The REC TwinPeak Series:
How improvements in production lead to better degradation resistance

REC has recently completed research into ensuring long-lasting high performance of REC solar panels with PERC technology and been successful at bringing this into production. These unique methods and improvements give excellent results that significantly reduce the impact of Light Induced Degradation on cells with PERC technology and the impact of increases in temperature on the output of the panel.

Light Induced Degradation

What is Light Induced Degradation?

Light Induced Degradation (LID) is a phenomenon seen in silicon solar panels where minor impurities and oxygen concentration in the wafer material[1] cause a permanent loss of power upon first exposure to sunlight. Although the panel stabilizes after a few days, it is irreversible in field mounted panels.

What effect does this have on PERC cells in particular?

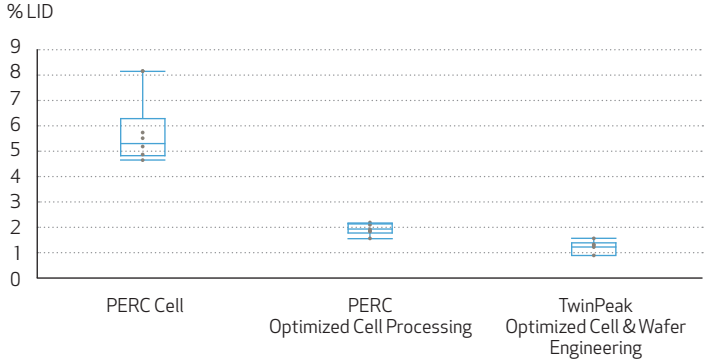
Passivated Emitter Rear Cell technology (PERC) is a relatively new technology in solar cell production which adds a layer of aluminium oxide which is reopened by a laser at selected points to allow contacting between the back surface and the silicon. However, as published in the industry journal Photon, a new form of LID has been noted in multicrystalline PERC cells over the last few years which has been shown to significantly affect the panel performance. There are several known causes why PERC cells are particularly susceptible to LID, such as the quality of the silicon bulk and the layer boundary to aluminium oxide[2]. REC has worked successfully to resolve this problem with proprietary solutions and the advantage of having an integrated value chain.

How does REC reduce the LID on its PERC cells and REC TwinPeak panels?

One of the technology cornerstones of the REC TwinPeak Series is its use of PERC cells to generate an extra 4 Wp per panel. Any such degradation to these cells would render the technology advances made in the development of the product ineffective and limit its success. For this reason REC has spent much time researching and developing various improvements and initiatives to reduce the effects of light induced degradation in PERC cells. This has been done with great success, ensuring reliable and durable energy generation for our panels.

Since 2012, REC has engaged with industry experts from renowned institutions such as ISFH to study the mechanisms of LID at both wafer and cell level, using the results of the work to generate in-house solutions and suppress the effects of LID in PERC cells. At wafer level, this can be attributed to modifications in the wafer growing recipe and wafer engineering, and at cell level further optimization of REC's proprietary production process in order to protect the cells. To assess the effect of this, REC TwinPeak panels were tested in Singapore, in high temperatures of between 40-60°C and a high humidity of average 80% for 120 kWhr, conditions well in excess of standard test conditions (STC). These developments demonstrated a considerable reduction in LID degradation in the REC TwinPeak Series, such as shown in the figure 1.

Figure 1: The Light Induced Degradation of REC TwinPeak panels seen in sun soaking test



As shown in the graph, the evolution of improved LID performance through REC proprietary solutions, reduces the average LID from over 5% to less than 1.5%. This low level of initial light induced degradation is comparable to an REC non-PERC cell, making REC one of the few panel manufacturers in the industry to have solved the problem.

Ensuring the customer is protected from excessive power loss, means they can be sure of the higher output power under radiation in the early period of panel use and the stability in production of PERC technology. These benefits are of course in addition to REC's industry-leading product quality, along with the reliability of a strong and established European brand.

Temperature coefficients

The conversion efficiency of silicon-based solar cells and panels is sensitive to temperature and will vary with changes in the working temperature. The temperature coefficient (TC) is the amount by which the PMPP will change depending on the temperature the panel is exposed to.

In a solar panel, the parameter that is most affected by an increase in temperature is open circuit voltage where dark saturation current density is highly temperature dependent. On the other hand, the short circuit current of a solar cell generally increases slightly with temperature due to the possibility of absorbing photons with lower energies to create electron hole pairs; the effect of this is however small compared to the temperature dependence of open circuit voltage.

What effect does TC have on my solar installation?

Under standard test conditions, the power of the solar panel is measured at 25°C. However, under real illumination conditions the working temperature of a panel can vary strongly depending on a number of factors such as ambient temperature, level of radiation, location and the capability of the panel to dissipate heat. For example, under 1 Sun illumination, the temperature of a solar panel will generally exceed 40°C[3]. This is where the TC comes in – this value indicates the amount of power loss due to a rise in temperature above 25°C. To make a better performing panel, REC works hard to ensure the TC is kept as low as possible and that the effect of heat on power production is minimized.

How does REC reduce the effect of temperature on its panels?

It is important for manufacturers to understand the TC of the solar cell in order to predict the real power that can be produced in the field

1 Light-induced Degradation in Crystalline Silicon Solar Cells, Jan Schmidt, Solid State Phenomena Vols. 95-96 (2004) pp. 187-196, online at www.scientific.net, © 2004 Trans

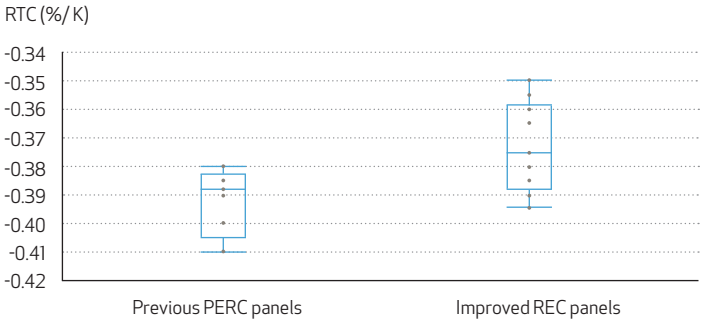
2 Photon International, May 2015, Text: Anne Kreutzmann, Photon Holding Gmbh, Aachen

3 Luque A, Hegedus S. Handbook of Photovoltaic Science and Engineering. John Wiley & Sons: Chichester, UK, 2003:714

installation. REC implemented proprietary changes in the production lines and through ongoing development work, has seen improvements reduce the TC and lead to extra power gain under operating field conditions.

In order to reduce the sensitivity of a panel to temperature, the VOC should be as high as possible. The manufacturing process also has a significant influence on the TC of the solar panels. REC's high efficiency manufacturing processes produce wafers and cells with a high open circuit voltage (VOC) with the PERC cell technology. REC is actively working on improvements at various levels and through the efficient and effective optimization of wafer recipes and production processes, REC TwinPeak panels have shown a lower TC with a reduction of an additional 0.02%/K on average and a best case 0.04%/K for recent panels. A test site installed in the sunbelt region in India (between 35 North and 35 South) yielded 2% higher kWh/kWp under the various climatic and solar radiation conditions at the installed location as shown in figure 2.

Figure 2: Relative temperature coefficients showing lower TC for REC improved solar panels at test installation in Hyderabad, India



Under field operating conditions, REC TwinPeak 270 Wp panels with lower TC are expected to gain an extra 1 to 2 Wp power at temperatures of 45°C.

The above studies and results indicate that panels with a lower TC have an improved performance than previous baseline panels as a function of solar irradiation, and this explains the higher total kWh generated by such panels.

Conclusion

REC has put a great deal of effort into improving in wafer and cell production in order to obtain better performance from its PERC cells. These efforts have led to much improved resistance to LID and reduced temperature coefficients, making REC one of the very few companies that have successfully tackled and resolved this issue. This success is backed up by the lack of product claims for LID in PERC cells, which have been used in production for REC TwinPeak panels since February 2015. Together, these advancements in performance reassure the customer of the high quality of REC solar panels and their suitability for the most demanding of applications.

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