Unlocking the secret of snail tracks

The solar industry is investigating so-called snail tracks – small, dark lines that appear on modules

For years, discolored lines known as »snail tracks« have been appearing on crystalline silicon solar modules from several different manufacturers. Research institutes are looking for the cause, but many questions remain unanswered. Snail tracks do not appear to compromise the electrical parameters of the affected modules. Moreover they have a practical side effect: they reveal a concealed problem, cracked cells, which can lead to lost output.

Snail tracks: These finger-thick dark lines crisscrossing solar cells result from a chemical reaction. The cause and effects of the reaction are still being researched.

Tim Gulden may have to come up with a new marketing strategy to sell solar systems. The owner of Minnesota-based installer Winona Renewable Energy LLC uses the photovoltaic (PV) array on his own house to bring in new business. When he's pitching solar to prospective customers, he brings them up on his roof so they can see the panels close up. The problem is that over the last several months, odd discolorations have formed on some panels – a phenomenon known as »snail tracks,« due to the small, dark, meandering lines that appear on the surface of affected modules. He's concerned that these blemishes could cause his customers to have doubts about installing PV on their homes.

Gulden brought the issue to the attention of Jay Miles, the representative at his distributor, Russell Pacific LLC. Miles put in an inquiry with the California-based manufacturer of Gulden's panels, Siliken USA Inc., requesting that they be replaced. In response, Siliken informed Miles that it has investigated reports of such discolorations in collaboration with testing agencies TÜV Rheinland and Underwriters Laboratories (UL). Together, they found that the snail tracks do not decrease performance or cause safety hazards. The company further said that all warranty claims require documented performance losses. This doesn't help Gulden: because his panels are performing at or near expected levels, he cannot get them replaced. The response did not alleviate Miles' concerns either. »The panels are only 12 months old,« he says. »We don't know what the long-term effects will be.«

Cracks and tracks

Gulden is by no means the only PV system operator fretting over strange panel markings. In Europe, there have been many reports of snail tracks appearing on modules. Moreover, Siliken panels are not the only ones affected. PHOTON knows of 13 different manufacturers (including Siliken) that are grappling with the problem. Presumably many more are affected, but exact figures are not available.

The system at the vocational college in Hesse, Germany, was connected to the grid in December 2010. In the fall of 2011, the operator discovered snail tracks on 10 percent of the modules, which were manufactured by CEEG in China. A close inspection revealed that the contact fingers in the affected areas seem to have turned brown.

Just like any other change to a module, this phenomenon raises questions among operators and installers like Gulden. What is causing the snail tracks? What long-term significance do they have? Will they continue to form over time?

To begin to understand the answers to these questions, one must first comprehend a closely related phenomenon: cell microcracks. Silicon PV cells must be handled with care. Knocks, pressure and shaking can cause the paper-thin silicon wafers to crack, and in extreme cases they can even break. While a broken cell can be identified at once, fine microcracks are not visible to the naked eye. Yet they can have a negative impact on the electrical properties of the cells, and, as a result, on the electrical properties of the modules produced from them. Microcracks lead to output losses, meaning that power yield is lower than anticipated for affected cells and the modules that contain them. There is an established method for finding microcracks, if a system operator wants to know whether his or her modules have this problem. The cracks can be made visible using an electroluminescence camera. However, this method is quite expensive and time-consuming.

Here's where snail tracks come in. The crisscrossing dark lines that Gulden and others have observed are the result of a discoloration process occurring over a period of many months that is caused by microcracks. In other words, snail tracks make microcracks visible to the naked eye, pointing to underlying damage to the cells that occurred during production, transport or installation. How do cracks lead to snail tracks? The small, dark lines are created by a chemical reaction that has been keeping scientists and the industry on their toes for some time now. More on that later. Unfortunately, the industry has largely been silent on the issue and has obliged all parties involved to do the same.

The scope of snail tracks

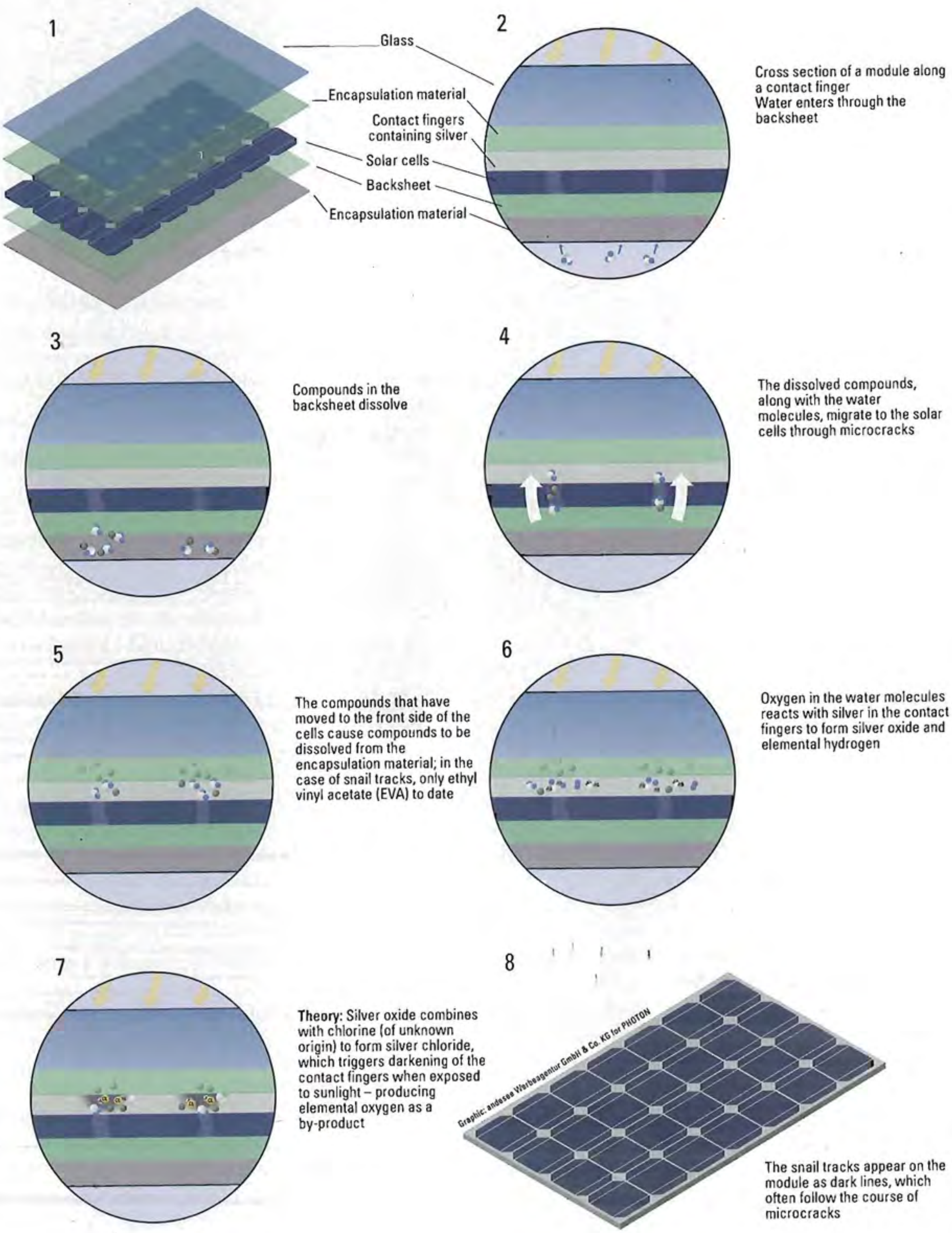
Marc Köntges, team leader for process technology at the Hameln, Germany-based Institute for Solar Energy Research GmbH (ISFH) has conducted diverse tests on snail tracks. At the 8th Photovoltaic Module Technology workshop, organized by TÜV Rheinland and the Energy Agency of North Rhine-Westphalia and held in Cologne, Germany, at the end of November, Köntges became the first scientist to make a public presentation attempting to characterize the scope of the phenomenon. The nine German experts he interviewed have been studying snail tracks since 2006 and have examined PV systems with a total capacity of 72 MW. The first report of snail tracks found by Köntges was from 2004. However, it is only in the last 3 years that the topic has started to impact an increasing number of people. Over the last few weeks, the PHOTON editorial office has received letters and calls from operators and installers in France, Germany, Italy, Spain and the US who have identified the phenomenon as occurring in both mono- and multicrystalline silicon modules. The first signs of discoloration develop around 5 months after installation. In some cases, 100 percent of the modules are affected. The manufacturers are mostly based in Asia and Europe; they include established brand names, as well as smaller producers. The only known US-based producer of affected modules is Siliken USA, which has a factory in California.

Analysis reveals a thin layer of polymer over contract fingers

To investigate the chemical processes underlying snail tracks, PHOTON wrote to 12 manufacturers cited by system operators as having produced affected modules. Three of them – Jinko Solar Holding Co. Ltd., Mitsubishi Electric Corp. and Chaori Solar Energy Science and Technology Development Co. Ltd. – did not respond to the inquiry. The answers provided by the other nine companies varied in terms of detail, depending on how much research each producer had done on the subject, or on how willing it was to reveal its findings (see table, p. 88). While the explanations also vary somewhat, there seem to be some agreement on the main points – that the encapsulant material surrounding the cells and microcracks in the wafers have decisive impacts on the formation of snail tracks.

»A combination of very specific materials, operating conditions and environmental influences have to coincide. Not all snail tracks are the same,« explains Christian Hagendorf, a physicist at the Germany-based Fraunhofer Center for Silicon Photovoltaics (CSP). Fraunhofer CSP received a number of assignments to research the cause of the discoloration in 2011. Hagendorf has been granted permission by the system operators to discuss

Formation of snail tracks according to current research



it. His team initially examined the silver contact fingers on several modules. What is perceived as a darkening of the contact grid is, according to this research, a thin layer of polymer deposited over the fingers. The contacts themselves do not seem to be subject to corrosion, and power losses on the modules were generally not observed. The polymer closely resembles the encapsulant material ethylene vinyl acetate (EVA) used in about 90 percent of all modules, with one difference: it contains many phosphorous oxides (phosphorous dioxides and trioxides). Where these compounds come from and how they trigger a separation of part of the EVA film remains unclear.

One of the companies contacted by PHOTON, Schüco International KG, supports the hypothesis that increased electrical resistance on a microcrack generates heat in the vicinity, causing substances in the EVA film to solubilize. These substances are then deposited on the cell as a dark residue. Schüco is still conducting its analysis, and any findings must be considered preliminary.

It seems reasonable to suppose that the film itself, or substances from nearby components, have to have a particular composition for this reaction to occur. After all, incidents of snail tracks have only been recorded for a few years now, and only on certain brands. »Every manufacturer has its own mix of components, and sometimes it isn't aware of which materials they actually contain,« Hagendorf explains. »There is an entire chain of missing information.« What has been established is that the reaction in question occurs under the influence of water or water vapor, which diffuses into the module via the backsheet. This penetration of moisture, the degree of which depends on the quality of the backsheet, will not necessarily trigger the formation of snail tracks. However, they seem particularly likely to occur when there are cell microcracks, which allow the moisture to pass through to the other side of the cells. There, the chemical reaction – whose exact nature is still being researched – takes place. The result is discoloration on the contact fingers that extend across the cracks. A correlation between microcracks and snail tracks is confirmed by both the Fraunhofer Institute for Solar Energy Systems (ISE), a Germany-based research organization (see interview, p. 86), as well as Marc Köntges from ISFH. It's also possible that the moisture migrates to the front side via the cell edges, causing snail tracks along the edges. The tracks may also form a frame-shaped discoloration located at a certain distance from the panel's edge. In all, Köntges has three snail track classifications: discoloration that crisscrosses along the microcracks (type I), marks along the edge of the cell (type II) and r-frame-shaped discolorations (type III). Type I tracks are the most conspicuous and indicate damaged cells.


Ignacio Evangelista / photon-pictures.com (2)

Most of the operators who reported snail tracks to PHOTON did not observe any impact on the output of their modules. But Javier Hernández from Ingeniería Medioambiental Helios in Spain says that his system's yield has fallen by around 20 percent. CSI, the manufacturer, has not taken any remedial action to date.

Reaction of silver with chlorine suspected

Köntges reported that several affected manufacturers no longer observed any snail tracks on their modules after changing their EVA suppliers. The completeness of the encapsulation does not play a role in the formation of snail tracks, he notes. Based on this and other findings, the physicist has developed a theory for the chemical processes involved. He qualifies his theory as »pure speculation,« since definitive proof is still lacking. Köntges believes that oxygen from the water molecules is reacting with the silver in the contact fingers, forming silver oxide. Trina Solar Energy Co. Ltd. and Siliken SA also mention the formation of silver oxide as a cause of discoloration of the contact fingers in their modules. Köntges also suspects a second, subsequent reaction under the influence of a halogen. The Fraunhofer CSP team has found a higher proportion of phosphorous oxides, as well as traces of sulfur, carbon, silver and several halogens (chloride, bromine and fluoride) on the surface of cells. Köntges' theory is based on the decisive impact of chlorine. Silver oxide could be reacting with the halogen to form silver chloride, which, in turn, can break down into amorphous silver and chlorine under the influence of light. This reaction is a familiar one in black and white photography. The exposed areas of the film appear dark, while the less exposed areas are lighter. This can be seen after the film has been developed; the negative only becomes stable after a fixing bath stops the reaction. With snail tracks, the silver blackens uniformly wherever there was previously silver chloride and silver oxide – that is, at the permeable spots close to the back of the module, along the cracks in the cells and the edges of the cells. However, it is not known where the chlorine or other elements are coming from. The information needed to determine this has not been provided by the encapsulant manufacturers. »That chlorine and sulfur react is clear. In dispute is whether this causes the snail tracks,« Köntges says.

One of the 12 surveyed manufacturers, Canadian Solar Industries Inc. (CSI), seems to have answered the chemical reaction question for itself. The company, which also claims to have solved the issue of snail tracks, has been working in cooperation with a number of research institutes, including Fraunhofer ISE. CSI's explanation

Guarantees »will not suffice«

Interview with Daniel Philipp, acting head of the PV laboratory at Germany's Fraunhofer ISE

For some time now, the Germany-based Fraunhofer Institute for Solar Energy Systems (ISE) has been investigating snail tracks on photovoltaic (PV) modules, within the scope of its industrial research agreements. One of the institute's clients is Canadian Solar Inc. (CSI), a Chinese cell and module manufacturer that announced it has resolved the problem of snail tracks. The company has made vague references to changes implemented in its production process, but CSI is not providing details. PHOTON spoke to Daniel Philipp, acting head of the PV laboratory at Fraunhofer ISE, in the hope of gaining some general information about the analyses performed by the institute.

PHOTON Why do the snail tracks usually spread along cracks in the cells?

Daniel Philipp There is a correlation between snail tracks and cracked cells. That does not, however, mean that cracked cells are the reason that snail tracks appear. Our experience has shown that they are a precondition to the formation of snail tracks on the cells.

PHOTON The discoloration of the contact fingers is the result of a chemical reaction that occurs in the module. Do you know exactly what is happening?

Philipp Our analyses have not progressed this far. Damage due to oxidization of the contact fingers does seem evident. My colleagues in the analysis team are currently isolating the exact chemical processes and are attempting to come to a conclusion about the potential products of reactions on the components involved. We are working on this with manufacturers on a confidential basis.

PHOTON Can you estimate when you will have the final results?

Philipp I suspect we will be working on this until the middle of 2012, but basi-

Daniel Philipp

Daniel Philipp

cally it is very hard to gauge. Our focus is on understanding which processes occur in the module in order to establish how the phenomenon can be prevented in future. The other question in this context is: what happens in the module in the long term, and should subsequent damage be expected?

PHOTON Are you also investigating this question?

Philipp Yes, we are also working on that. But to answer the question with any certainty and foresight is difficult and will not be possible in the short term. We are doing different tests – largely quality tests and combinations of several weathering factors. Tests like these are easier to do when the degradation processes have been understood.

PHOTON As I have learned from discussions, there are several factors involved in causing snail tracks. But at least one of them must be relatively new, which means an aspect of the module manufacturing process must have been modified in some way. This is why the phenomenon has only been occurring for a few years now. Are you able to tell us which parameter is the culprit?

Philipp The subject is a complex one. Cracked cells do seem to be an important factor. However, several factors in the wider market are obviously coinciding, as diverse manufacturers have been affected. Because the investigations are not yet complete, I'm unfortunately unable to say more about this issue. Module designs and the components used in production have become much more varied in the last few years, which doesn't make our task any easier.

PHOTON What course of action would you recommend to system operators who discover snail tracks on their modules?

Philipp At the moment there is no evidence that snail tracks directly affect output. Cracked cells, which, as I said, are a precondition for snail tracks to appear, can certainly have a negative impact on module performance, depending on the number and extent of the cracks. In terms of module output, my current recommendation is to focus on the modules with the most affected cells. It's not a bad idea to keep measuring the output of a few of these over time in order to determine whether there is any degradation. As for the larger question of when, how and why the cracked cells got into the modules in the first place, in general, I can only recommend that manufacturers and operators place value on product quality. The module price, IEC certificate and warranty obligations will not, from our perspective, suffice to allow the prospective operator to make an informed decision about purchasing a particular module type. The task of the relevant research and test institutes is to provide procedures that allow quality and trust in photovoltaics to be enhanced. This is why we encourage all manufacturers and operators to take this issue seriously and to provide us with support.

PHOTON Thank you for speaking with us.

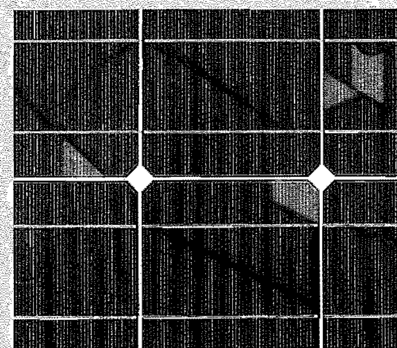
Interview: Ines Rutschmann

Significance of microcracks

Snail tracks usually develop along microcracks in cells, making the cracks visible. Not every module with a microcrack will be affected by discoloration, however. According to the current state of knowledge on the subject, performance degradation in affected modules has less to do with the snail trails themselves than with the underlying microcracks. If a crack isolates a section of a cell, current cannot flow from the contact fingers to the bus bars. The effect on the output from the module as a whole depends on how many cells exhibit broken surfaces.

Microcracks develop due to a variety of causes and can occur during production, transport and installation. Did the cracks already exist when the modules were delivered or did they only appear afterward? Did the installer handle the modules too roughly, or was the load they were subjected to by snow or hail the previous winter too great? The current consensus is that completely preventing microcracks during production is very difficult. A large number of cracks can develop in mono- and multicrystalline silicon ingots due to improper handling. Strong mechanical forces can also crack cells during cell production and during module lamination and stringing, sometimes breaking cell completely. Quality assurance and testing using electroluminescence can filter out damaged products before distribution.

However, an electroluminescent photograph cannot reveal every defect in each cell. At the 8th Photovoltaic Module Technology workshop, held by TÜV Rheinland and the Energy Agency of North-Rhine Westphalia, Stephan Schönfelder from the Germany-based Fraunhofer Center for Silicon Photovoltaics explained that microcracks primarily occur in wafers whose structures make them predisposed to cracking. The more stress a cell is subjected to, the more likely it is to crack. Thinner wafers are more likely to crack under lower stresses. It doesn't matter whether this stress occurs during production, transport or in the field. In order to avoid microcracks, the solar industry must adopt gentler methods for handling goods.


Bernd Roselieb / photon-pictures.com [M]

Snail tracks that result in isolated cell segments are indicated with red lines in this diagram. Such an area occurs when the connections of contact fingers to both bus bars are broken.

One former employee of a Germany-based module maker says that in his experience, microcracks occurring in production are more likely to result in snail tracks than cracks caused by transport and installation. His employer was able to eliminate the formation of snail tracks by optimizing the handling of cells and modules. »We were able to prevent cracks by improving the inspection of incoming goods and working more gently,« the former employee says, adding, »From this point on, we no longer had a problem with snail tracks.« *iru*

is cryptic: the discoloration is the result of certain chemicals used in cell production by certain companies through the end of 2010. »We believe that the supplier of the chemicals has stopped using these specific components in its product,« says CSI spokesman Daniel Heck. The company is not revealing what the chemicals in question are. If this explanation is correct, then the discoloration should not appear on CSI modules produced after 2010.

Yet results from Germany-based cell and module manufacturer Q-Cells SE cast significant doubt on the solution developed by CSI. Q-Cells noticed occasional snail tracks on its own products and decided to get to the bottom of the problem. It established that certain compounds were being dissolved out of the backsheet when moisture penetrated the module – for instance, the phosphorous oxides mentioned by Hagendorf, in addition to other chemicals – and that these were migrating to the front side via cracks in the cells or the edges of the laminate. There, the substances react with the EVA film and cause the contact fingers containing silver to oxidize. »That is a surface effect,« says Q-Cells' head of technology, Peter Wawer. »This is not, however, impairing the contact fingers,« he adds. Exactly how the individual chemical reactions take place still needs to be clarified. The frequency with which snail tracks appear depends on the type of EVA, the type of backsheet and other factors, Wawer explains. Q-Cells only uses compatible combinations of tested materials. It established complex test procedures to reveal which combinations are dangerous and which are harmless. This is because some film manufacturers do not specify what compounds their products contain. Additionally, some film types can vary so widely from batch to batch that the same encapsulant may cause reactions in some instances but not others. Q-Cells has therefore developed an electrical and thermal accelerated test procedure for modules to identify any potential interactions. Modules susceptible to snail tracks should not be brought to market, the company says. »Our experience has shown that the reliability and electrical properties of the modules are not being compromised. However, this is producing a visual defect,« Wawer admits.

Response of manufacturers affected by snail tracks*

	Canadian Solar Inc. (CSI)	CEEG (Shanghai) Solar Science & Technology	Chaori Solar Energy Science and Technology Development Co. Ltd.	GermanSolar AG	Hongchen Photovoltaic Energy Co. Ltd.	Jinko Solar Co. Ltd.
			no photo available			no photo available
Module type(s)	CS5A-180P und CS6P-225P	SST 190-72M	CRM 225S 156P	No information available	HCP185D-24	JKM-230P-60
Installed since	2007 and 2010	2010	2010	2009	2010	2010
Explanation of the phenomenon	The discoloration is caused by a certain chemical that is used in cell production. The supplier has stopped using this chemical in its products since early 2011.	A team has been formed to research the phenomenon. Results are still pending.	Chaori did not respond to PHOTON's inquiry.	Because the final report from the test institute assigned the task has not been submitted, results are currently not available.	The discoloration is being caused by the EVA film. Hongchen is not releasing any further findings. The technical team is currently engaged in researching the phenomenon.	Jinko did not respond to PHOTON's inquiry.
Reaction to the phenomenon	Snail tracks have been eliminated in production since early 2011, CSI says. Operators who discover modules with the corresponding discoloration must be able to prove a loss of output. The company classifies the phenomenon as a visual effect.	Two modules underwent a power test at TÜV Rheinland, passing it. The company does offer its customers a test of affected modules every 2 years in its laboratory in Shanghai, China. CEEG will pay the cost of transport.		The company has had a comprehensive test performed at the Photovoltaics Institute in Berlin, Germany. Result: no relevant drop in output.		

* this table consists of manufacturers that were reported to PHOTON by system operators because their modules were affected by snail tracks

»An optical discoloration, not a defect«

The industry is unanimous regarding the consequences of snail tracks. CEEG (Shanghai) Solar Science & Technology Co. Ltd., CSI, GermanSolar AG, Schüco, Siliken and Trina all state that, according to current knowledge, the phenomenon has no impact on module performance. This position is based on evidence. CSI, GermanSolar and Siliken have performed both solar simulation tests and accelerated aging tests on affected modules. After this testing, the maximum output power was found to fall only slightly and well within the tolerance range, according to CSI. GermanSolar refers to similar results of accelerated module aging performed at the PI Photovoltaic Institute in Berlin, Germany, saying that the result was an insignificant loss of output. New tracks had not appeared and existing ones had not spread. Quite the opposite: the time spent in the climate chamber reversed the discoloration in parts of the modules – the contact fingers subsequently appeared a bit more silvery again. This observation had already been made at the ISFH and can be explained by Köntges' theory – namely, that the darkening is produced by the effect of light and is reversible in its absence. »For us, this makes it a visual discoloration, but not a defect,« says Antonio Romos, quality manager at Spain-based Siliken AG (the parent company of Siliken USA). TÜV Rheinland Energy and Environment GmbH subjected 15 Siliken modules, some with and others without snail tracks, to the tests described in the International Electrotechnical Commission (IEC) standard 61215. It found that the maximum degradation was 3 percent.

Q-Cells SE

In contrast to other manufacturers, Q-Cells considers snail tracks to be a defect. »Our standard is to have our modules free of electrical and optical defects,« says Peter Wawer, Q-Cells' head of technology.

Nevertheless, there are modules with snail tracks that exhibit a loss of output. Since the end of 2010, Germany-based Adler Solar Services GmbH has regularly received inquiries about testing modules with snail tracks, finding that some showed a negligible loss of output. »However, the question of whether slight deviations in

Mitsubishi Electric Corp.	Q-Cells SE	Schüco International KG	Siliken SA	Solpower AG	Trina Solar Energy Co. Ltd.	Upsolar Europe SAS
	no photo available	no photo available			no photo available	no photo available
PV-MF130EA2LF	QC-C05-4-230	No information available	SLK 60M 6L 250	GM 572-175 S	No information available	UP-M180M
2006	2010	no information available	2009 und 2010	2009	2011	2010
Mitsubishi did not respond to PHOTON's inquiry.	The formation of snail tracks is related to the backsheet and the encapsulant material. Water that has penetrated reacts with compounds from both plastics on the front of the cells. This results in discoloration of the contact fingers.	Microcracks in the wafer are responsible for the development of snail tracks. The increased electrical resistance causes a localized generation of heat in these areas. This triggers the release of compounds from the encapsulant material, ethyl vinyl acetate (EVA), which appear as a dark film on the cell.	The discoloration is caused by oxidization of the contact fingers. The EVA film is involved in the reaction.	The companies in the Solpower Group have not contacted the producers of the affected modules and have not processed any claims on behalf of the customers to date. The company has not revealed who manufactures the modules labeled as Solpower.	The discoloration is a surface effect without impact on the contact grids. The silver oxidizes to silver oxide.	The company is still investigating the snail tracks. Conclusions have not yet been reached.
	Q-Cells has developed a test procedure to identify components that facilitate the formation of snail tracks. These will not be used in production. Discolored modules should not be distributed on the market. Modules affected by snail tracks that were already delivered can be returned in the event of a loss of output.	The microcracks that often cause snail tracks to appear on the cells generally do not have an adverse effect on output. Customers who report snail tracks are addressed on a case-by-case basis. An appraisal of the system is made, along with power tests. Depending on the result, the affected modules may be replaced.	A power test performed on 15 blemished modules by TÜV Rheinland proves that the phenomenon causes no significant loss of power. Even an accelerated aging test failed to result in any drop in output not covered by the guarantee.		Power tests did not reveal unusual degradation and electrical resistance remains unchanged.	

power can be ascribed to the snail tracks or to natural module aging processes remains unresolved,« says company spokesman Claas Rohmayer.

Among the systems affected by snail tracks that have been reported to PHOTON, the overwhelming majority has not exhibited lower yields. Only two system operators point to output losses. Both installed CSI modules, model CS5A-180P and CS6P-225P. The first system was made in 2007 and is located in Spain; the other one was installed in Germany in 2010. Both owners sent modules to PHOTON Laboratory for yield measurement. Two of the panels from Spain registered degradations of around 22 percent after being in operation for less than 4 years, and another demonstrated a degradation of 26 percent. The devices from Germany delivered about 5 percent, 8 percent and 17 percent less output after 1 year of operation, respectively. CSI is aware of both cases, but the company is claiming that it has not received any proof of the loss of output, which is why it is not making any concrete statement on the matter. Heck, the company's spokesman, says: »The results from the test laboratories show that the discoloration has no impact on the electrical properties of the modules.«

Loss of output may be due to microcracks

The view maintained by the scientists at Fraunhofer ISE, ISFH and Fraunhofer CSP is that the discoloration of the contact fingers does not have negative consequences for module performance. However, the cracks in the cells behind the crisscross discoloration could be problematic. The courses the cracks take impact the transport of current. Depending on the number of such defects and the size, shape and position of each, this can have an effect on the output of the module (see box, p. 87). The phenomenon of snail tracks has been classified by CSI and other companies as a purely »visual abnormality.« Customers are being notified in writing that there is no »defect in the legal sense.« It is correct that the discoloration is not a ground for concern, in itself. However, the same cannot be said for certain about microcracks. Snail tracks make cell defects visible; therefore, their presence indicates that the affected cells are of lesser quality. They also draw the attention of installers and system owners to problem modules in an array. Back in Minnesota, snail tracks certainly grabbed the attention of Tim Gulden. He will definitely be keeping an eye on the performance of his modules over time.

Ines Rutschmann, Michael D. Matz