



aleo

high yield · high efficiency
long lasting value



- ◆ **About aleo**
- ◆ **Technology**
- ◆ **Quality**
- ◆ **Advantages**

about aleo

aleo



aleo solar GmbH produces and markets mono-crystalline premium solar modules, and is a systems provider to the global photovoltaic market. The company employs approximately 200 people in sales and at its plant in Prenzlau (Brandenburg, Germany).

Established in 2001, the company has been part of Sino-American Silicon Products Inc., Yilan Branch. since 2014. The cell maker develops, manufactures and markets high-efficiency solar cells worldwide.

→ **Being part of SAS group means access to the latest technological developments and the stability deriving from a solid group**

	2011	2012	2013
Turnover	598.268.508 USD	623.338.508 USD	753.063.288 USD

Recent results of SINO-AMERICAN SILICON PRODUCTS INC. AND SUBSIDIARIES

- With plants in Taiwan, Japan, China and USA, SAS Group has a global footprint
- aleo solar is the first company of the Group in Europe

about aleo: our presence

aleo



aleo solar

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about aleo: why just buying a normal module?

aleo

→ **more energy production, more savings
with same size and nominal power**

- Not all PV plants are the same but they have one thing in common: they are designed to produce energy, as much as possible, as long as possible.
- With its new 300 W class modules, aleo solar is the smart choice thanks to higher yields at all irradiances achieved through the use of the most efficient technologies available in the market, combined with more than 10 years of expertise in modules manufacturing
- Conventional retrofit or BIPV installation solutions are both available. With the same level of quality.
- If you need more than “just a module” then read through

our energy generators

aleo



aleo S19



aleo S79
Black line



aleo S79
Solrif Black line



aleo S25



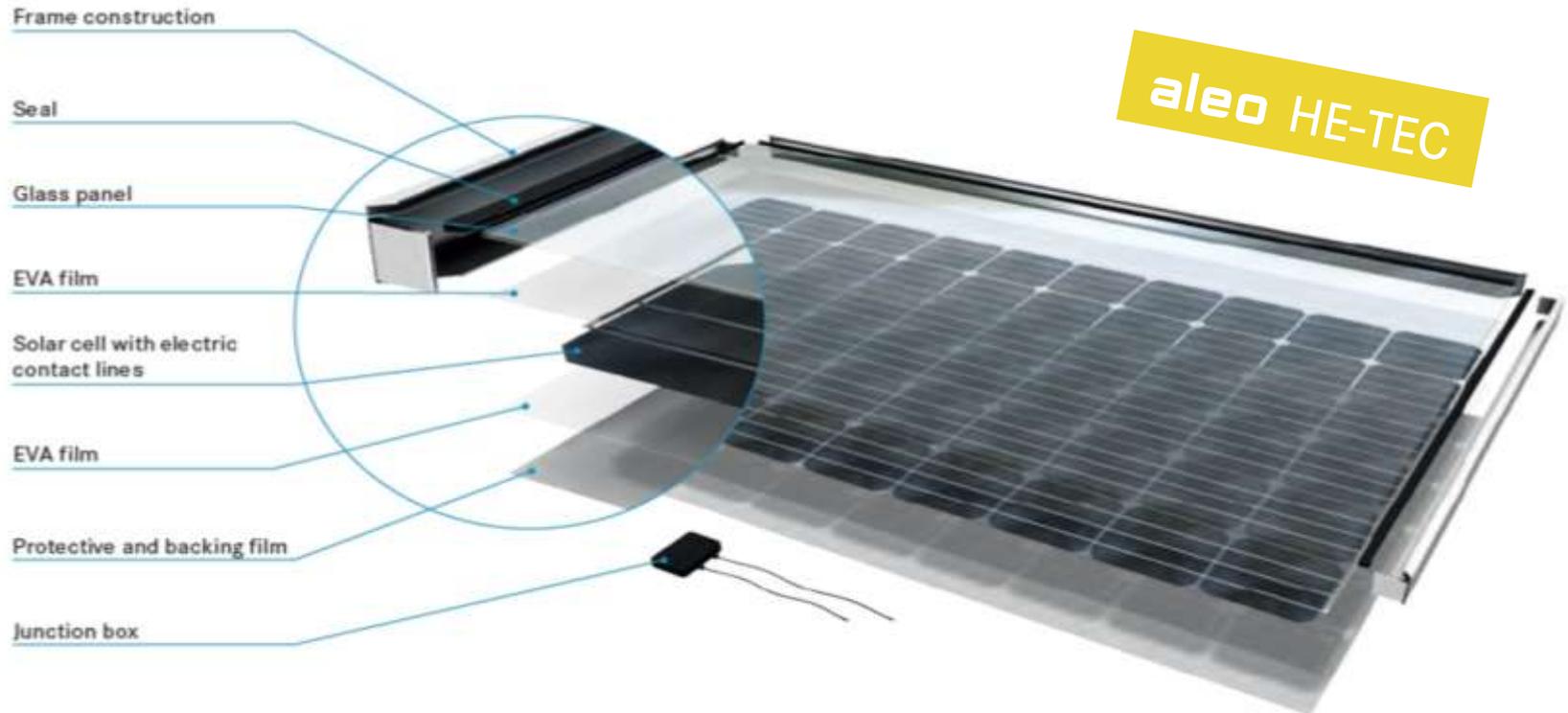
aleo S75

higher production and space utilization

For certifications and updated warranties of aleo PV panels please visit: <http://www.aleo-solar.de/en/products/guarantees/>

about aleo: why just buying a normal module?

aleo



→ the aleo S19 290 transforms sunlight into energy in a more efficient way thanks to a unique combination of components. We call this combination the “aleo HE-Tec”

about aleo: why just buying a normal module?

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aleo HE-TEC

→ Just like a super car needs adequate tyres, our modules are equipped with the right tyres to transfer the power into usable energy.



how?

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unique combination

With a unique combination of high efficiency optimized panel components. Among others: high efficiency cells, antireflection coated front glass, highly transparent embedding EVA film or optimized cells connectors with LHS Technology

robust and reliable

With its 50 mm aluminium frame the aleo S19 290 is robust and reliable over time. This panel doesn't fear high temperatures neither, because it has been heavily tested during the PVDI



adequate for all conditions

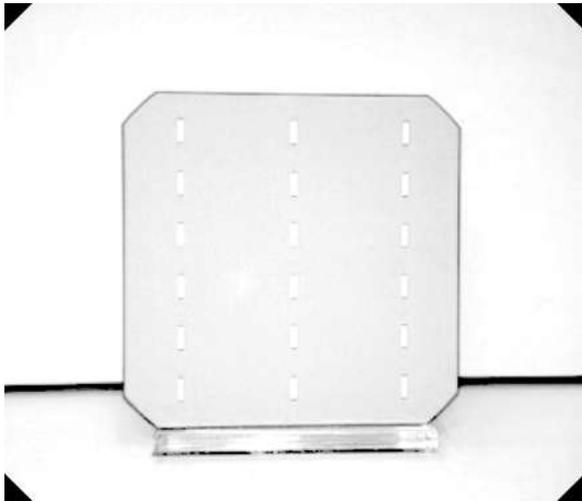
Red sky at night, sailor's delight! Our high efficiency panels can be installed also in case of weak light conditions or in smog polluted areas.

higher yield on equal size

Not enough space on your roof? With a higher yield on equal size, installation costs can be reduced both in terms of racking systems and practicality.

celco cells, why?

aleo



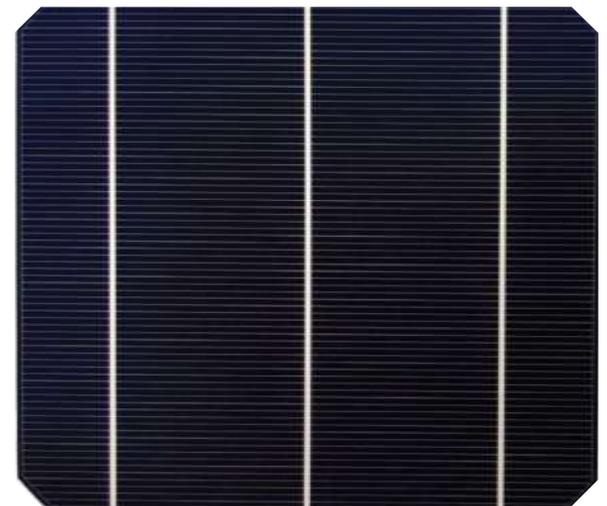
Because they guarantee higher performances, always .

Our panels use CELCO cells from the renowned cell technology leader

Sino-American Silicon Products Inc., Yilan Branch, formerly known as Sunrise Global Solar Energy Co. Ltd.

The cells with CELCO cutting-edge technology stand out because of their:

- High efficiency
- High efficiency stability over time
- High yield even at low solar irradiation



high transmittance antireflection coated front glass

aleo

- **aleo** high efficiency panels capture more light. This is made possible by a thin film made of silicon dioxide, which covers the front glass.
- Air and glass reflect light in different ways. These ways have been measured and named “refractive indices”. The difference among these indices allows comparison between standard panel front glass and aleo anti reflection (AR) front glass. The thin silicon dioxide coat reduces the refractive index on the glass surface and consequently light reflection.
- It means that panels with antireflection coated front glass compared with standard solar front glasses increase their power of about 2.5%.

high transmittance antireflection
coated front glass

aleo

→ This is how light behaves

without AR Glass

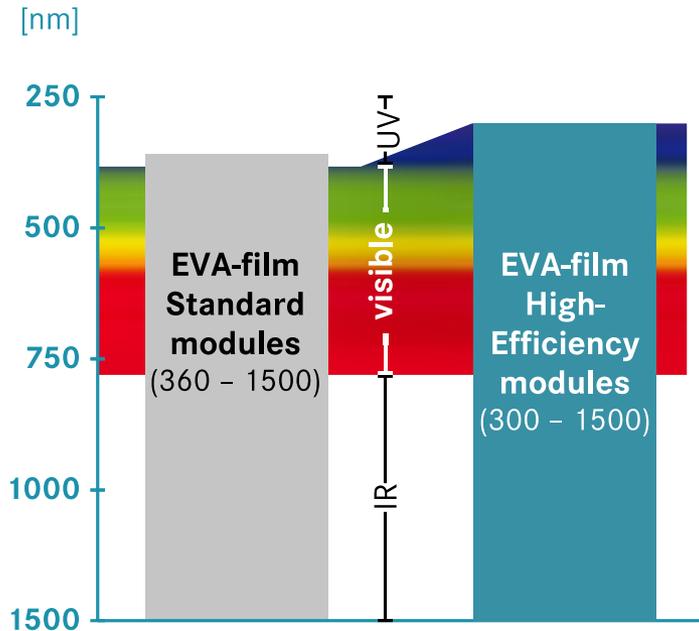


with AR Glass



highly transparent EVA embedding film

aleo

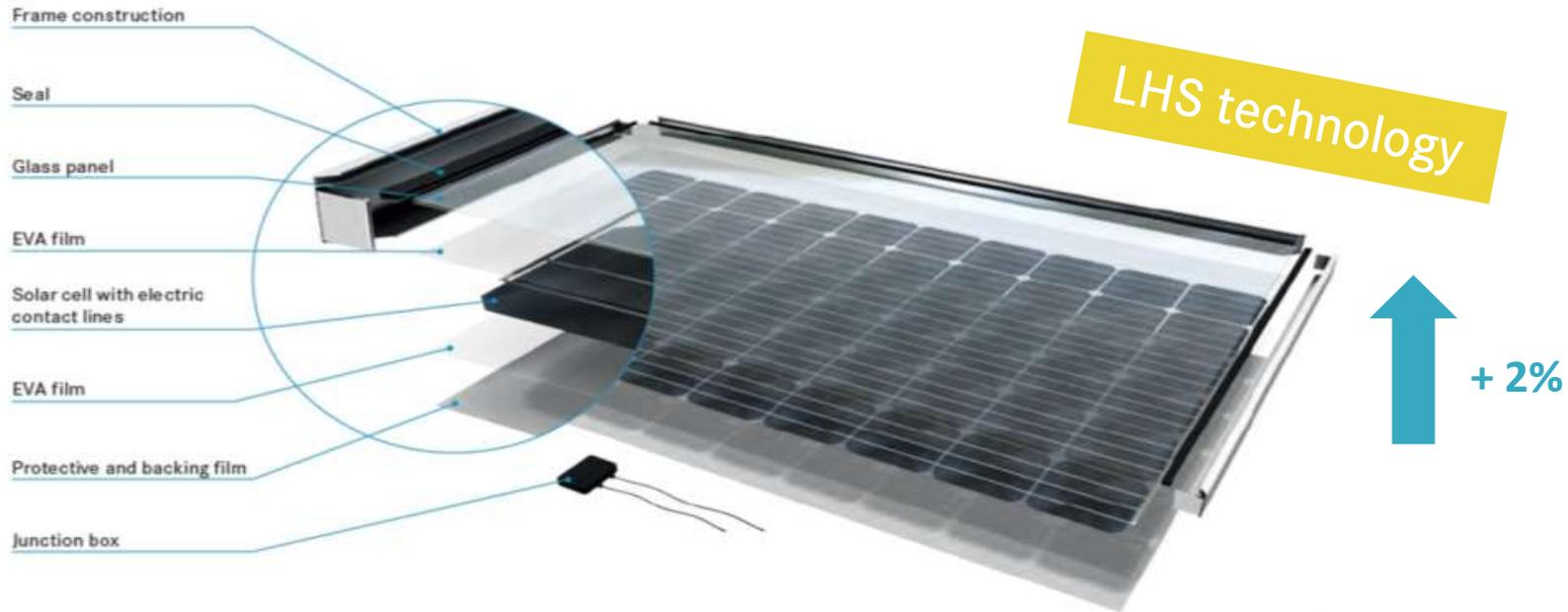


Better transparency in the UV spectrum

- The special EVA (Ethylene Vinyl Acetate) film we use, allows a better light transmission in ultraviolet spectrum.
- The improved characteristics of the highly transparent EVA film extend transmitted radiation spectrum and enhance its transmission. This process enables a greater quantity of light to get to the cells, passing through the film from the front side of the panel.
- Thanks to the highly transparent EVA film, panel increased power ranges between 1% and 1,5 %.
- We also add a UV blocker in the EVA film on the back of our cells to protect the panels backsheet.

LHS Cells Connectors: panels power further increased

aleo



- A further increase of panels power is achieved via special cells interconnections, called “Light Harvesting String” (LHS) technology. It was first developed by the Massachusetts Institute of Technology (MIT) and directs more light to the cells.
- Panels with LHS connectors see a power enhancement of 2% in comparison with those bearing non-structured connectors.

LHS Cells Connectors: panels power further increased

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- the concept of LHS stand to the current cell interconnection technology as smart phone stand to the first GSM mobile phone



→ quality means much for us

We aim for exceeding expectations and honour what we promise. This is why quality means so much for us.

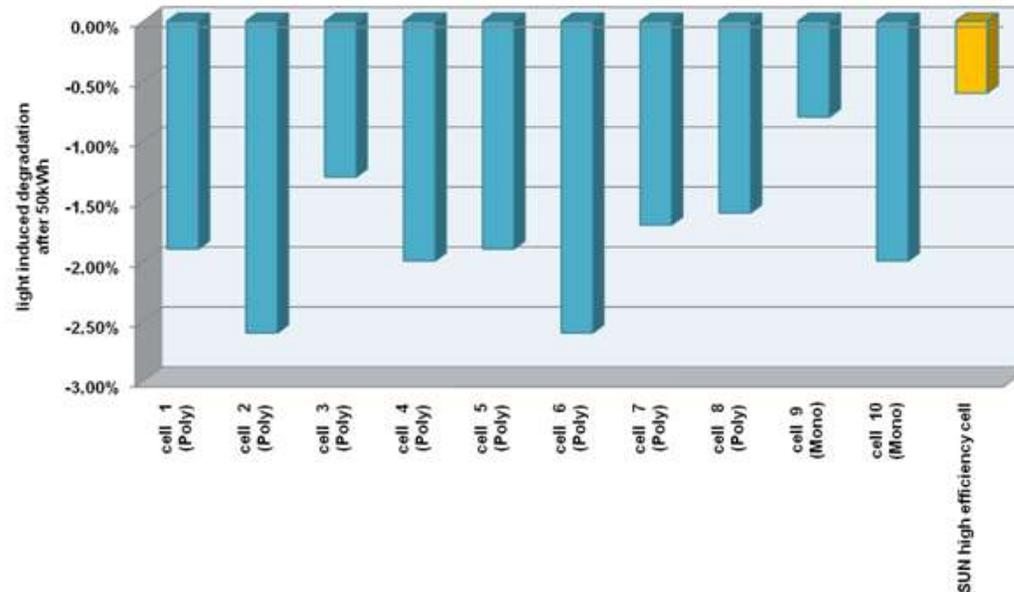
We let our panels be tested extensively from independent external certification bodies renowned PV Institutes. We run internal quality audits daily, our panels have to undergo several tests during processing and are tested extensively at the end.

You see, we do a lot to deliver panels with outstanding quality.



Superior light induced degradation (lid) behaviour

aleo



During their **first several weeks** exposed to light, solar panels suffer from the so called **light induced degradation process**, which reduces the efficiency of the PV panels continually until they stabilize at a lower efficiency level. Usually, the reduction of conventional panels is as high as 1 to 4% of the initial power output after 50 kWh. In contrast, aleo panels show a very minor degradation effect only (about 0.6%).

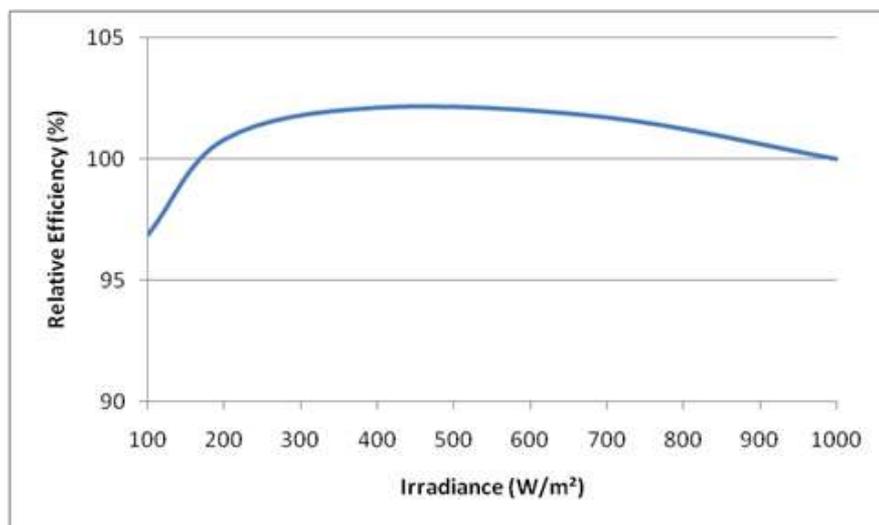
As part of aleo's quality management standards, we **solely use** the cells that are tested in our internal laboratories before. In addition, we also regularly run tests in natural sunlight.

This ensures the high yield of aleo panels pertaining far longer compared to conventional panels.

excellent low light behaviour

aleo

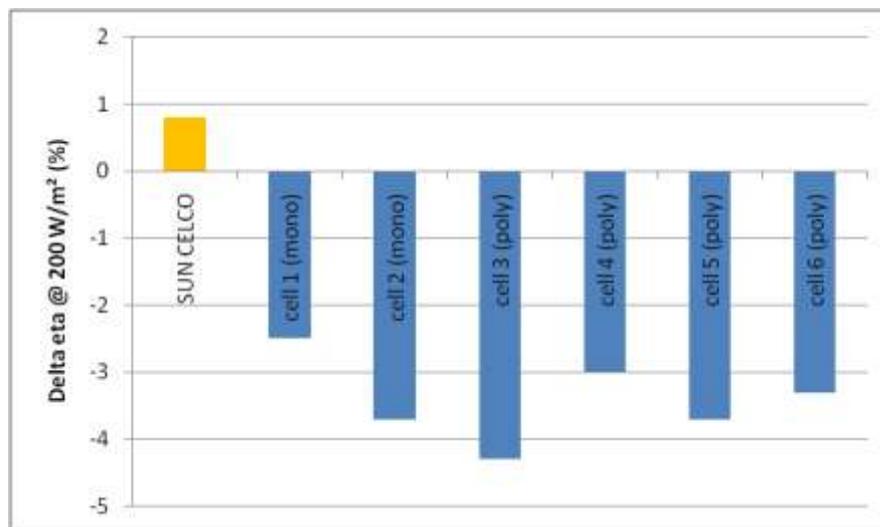
→ high energy output under non-ideal conditions



Tests were performed at PI Berlin (03/2013).

Aleo panels with high-efficiency monocrystalline cells accomplish a very high energy output also under non-ideal illumination conditions (cloudy weather, dawn).

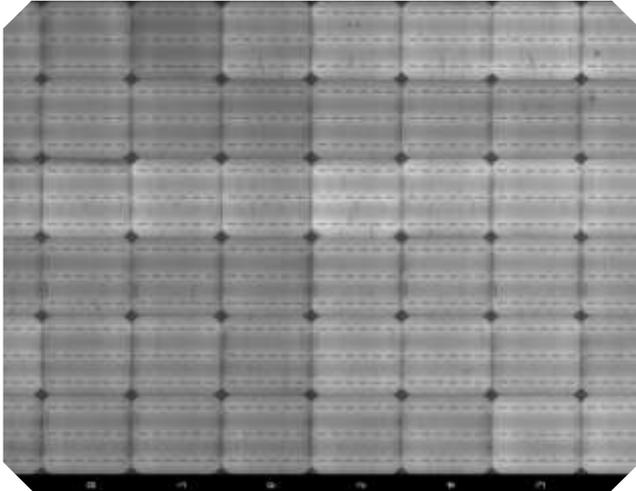
→ high yield under real conditions



While modules with conventional poly or mono crystalline cells usually suffer from efficiency losses between 2 and 5%, our modules even give an efficiency gain for 200 W/m² thereby ensuring high yield under real conditions.

2 x 100% EL test

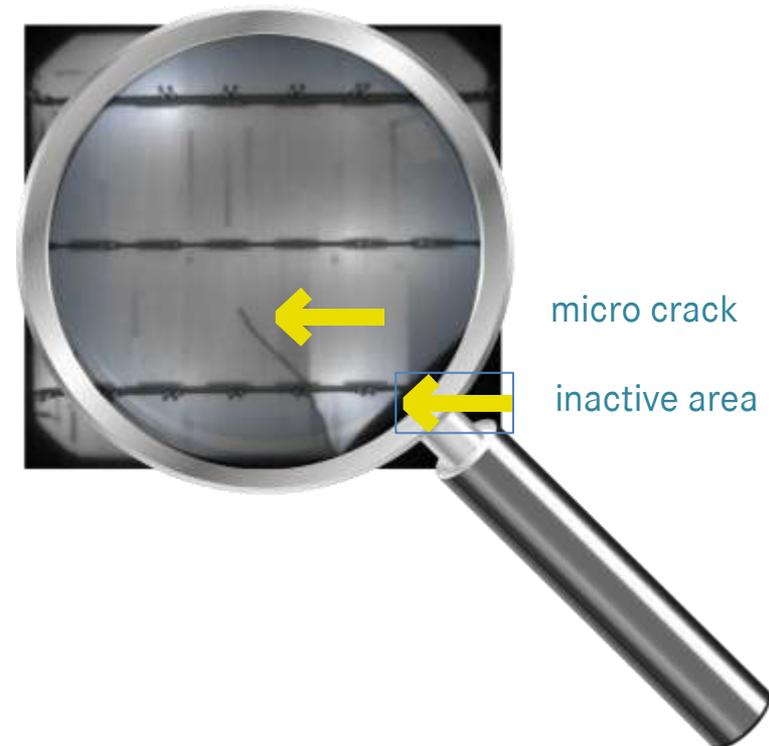
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All aleo modules are tested twice by the EL method. The first test is done before the lamination process in order to sort out defective cells or strings. The second test is done as part of the final quality control. Only modules that pass the strict test criteria are labelled as class A modules.

Moreover, **aleo** performs sampling EL tests on every cell delivery as well as on strings directly after the soldering process.

Using this principle of electroluminescence (EL), defects like micro-cracks or poorly contacted regions can be made visible as they show up as dark areas.



Snail trails free

aleo

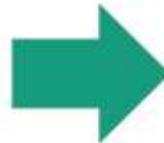


Snail trails are a non-reversible discoloration effect of cell fingers due to the formation of Ag nano particles in the vicinity of micro cracks. Snail trails deteriorate the visual appearance of the modules considerably.

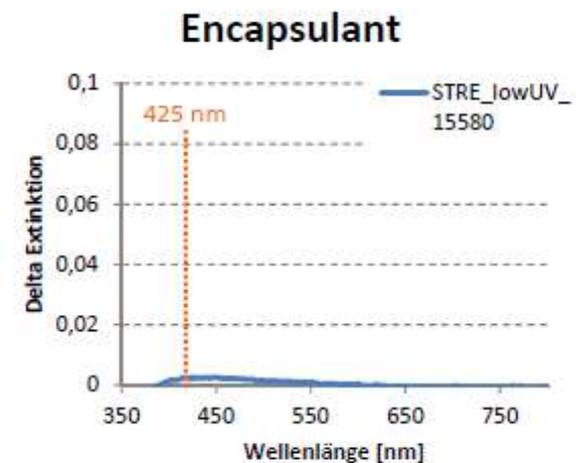
We solely use combinations of embedding foils and back sheets that are not susceptible to trigger snail trails. This has been proven by various tests at Fraunhofer CSP, Germany.



EVA Ref.



EVA SNP-Test



twice the required IEC 61215 Standards

aleo

→ **aleo really cuts the mustard**

All panel producers long for perfection, but aleo really cuts the mustard. We internally test our modules with twice the required IEC 61215 certification standards. What does that mean?

In a 25 year-long existence, it might happen that panels present failures. Since it's not possible to evaluate every module sold (millions) for 25 years, we need a set of tests that somehow accelerate stress performances, so to be enabled to produce over time reliable and faultless new modules. These tests are all considered in the IEC 61215 Certification, which is mandatory for all module producers

→ **Now, imagine these tests repeated twice.
Redundant? Not when it's about our panels**

PID Test

Damp-heat test
with UV irradiation

Static and dynamic
mechanical stress



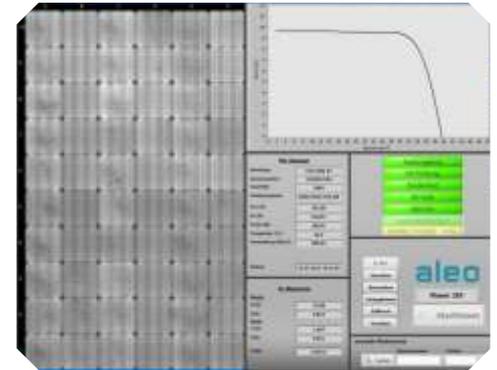
Temperature
cycles

100% Diode testing

aleo

→ hot spots

Bypass diodes which are contained in the junction box provide a current path around the string in the event that the string or part of it becomes faulty or shaded. If defective, the diode cannot provide the by-pass path thereby forcing the current produced by the unshaded panels to flow through the shaded string. This usually results in heating up the shaded cell string locally at so called “hot spots”.



→ aleo tests every single panel

This is the reason why **aleo** tests the diodes of **every single panel** before it leaves our factory as part of our thorough final quality control. In diode forward direction the potential difference over all diodes is measured at an applied current.

Diodes with too high or low resistivity are replaced immediately.



Low Carbon footprint

aleo

→ Carbon footprint

The term “Carbon Footprint” means a certain amount of gaseous emissions (CO_2) produced by human activities or cumulated over the life cycle of a product.

Ever wondered how much carbon is needed to produced a single solar panel?

→ aleo did!

In 10 months our modules are completely neutral and in about 20 years you'll save 5 Tons CO_2^*



215Kg CO_2 eq



*depending from module type and location of the module

→ **first module producers to enter the pV Cycle Org**

We are proud to be one of the first module producers to enter the PV Cycle Org in 2007. This European, non-governmental organization collects end-of-life solar panels in order to recycle 85% of the material modules are made with.

With our PV CYCLE membership and the existing service contracts we ensure that we are fully compliant with the European WEEE regulation.

Less than 40 modules can be disposed free of charge at the PV CYCLE collection points. With more than 40 modules, PV CYCLE will pick them up free of charge upon request.



100% automated geometry control

aleo



→ **electrically safe**

In order to ensure modules to be electrically safe, every laminate is checked by an automated inline vision system, as well as location and geometry of every cell string. As a result, an homogeneous appearance of distances in the modules can be achieved.

linear power guarantee

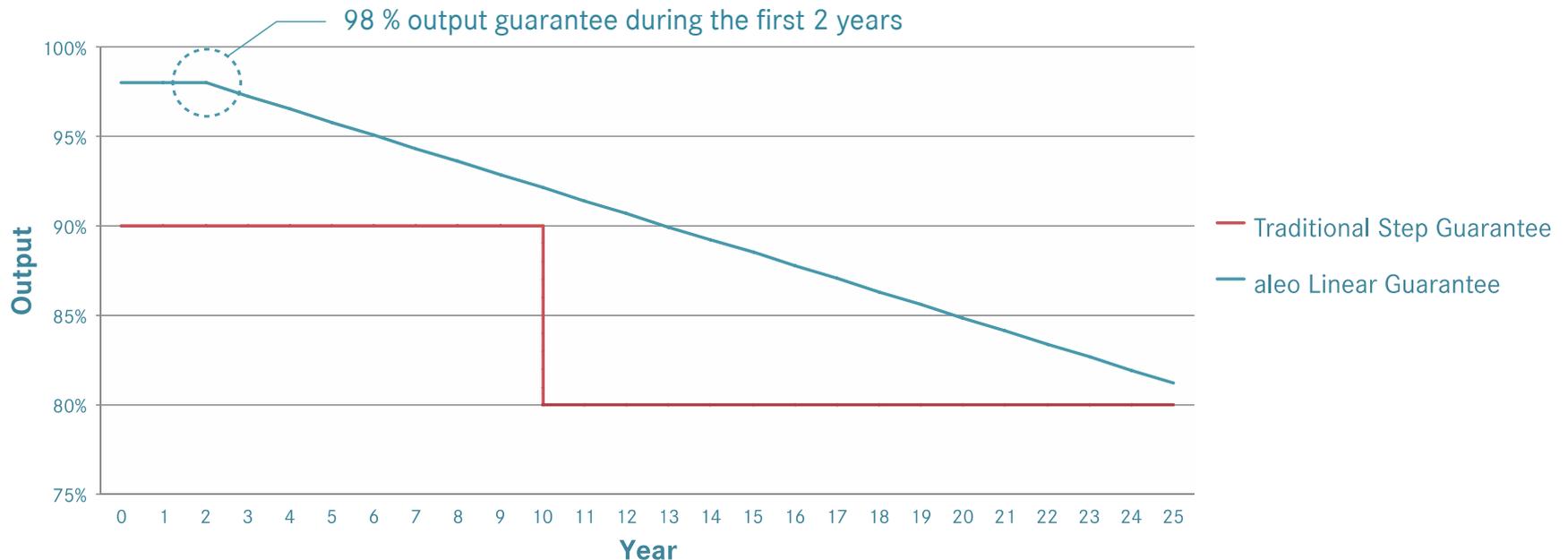
aleo

→ best in class

We have extensively tested our modules, analyzed hundreds of possible material combinations to be matched with the cells we use.

That's why we can now commit to a best in class linear guarantee for the performance of our modules.

We know our modules will not disappoint you.



linear power guarantee

aleo



25 years linear guarantee

we take this commitment seriously and put all our expertise and passion on every module we manufacture, every day.

10 year product guarantee

➔ **reimbursement of replacement costs for guarantee cases**

When you buy an aleo product you put on your roof a product which is only apparently simple. And that's OK. We take care of all details, from design to packaging, so that you can enjoy the benefits of this source of green energy.

And if something goes wrong, we will take care of it.

That's it. Simply.

Benefits for the installer

aleo

- Directly from the factory*
- You can offer a product that represents a best in class while using a consolidated and robust technology: no surprises!
- Faster installation time
- Less modules for easier layout
- Perfect match for microinverters or power optimizers: 1:1 savings on BOS costs
- Replacement costs for guarantee cases are reimbursed so your margin, even in case of claims, is not affected



Benefits for the end customer

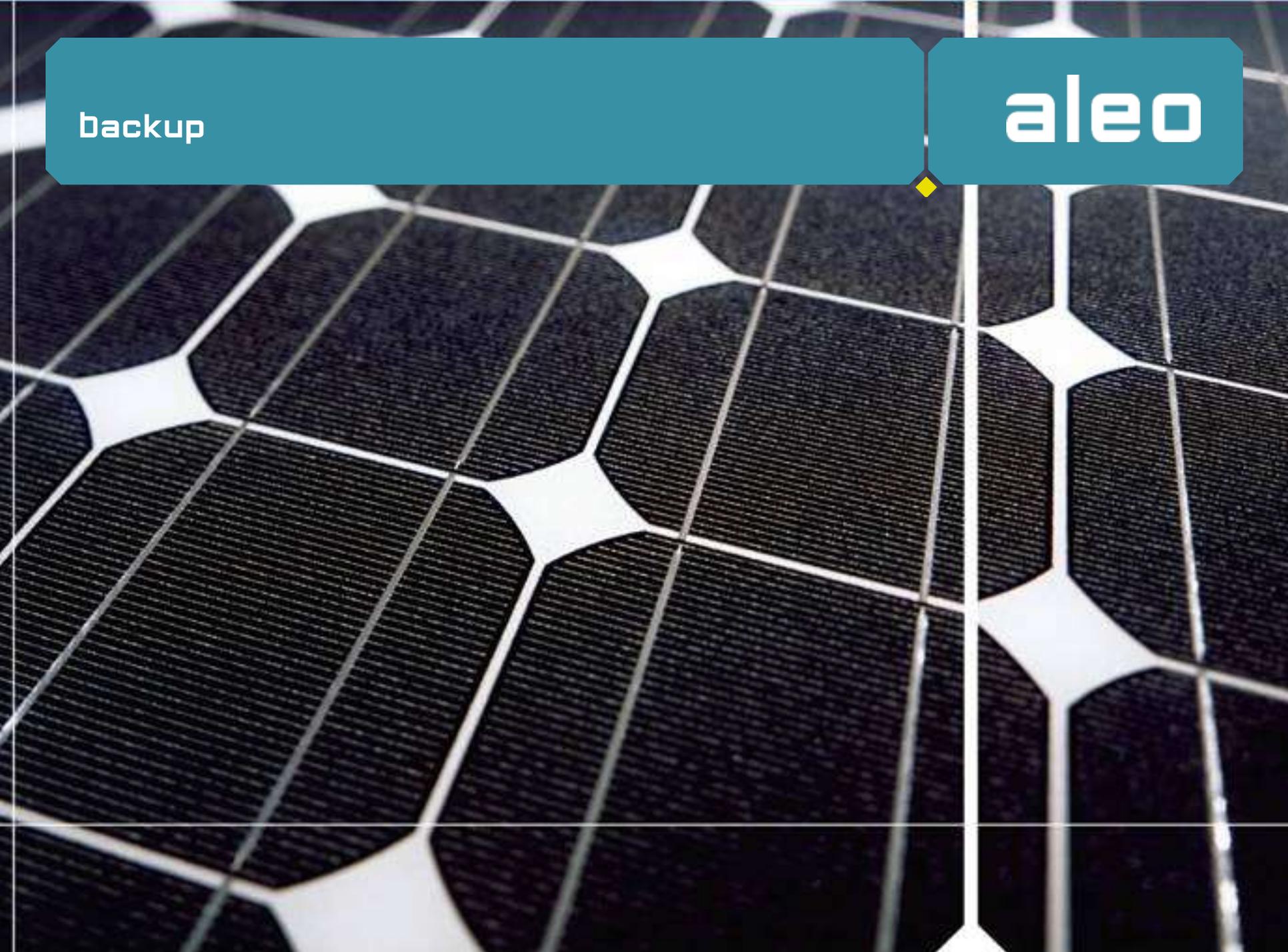
aleo

- When installing an aleo solar module on your roof, you install a robust all-weather performer that allows a predictable, secure return
- Consolidated technology values your peace of mind: we ill-treated our modules enough to be sure they will deliver what promised
- From London to Rome, in Paris or Munich. At the sea or in the highest mountains.
- Robust and reliable as Made in Germany products can be



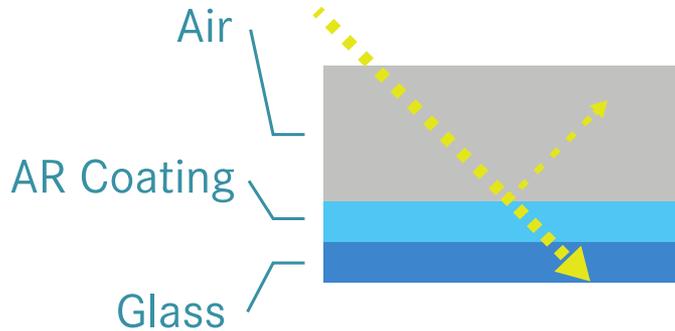
Backup

aleo

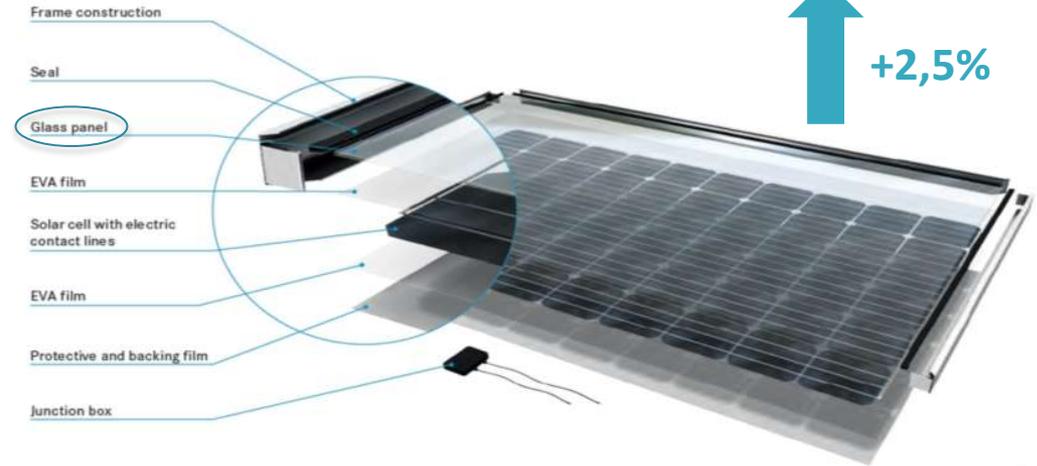
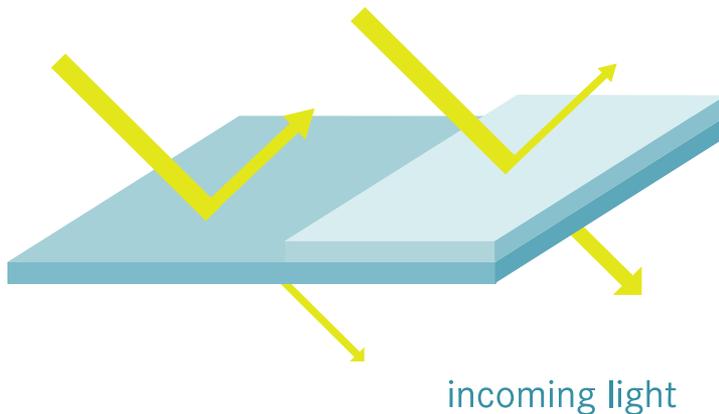


high transmittance antireflection coated front glass to capture more light

aleo



Reflected light



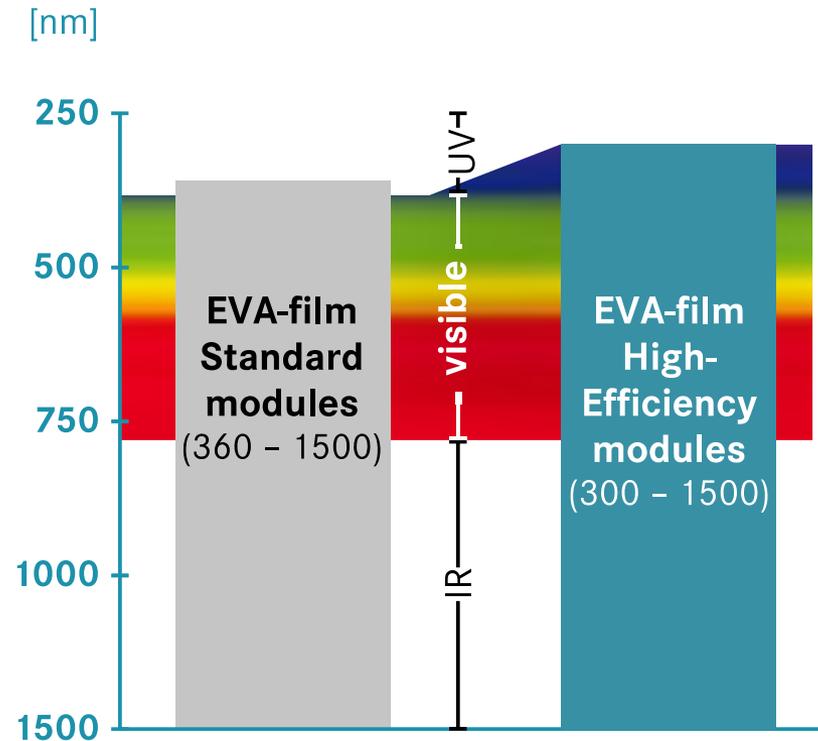
→ **aleo** high efficiency panels capture more light. The enhancement in light transmission is made possible by the thin silicon dioxide coat covering the front glass. The stability of this covering has been tested in environmental chamber.

→ Due to the different refractive indices of air ($n = 1$) and glass ($n \approx 1,5$), standard solar front glasses usually reflects 4% of the light (see table). The thin silicon dioxide coat reduces the refractive index on the glass surface and consequently light reflection.

→ Therefore, if compared to standard solar front glasses, panels with antireflection coated front glass increase their power of about 2.5%.

highly transparent EVA embedding film

aleo



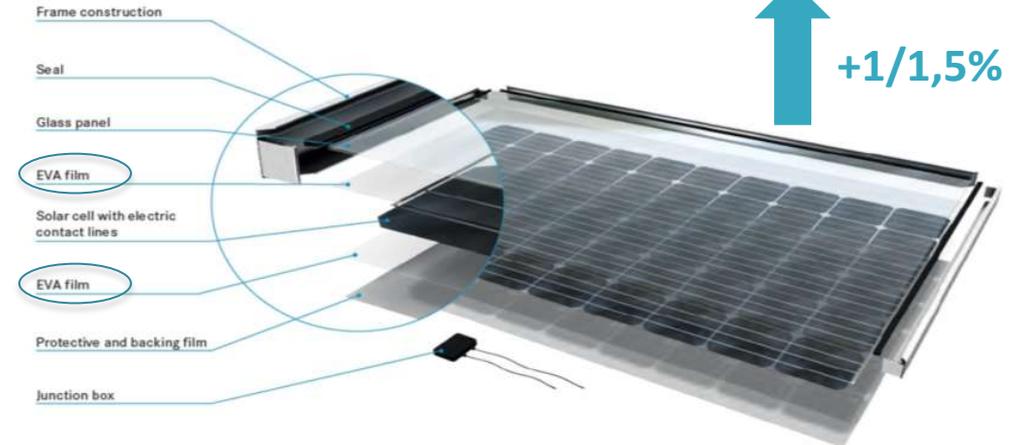
Better transparency in the UV spectrum

EVA: Ethylene Vinyl Acetate

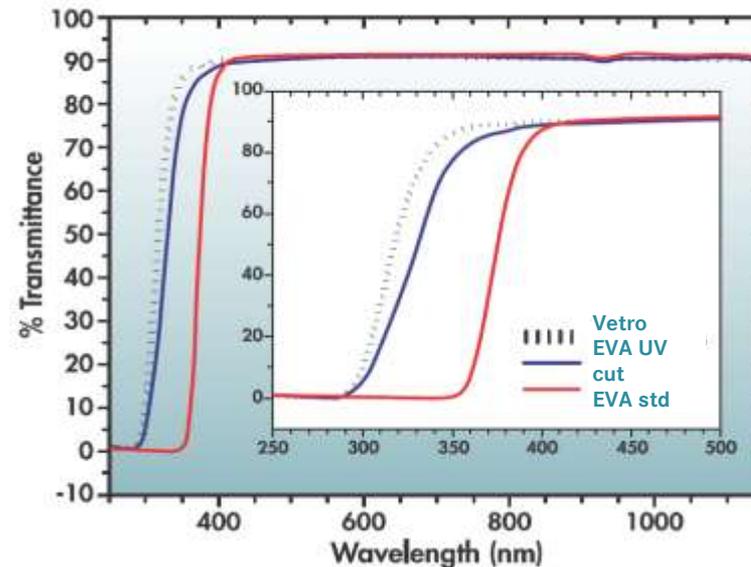
highly transparent EVA film.
Why? More light for the cells

aleo

- The special EVA (Ethylene Vinyl Acetate) film we use allows a better light transmission in ultraviolet spectrum.
- The improved characteristics of the highly transparent EVA film extend transmitted radiation spectrum and enhance its transmission. This process enables a greater quantity of light to get to the cells, passing through the film from the front side of the panel.
- Thanks to the highly transparent EVA film, panel increased power ranges between 1% and 1,5 %.

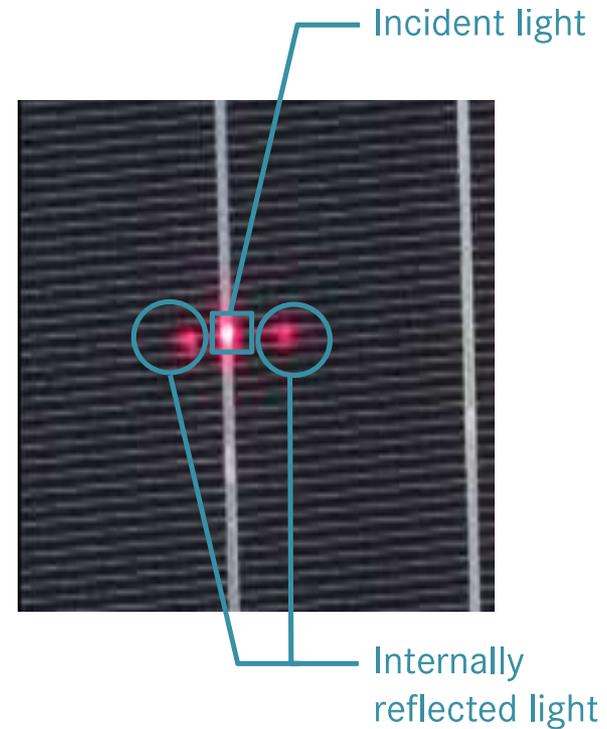
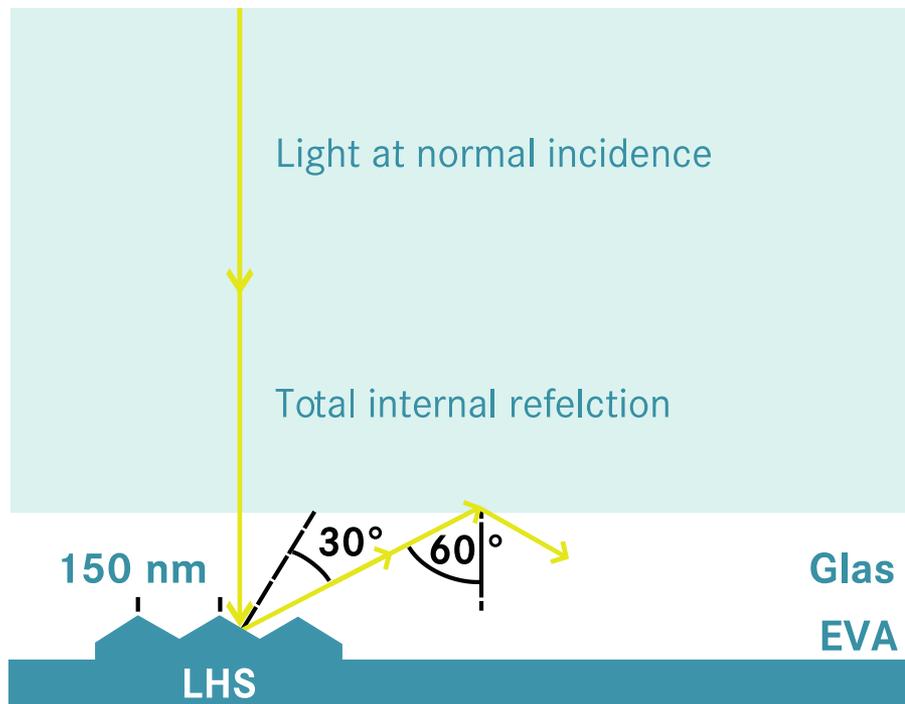


Higher UV-Transmission: Improved Blue Response



Optimised cells connectors with LHS technology

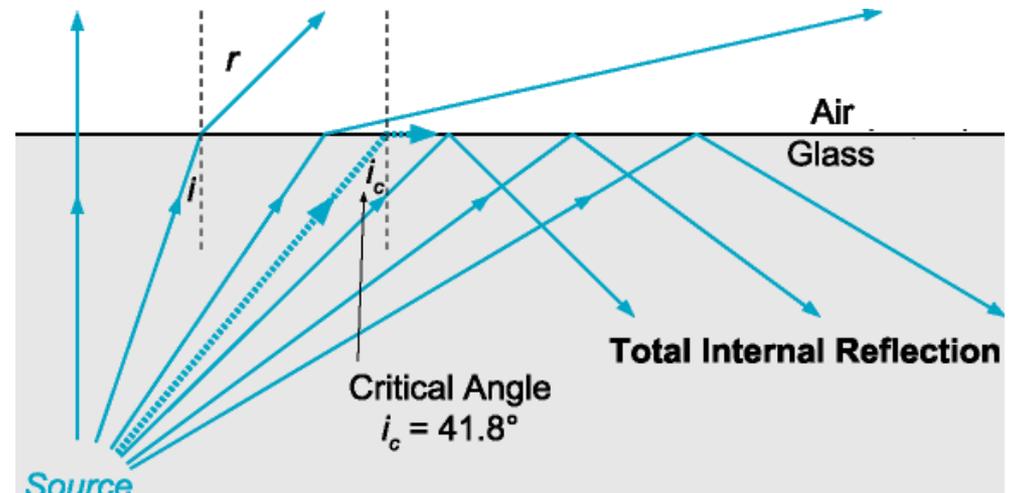
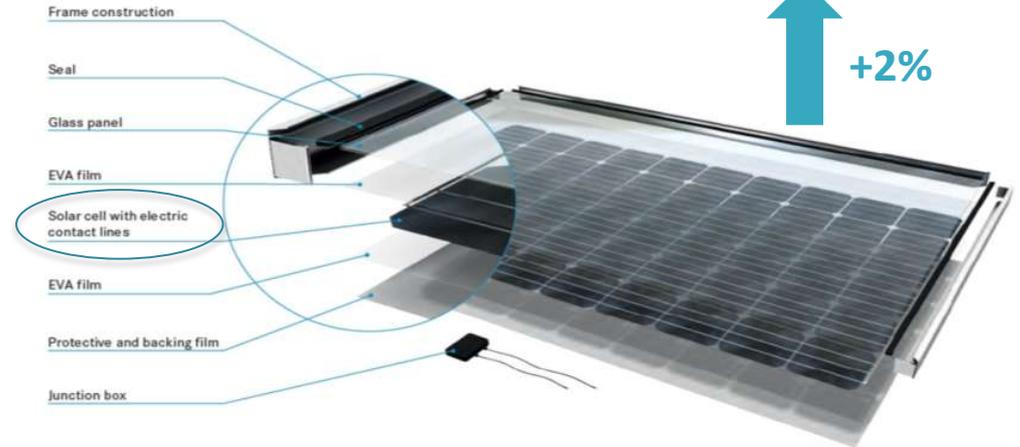
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LHS Cells Connectors. Why? panels power further increased

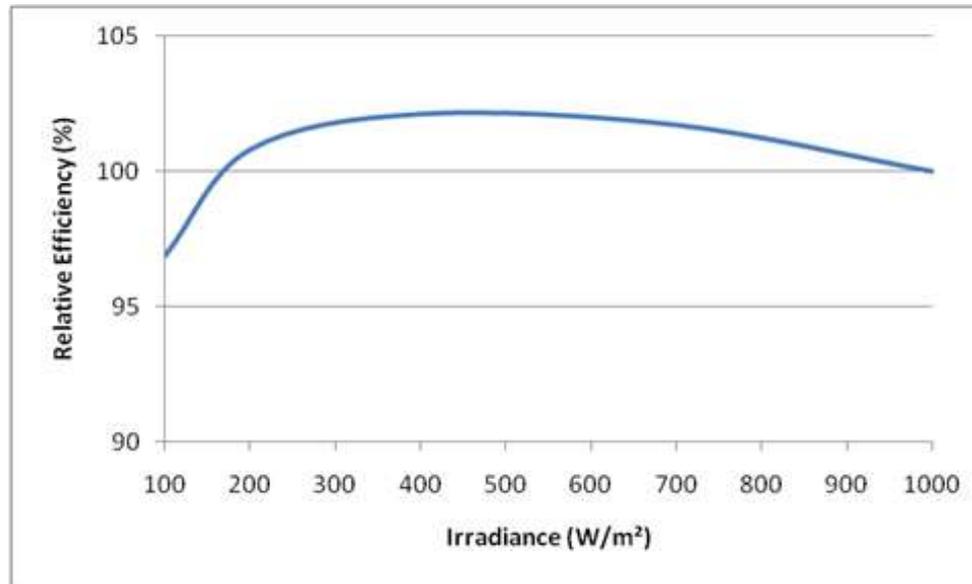
aleo

- A further increase of panels' power is achieved via special cells interconnections:
- the “Light Harvesting String” (LHS) technology, which was first developed by the Massachusetts Institute of Technology (MIT), directs more light to the cells.
- The expressly created microstructured silver surface of the copper connectors yields a direct reflection of incident light. Its angle induces a total internal reflection, so the light is guided back to the cells (see table).
- Panels with LHS connectors see a power enhancement of 2% in comparison with those bearing non-structured connectors.



Low light behaviour of aleo HE Modules

aleo



At the end of each panel production line, the panels are tested at so called standard test conditions: 25 C, 1000 W/m², AM1.5g.

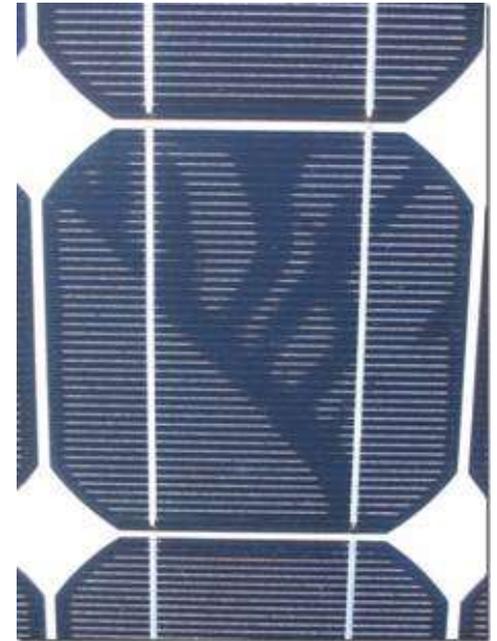
However, in real operation such conditions are hardly ever reached. At most of the time, the panels operate at much lower irradiance levels. To ensure that also for such conditions the panels give high yield, the low-light characteristic of the cells used is important.

The Celco cell used in aleo modules rank among the top-market cells in terms of low irradiance behaviour. Down to 200 W/m² the cells do not show any reduction in efficiency.

Snail trails are a non-reversible discoloration effect of cell fingers due to the formation of Ag nano particles in the vicinity of micro cracks. Thus, snail trails make micro cracks visible which in turn indicate the risk of power losses due to electrically inactive cell areas.

Moisture penetrates through the back sheet. In a micro crack, the water molecules split up through electrolysis resulting in the creation of hydrogen. Finally, there is a chemical reaction between the hydrogen, the silver ions in the metallization paste of the fingers and additives (like halogens) of the EVA foil forming silver nano particles which appear brownish.

We do 100% EL inline inspection twice in order to minimize the occurrence of micro cracks. We use combinations of EVA and back sheets that are not susceptible to trigger building silver nano particles which has been proven by tests run at Fraunhofer CSP, Germany.



twice the required IEC 61215 Standards

aleo

We internally test our modules standard equipment with twice the required IEC 61215 certification standards.

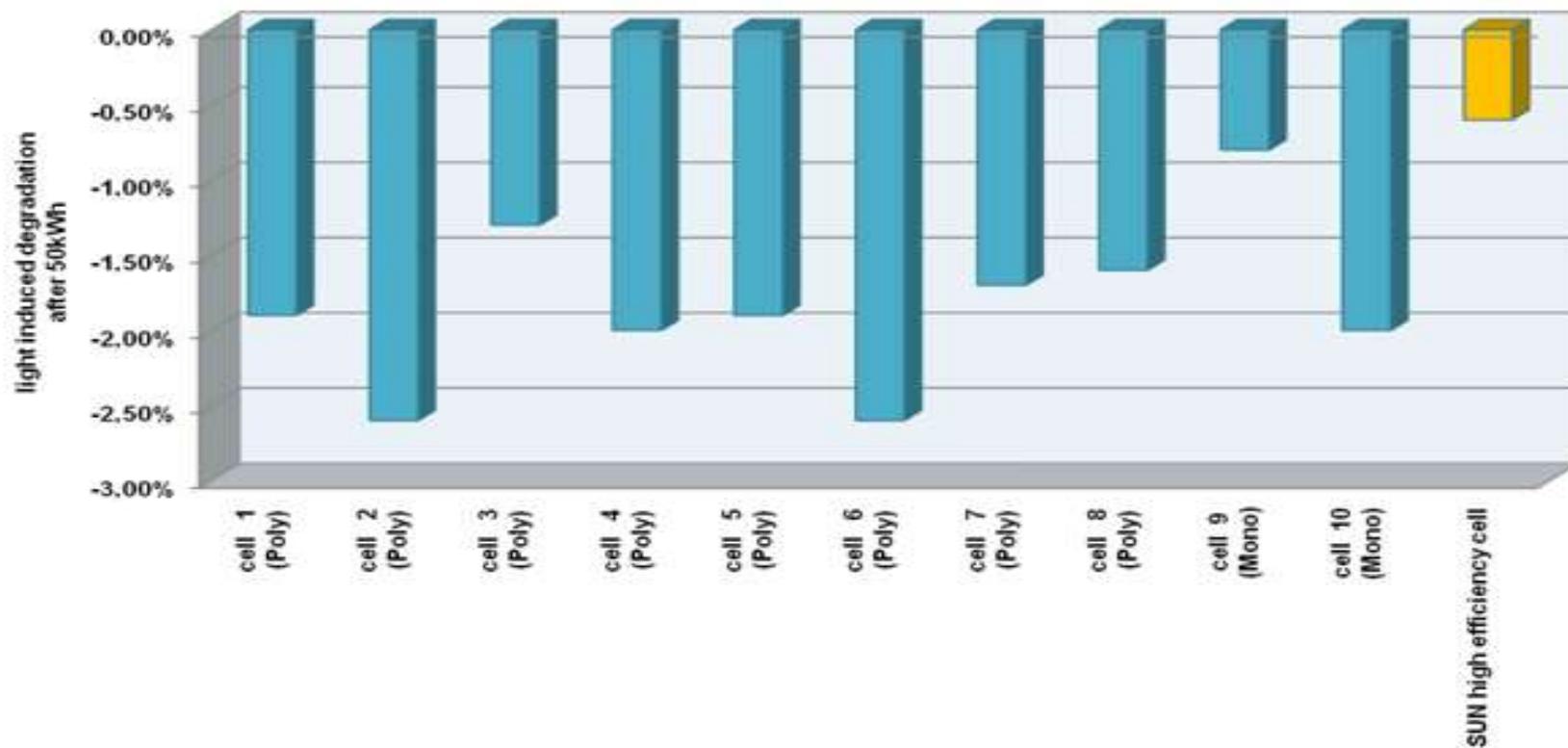
2000h x Dampheat
400 x Thermal Cycles
20 x Humidity Freeze Cycles (40 in the case of junction box)
20 x UV Test for EVA Film and backsheet

ICE 61215 tests	mandatory by law	performed internally by aleo again
THERMAL CYCLES	V	V
DAMP HEAT	V	V
HUMIDITY FREEZE	V	V
UV TEST	V	V* 20 times

light induced degradation (lid)

aleo

Performances of Sunrise Global Solar Celco Cells (used by **aleo**) compared to competitors



Compared to conventional polycrystalline cells, the high-efficiency mono crystalline cells used in aleo modules show a very minor light-induced degradation effect. This means that the initial power drop usually observed for standard modules is less than 1.0% for our modules. The LID effect is determined as part of the qualification process for new materials (55C , till 50kWh) and monitored regularly on our test field modules in natural sunlight.

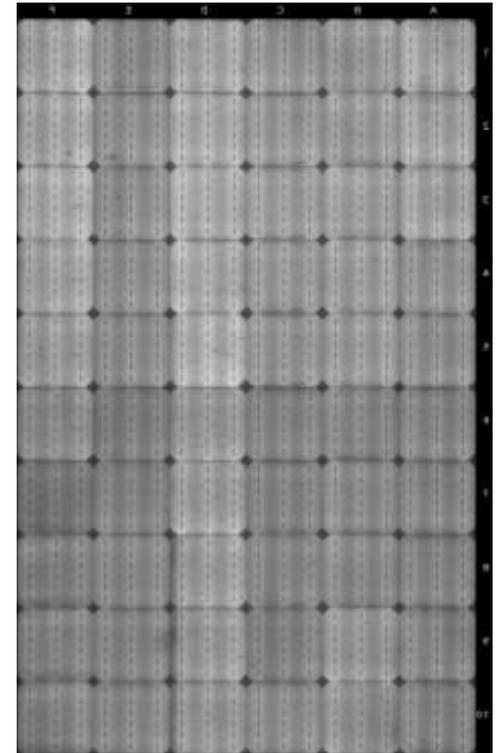
2 x 100% EL test

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The silicon based cells in the panel emit infrared light when external voltage is applied in forward direction. The intensity of the emitted light which is captured by an infrared sensitive camera shows the cell's capability to convert light into electricity. Dark areas indicate the presence of micro cracks, poorly contacted regions or inactive parts of the cell.

aleo performs a 4 steps EL test before releasing its modules

1. On sample for every cells delivery
2. On sample during the soldering process
3. 100% before the lamination process
4. 100% at the end of production.



aleo

pvdi photovoltaic durability initiative

fraunhofer ise pvdi test 2013

aleo

After 2006 (Stiftung Warentest, S16) and 2010 (Ökotest, S18) we have an new successful aleo Module test done by the Fraunhofer ISE Institute



- 5 test runs: PID, UV/DH, dyn. mech. load....
- 3 of 5 times best ranking with `5` of 5 possible points
- TOP at PID, UV and damp heat and thermal cycle test
- results:
- Nearly no power degradation
- Only a single digit percentage degradation
- Also TOP: 2 of 5 times 2nd place with `4` of 5 possible points

Rating r	normalized cumulative performance P
5	$P \geq 0.95$
4	$0.88 \leq P < 0.95$
3	$0.75 \leq P < 0.88$
2	$0.50 \leq P < 0.75$
1	$P < 0.5$
0	$P = 0$

	PID		UV/DH		dyn. load		stat. load		Therm. cycling	
	P	r	P	r	P	r	P	r	P	r
PVDI 01	-	5	-	5	-	5	-	5	-	5
PVDI 02	-	4	-	5	-	5	-	5	-	5
PVDI 03	-	4	-	5	-	5	-	5	-	2
PVDI 04	-	5	-	5	-	5	-	4	-	2
PVDI 05	-	5	-	5	-	4	-	3	-	4
Aleo	0,98	5	0,98	5	0,93	4	0,90	4	0,95	5
PVDI 07	0,92	4	0,96	5	0,89	4	0,91	4	0,94	4
PVDI 08	0,85	3	0,95	5	0,77	3	0,73	3	0,78	3

The ranking provided in the table is not meant as test placement

thank you

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