complex liquid crystal displays (LCD) should be able to do the same for a-Si panels and a-Si/µc-Si modules with higher efficiencies.

## A case with wide repercussions

But the do-gooders in the PV business never expected that this former weapons company would introduce business methods rather uncommon in the PV industry. On June 10, 2008, they learned better. That was the day the Swiss company, once again riding under the flag of Oerlikon, submitted a lawsuit to the Dusseldorf district court against German company Sunfilm AG. The reason: »Oerlikon's intellectual property is being knowingly infringed upon by Sunfilm AG,« accused Oerlikon Solar CEO Jeannine Sargent in a press release.

Sunfilm AG, based in Großröhrsdorf, Saxony, is a relative newcomer to the thin-film module business. The company was founded at the end of 2006 and is currently constructing a production facility with a 60 MW capacity – it has plans to employ 180 workers. The PV industry is annoyed. Patent disputes – that's something you hear about in the semiconductor industry, but not the PV industry, which is an enormous growth market offering plenty of room for lots of companies, says one industry insider, who chooses to remain anonymous. He's not the only one who feels this way. Many solar experts talked to PHOTON International about this case, although off the record, but none of the thin-film manufacturers were willing to take an official stand. After all, they may want to do business with one of the parties involved in the dispute or may already be working with them.

This case has much larger repercussions than one would expect at first glance: Oerlikon's lawsuit against Sunfilm is actually aimed at Applied Materials Inc. The Großröhrsdorf-based start-up ordered a thin-film production line from Applied Materials, located in Santa Clara, California. »We've sold systems together with the processes,« confirmed Charlie Gay, CEO of Applied's PV division, to PHOTON International. But his company has vehemently denied the charge of patent infringement – likewise via a press release.

Applied is not only Oerlikon's largest competitor in the battle for the lucrative market for silicon thin-film module production lines, but also the leading provider of production systems for the semiconductor sector. And in this business area, Oerlikon endured a nasty setback when it battled with Applied Materials a few years ago. Whereas Applied continued to manufacture increasingly fast production machinery for ever-larger LCD screens (the current generation 8.5 devices process 5.7 $m^2$ glass panes), the Swiss company couldn't maintain the same pace of development. It called it quits at generation 5 (1.4 $m^2$). The result: Applied dominates the world's market for LCD equipment. Apparently, Oerlikon is now worried the same will happen in the area of PV technology. After all, Applied is doing no less than offering its PV customers that same successful machinery for LCD displays, but in a modified form. The response has been overwhelming so far. And at the end of May, Applied staged its final coup: it

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**Strongly armed: Weapons from Oerlikon's own production, photographed on the roof of its headquarters a few years ago, might say something about the company. While the weapons business was sold off some time ago, an uncommonly aggressive business style has apparently remained.**

proudly announced a contract with the Masdar Initiative, based in Abu Dhabi, for thin-film lines with a total capacity of 210 MW (see interview, p. 58). Thus, the California-based technology company now lists 12 thin-film factories on its order books. That amounts to a capacity of at least 1.5 GW by 2010. The contracts are worth around $3 billion.

### The lawsuit is not without risks for Oerlikon

As if Applied wouldn't suffice as an opponent, Oerlikon's lawsuit against Sunfilm means it will also butt heads with other big PV companies. Sunfilm belongs to Swiss company Good Energies Inc. and Norsun AS, based in Norway, among others. Good Energies is the leading investor in the PV industry. It holds shares in Q-Cells AG and has investments in many other thin-film start-ups, for instance, CSG Solar AG, which, incidentally, was the first PV customer to buy Oerlikon's deposition furnace. Norsun is an investment company run by Alf Bjørseth, founder and former CEO of REC ASA, the world's largest PV company, which has also invested in US-based CIS thin-film module company Ascent Inc. Hence, it's no wonder that we've heard comments such as »declaration of war« and »delusions of grandeur« more than once when conducting research for this article.

So why is Oerlikon pursuing its grievance at Sunfilm's expense? And why did it launch its lawsuit in June, just before Intersolar, flanked by a self-promoting press release to ensure that no one in the industry would miss it?

Sunfilm wasn't Applied's first customer (Spain's T-Solar SA and India's Moser Baer Ltd. signed contracts one month earlier), but the German company is the first to jump right into the production of modules made of amorphous silicon and a microcrystalline layer. Most other companies plan to begin with the production of simpler amorphous modules. These simpler modules have the lowest efficiencies of all common thin-film technolo-

## Structure and manufacturing of silicon thin-film tandem solar cells

Two solar cells are stacked on top of each other to produce a silicon thin-film tandem or micromorph solar cell: one cell made of amorphous silicon (a-Si), the other made of microcrystalline silicon (µc-Si). Both thin-film solar cells have their own pin structure. This consists of an intrinsic silicon layer that lies between a p-type and an n-type silicon layer. This construction allows an electrical field to develop in the intrinsic layer that separates the photon-generated charge carriers.

By stacking the solar cells, a series connection is produced. Thus, the voltages of the individual solar cells are combined. It's important that both cells produce the same amount of electricity, otherwise valuable power will be lost. In a solar module, the tandem solar cells are monolithically series connected via two conductive layers. The front contact consists of a transparent conductive oxide (TCO). The TCO is roughed up to create more light scattering (haze) and therefore to lengthen the sunlight's path to the absorber layer. The back side contact accomplishes two tasks: it collects electricity and reflects light back into the solar cell – since the thin, microcrystalline silicon layer absorbs only a small amount of light.

In the diagram, the various cell layer structures produced with equipment from Oerlikon Solar and Applied Materials are compared. Oerlikon uses zinc oxide (ZnO) as its transparent front contact, which is applied with low-pressure chemical vapor deposition (LPCVD). This way the ZnO layers have a higher haze value from the start. Applied Materials suggests its customers purchase glass with a $SnO_2$ layer, which either has a high haze value already or can be etched to create a higher haze value.

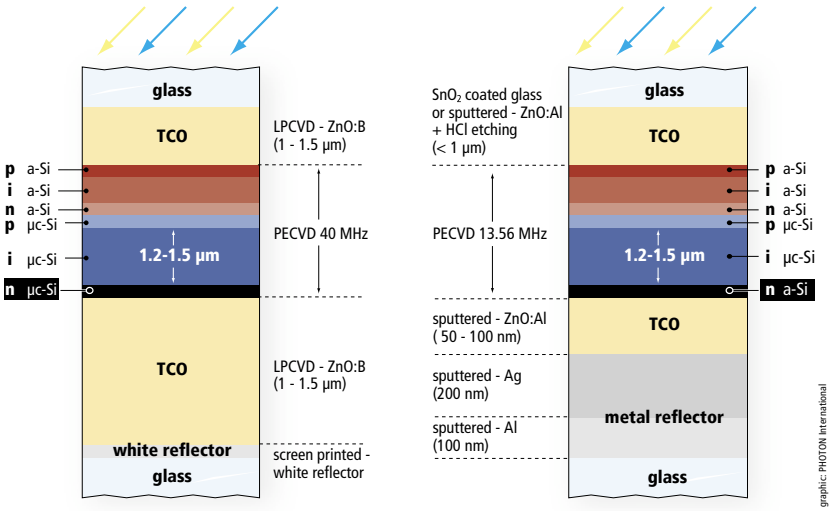
After applying the front contact, the amorphous silicon pin layer is deposited in a multi-step plasma-enhanced chemical vapor deposition (PECVD) process. For this, Oerlikon uses a system with one processing chamber. To avoid impurities in the individual layers, the chamber is cleaned repeatedly between the individual process steps. Oerlikon achieves high deposition rates – and thus a high throughput – by firing its plasma with a 40 MHz frequency. By contrast, Applied Materials fires its plasma at 13.56 MHz, although at higher pressures, which also accelerates the deposition process. Moreover, the American company uses a system that has individual processing chambers for the p, i and n layers. This prevents impurities in the layers, without requiring an additional cleaning step.

Oerlikon has the exclusive license for the micromorph cell from the University of Neuchâtel. With this technology, the microcrystalline portion of the tandem cells is completely deposited as microcrystalline silicon; the p, i and n layers also have this crystalline structure. Applied Materials, on the other hand, uses patents from the Research Center Jülich (FZJ), with the n layer being made of amorphous silicon.

The two technologies also have differences when it comes to back side contact construction. Oerlikon uses the same process it uses for the front contact – an LPCVD process to apply ZnO as a back side contact. To reflect the remaining light back onto the cell, a layer of white color is deposited onto the ZnO. Again, Applied Materials' back side contact profits from the experience and patents of the Research Center Jülich (FZJ). In this case, a nearly 80 nm thin ZnO layer is sputtered, followed by silver and aluminum layers that are 200 nm and 100 nm thick, respectively. Unlike Oerlikon's single, white layer, Applied Materials' double reflective layer not only reflects the light, but also discharges electricity. *op*

**Oerlikon**
based on process developed at the University of Neuchâtel

**Applied Materials**
based on process developed at Research Center Jülich (FZJ)




**The diagram shows how the microcrystalline thin-film modules produced on machinery from Applied Materials and Oerlikon differ.**

gies: just 5 to 7 percent. In contrast, modules using a-Si/µc-Si technology – also called micromorphous or tandem modules – have considerably higher efficiency potentials. The world record is more than 14 percent, although that was measured under laboratory conditions – there is no commercially operated mass production.

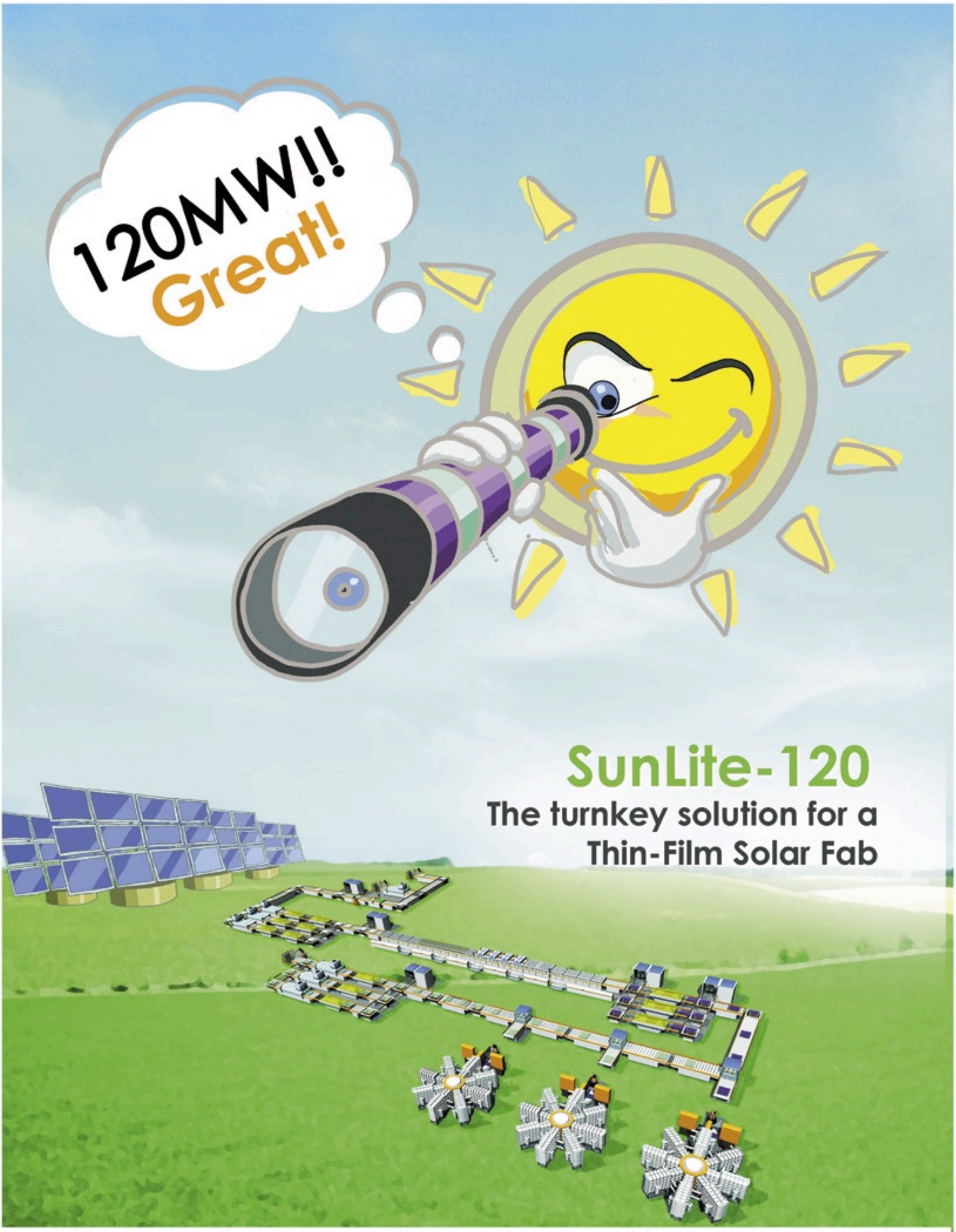
If Oerlikon had its way, it would be the only supplier of production lines for a-Si/µc-Si modules, at least in Europe, where the company believes its patents for tandem cell technology and manufacturing are protected through licenses with the University of Neuchâtel. »Sunfilm AG has publicly announced plans to enter the market with tandem junction photovoltaic modules, in violation of Oerlikon's exclusive license,« said Oerlikon, explaining the lawsuit in its June 11 press release. But the public has known about Sunfilm's plans to produce thin-film modules for more than a year. The lawsuit could have been launched much earlier. The fact that it's happening now could be a reflection of Oerlikon's inability to adequately assess its US-based competitor. Applied announced its expansion into the PV sector just three years after Oerlikon – in spring 2006. Usually, it takes quite a while for a company to develop systems for thin-film production – half a decade isn't an unusually long amount of time.

But just two years later, in June 2008, one of Applied's customers, Signet Solar GmbH based in Mochau, Saxony, was the first company to present a 5.7 $m^2$ amorphous module to the public at Intersolar in Munich (see PI 7/2008, p. 10). It seems likely that this caused panic to break out in Oerlikon's ranks and the company began a hunt for a means to slow Applied's rise. After all, right now the Swiss company can only offer customers coating equipment for smaller 1.4 $m^2$ modules. »It was a shot across the bow to deter potential customers,« says one source laconically.

## Quadruple appeal

The irony in this whole saga is that there's been a dispute smoldering for some time over the very legality of Oerlikon's patent. On June 14, 2006, over two years ago, the EP 0871979 B1 patent from the University of Neuchâtel, for which Oerlikon has licensed the exclusive usage rights, was finally approved after almost 10 years of examination by the European Patent Office. In March 2007, just before the end of appeal period, four other parties submitted objections to the European Patent Office: Sunfilm, Q-Cells, Japanese thin-film manufacturer Kaneka Corporation and Sabine Schönfeld-Schnuck, whose origins remain somewhat mysterious – she apparently represents a party that does not wish to be directly involved in the quarrel. It's not known whether Applied Materials also submitted objections.

If you take a closer look at the patent from Neuchâtel, it quickly becomes clear that it contains dangerous language for all companies working with high-efficiency a-Si/µc-Si solar modules. They have not only patented the composition of microcrystalline solar cells, but the manufacturing processes used to produce them, too. The critical point here is the description of the deposition and purification process for the microcrystalline layer. According to the patent, microcrystalline cells are protected by an oxygen content of up to $2 \times 10^{19}$ atoms per $cm^3$ in the so-called intrinsic layer – this layer separates the p- and n-doped layers in thin-film solar cells. Thus, competitors' cell structures must have higher oxygen concentrations to avoid conflict with the Neuchâtel patent. The problem is: the more oxygen in a crystalline silicon cell, the lower the efficiency. If the oxygen concentration exceeds the patented threshold 10-fold, it becomes

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**Made in Switzerland?: Oerlikon's attempt to protect its intellectual property is somewhat reminiscent of a popular TV ad from Ricola, which shows a representative of the famous Swiss herb candy company in various countries asking natives with the sweets in their hands: »Who invented this?«**

impossible to produce a functioning microcrystalline solar cell. Moreover, the feedstock gases used in producing tandem silicon solar cells are so pure that the oxygen content in the intrinsic layer will remain below the patented threshold by default. To achieve higher oxygen content, a manufacturer would have to add oxygen to contaminate the gas – this makes no sense.

So it's no wonder that the opposition is trying to eliminate the Neuchâtel patent. Above all, they dispute whether the Swiss company has actually invented something new – the ultimate argument in any patent disagreement: as early as December 1993, Shunpei Yamazaki (a Japanese inventor with more than 1,700 US patents) described micromorphous solar cells in his patent US5349204. Then there's Johannes Meier, one of the inventors in Neuchâtel, who was said to have submitted a paper on the effect of oxygen on the intrinsic layer of microcrystalline silicon layers some three years before he submitted the patent as an employee of the Swiss University. Such a publication would also partially strip the Neuchâtel patent of its legal justification.

In December, the University of Neuchâtel defended itself in a letter to the European Patent Office on the grounds that Meier's publications looked at a different problem. So, the dispute remains unresolved – and recently entered the second round of appeals. They began on June 13, when Kaneka again submitted its objections. Additional letters from other parties are expected to arrive in coming months. Only then will it come to oral negotiations before the European Patent Office.


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**Jeannine Sargent, CEO of Oerlikon Solar, with a miniature version of its module. Her company is taking an indirect course of action against Applied Materials. Sargent is accusing the Americans of using patent-protected technology in the production facilities for its large modules, which Applied Materials' solar group CEO Charlie Gay denies.**

»Filing a lawsuit to defend an opposed patent simply makes no sense,« Applied Materials CEO Mike Splinter told PHOTON International. And indeed, as long as no decision has been made by the patent office, the trial in Dusseldorf will likely be put on hold. That means that Oerlikon's lawsuit won't negatively impact Sunfilm's business, for now.

Without even flinching, Sunfilm celebrated laying the cornerstone for the expansion of its second production line in mid-July. Moreover, the lawsuit won't have much of an effect on the businesses of other Applied customers interested in the field of microcrystalline production either.

In the end, it looks like Oerlikon could draw the shorter straw. Several of Applied's customers said that they have an interest in a potential second equipment supplier to ensure they're not becoming too dependent on the American company. But as a consequence of Oerlikon's behavior, its name has been eliminated from this list for the moment.

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