Q.ANTUM VS. PERC

PERC TECHNOLOGY

In traditional BSF (Back Surface Field) solar cells some charge carriers and light are lost to the metallization at the rear of the cell. With PERC (Passivated Emitter Rear Cell) technology a passivation layer is added to the rear of the cell so that the otherwise lost charge carriers and light are reflected back into the silicon.

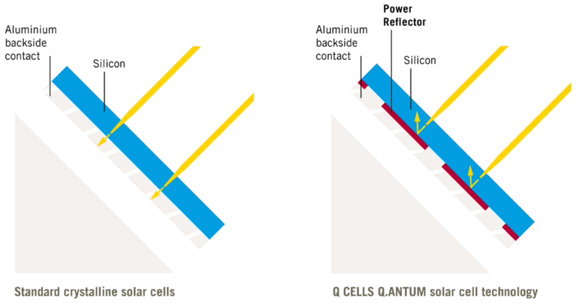

Figure 1: Additional "Power reflector" in Q.ANTUM solar cells

The reflection of charge carriers increases power generation of the cell under all conditions, however the reflection of light specifically improves the power generation from longer wave lengths of light, namely infrared [> 700 nm], and adds a noticeable improvement to the performance under typical real world weak light conditions. This advantage comes from the shift to longer, redder, wavelengths of light falling on the cells at sunrise and sunset. In standard test conditions PERC cells are around 5 % more efficient than traditional BSF cells, in terms of a 60-cell solar module this is about 15 watts.

Q.ANTUM TECHNOLOGY

Hanwha Q CELLS has been developing its Q.ANTUM technology since 2007 and whilst PERC techniques are a vital part of what makes Q.ANTUM special, it is one of the many features which makes it stand out. Anti LID, Anti PID, Hot-Spot Protect, Tra.Q™ and Quality Tested all come together to form Q.ANTUM and provide the most powerful, long lasting, stable and secure modules. Q.ANTUM is the most mature PERC technology, with experience gained from 10 years of R&D, 5 years of mass production and cumulative installation of over 5 GW globally. Hanwha Q CELLS has annual production capacity approaching 4 GW, with further expansion plans in new and existing production sites.

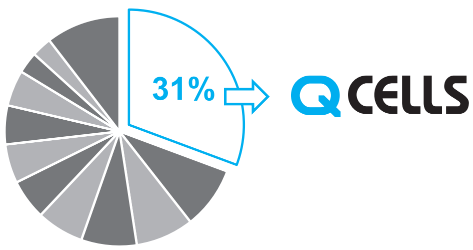

Figure 2: Q.ANTUM as a share of global PERC cell production

Others clearly struggle to bring PERC technology to market, with small production volumes and a focus on Mono PERC. One of the major reasons for this is potential for high initial degradation in PERC cells if not actively addressed. The primary causes of intial degradation are LID, Light Induced Degradation, and LeTID, Light and Elevated Temperature Induced Degradation. These have different underlying causes, so Hanwha Q CELLS utilizes multiple proprietary processes to minimize initial degradation in Q.ANTUM cells.

ANTI LID

In the past Mono modules have always suffered from higher LID than Poly modules. This is due to a higher concentration of Oxygen in the silicon wafers from which the cells were produced. This is an unavoidable side-effect of the Mono wafer production process. Oxygen forms complexes with the Boron added to make wafers "P-Type". During the initial exposure to light these B-O complexes trap free electrons, permanently reducing the power of the module by up to 3 %.

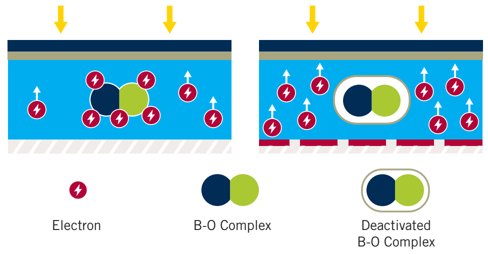

Figure 3: Boron-Oxygen complex in standard cell and Deactivated Boron-Oxygen complex in Q.ANTUM cell

Q.ANTUM's Anti LID Technology permanently deactivates these Boron-Oxygen complexes in the factory. Thus ensuring minimal LID in Q.ANTUM Mono cells.

ANTI LETID

LeTID (Light and elevated Temperature Induced Degradation) requires both light and high temperatures to occur and progress. It was thought that LeTID only affected Poly PERC, however as the availability of PERC products has increased the industry has become aware that this degradation also affects the much more common Mono PERC modules.

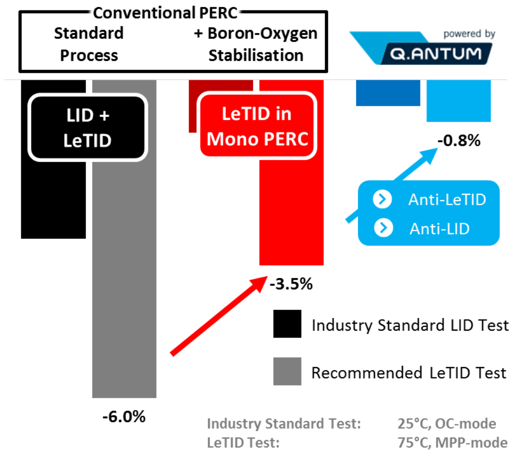

Figure 4: Observable degradation from industry standard LID test and LeTID testing for differently processed PERC modules.

LeTID can cause degradation of 6 % within the first 3 years of operation, depending on the climate of the installation site. It is recommended that anyone using PERC modules should test for LeTID. Testing using a climate chamber to maintain a temperature of 75° along with current injection to the module of about 1 ampere (1A) for several days will reveal LeTID in PERC modules. Such testing needs to quickly become industry standard to protect investments. Q.ANTUM, as the most mature PERC technology, protects from degradation phenomena such as LID, LeTID and others like PID.

Q.ANTUM VS. PERC

ANTI PID

PID (Potential Induced Degradation) comes from a difference in electric potential between the solar cells and the frame of the module. PID can reduce module performance by 80 %.

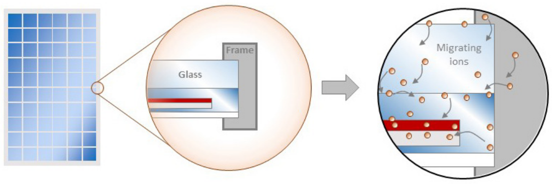

Figure 5: Migrating sodium ions in PV module, the force behind PID

Hanwha Q CELLS started analyzing the PID effect in 2008 and started to publish about the PID effect in 2011. Then in 2012 Anti PID Technology was introduced on all Q CELLS products. Hanwha Q CELLS understands the causes of PID in the field. Results from testing cells and modules as well as from sites around the world allow Hanwha Q CELLS to accurately model the PID effect, ensuring secure yields in any environment.

HOT-SPOT PROTECT

The processing of silicon wafers can cause imperfections which lead to Hot-Spots. Hot-Spots can lead to delamination and power degradation over time as the backsheet begins to degrade in the high temperature. The industry standard is to use the cells' electrical parameters to identify Hot-Spots, however due to the low resolution of this process most Hot-Spots are overlooked. Hanwha Q CELLS uses an IR camera to test each and every cell for potential Hot-Spots. Spatial resolution of the IR camera allows for removal of 100 % of affected cells during production.

TRA.Q™

At the heart of every Q.ANTUM solar cell is Traceable Quality (Tra.Q™). This unique laser engraved matrix barcode not only ensures original Q CELLS quality, but allows every cell produced to be traced back through its entire lifetime from wafer to field. Production information in this detail means Hanwha Q CELLS can optimize production and raise quality using a level of detail not found elsewhere in the PV industry.

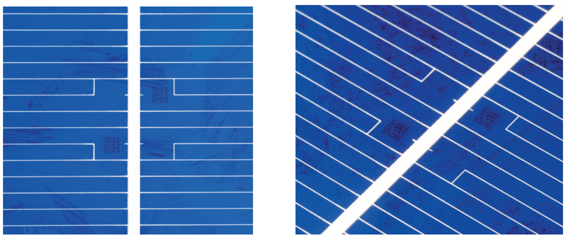

Figure 6: Close up of Q.ANTUM solar cells showing Tra.Q™ markings

Q CELLS QUALITY PROGRAM

Despite the best warranty conditions, a solar PV system will turn into a nightmare if modules need to be replaced on a regular basis. Together with the VDE, a renowned German certification body, Hanwha Q CELLS implemented the most comprehensive quality program in the industry – VDE Quality Tested.

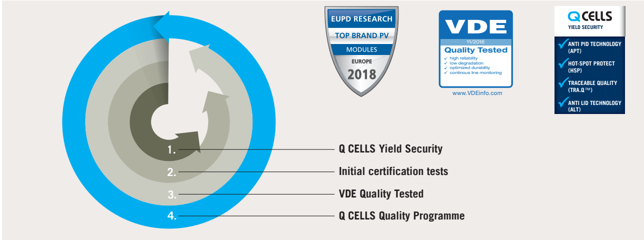

Figure 7: Stages of Q CELLS Quality Program

VDE Quality Tested goes far beyond the minimum IEC and UL certification requirements, to more realistically simulate real world stresses. This includes extending the minimum test times, adding mechanical load tests before climate chamber tests and lowering the allowed level of degradation caused by these tests. After the initial certification tests VDE Quality Tested then continues with monthly retesting to guarantee consistent product quality. Q CELLS ongoing Quality Program requires a 100% EL inspection along with wet leakage, high pot, reverse current, grounding and cross linking tests. Additionally to this modules are randomly selected from production for complete re-inspection, mechanical loads, climate chamber and performance tests.

BENEFIT OF Q.ANTUM

Q.ANTUM modules are available in power classes up to 20 % greater than standard BSF modules. For a residential roof top installation of 5 kWp this is 16 instead of 20 modules, providing savings in installation labor and BOS.

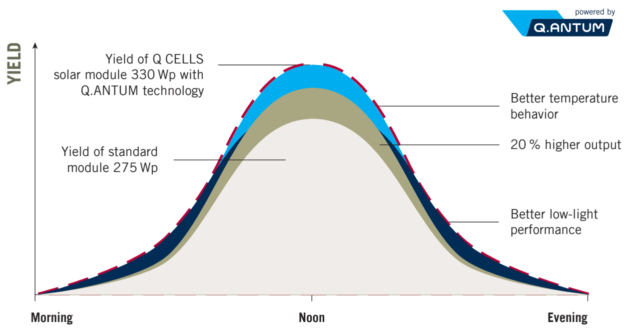

Figure 8: Benefits of Q.ANTUM Technology

Most crystalline solar modules suffer on hot days, but Q CELLS solar modules produce reliable yields and lose less efficiency than standard solar modules with an excellent temperature coefficient of up to -0.37 %/K. Q.ANTUM modules also have first class energy yields even in weak light conditions, for example during sunrise and sunset, but also in autumn and winter when the sun is low over the horizon.

These factors in combination with positive sorting gives a first class specific energy yield, which has been independently confirmed in the harsh desert conditions at Alice Springs DKA, where Q.ANTUM powered modules show 1 % higher specific yield than competitor BSF modules.