Maximizing cell performance
How REC's use of Passivated Emitter Rear Cell technology improves the capture of light and optimizes cell performance

REC has introduced an innovative cell design into production that includes Passivated Emitter Rear Cell technology (PERC). This technology has been developed for use on a polycrystalline platform by REC and is one of the crucial steps in allowing the production of polysilicon cells with average efficiencies of above 18 percent.

As part of the roadmap to improve the efficiency of its cells, REC has developed a new cell structure that combines the cost-effective basis of a polysilicon platform with the latest technical advances to compete strongly with mono p-type and n-type products on the market.

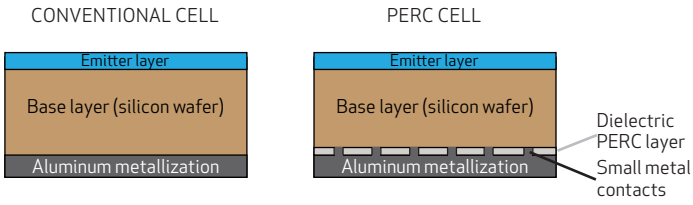
Offering an increase in power output from a polycristalline cell, one of the key technologies in solar panels achieving this high level of performance is the passivation of the rear side of the cell.

What is PERC technology?

Based on a change in the design of the rear of the cell which improves the capture of light falling on its surface, REC has introduced PERC technology (also known as backside passivation) into its cell production process and been able to bring it to full production level.

In a conventional solar cell, there is an aluminum metallization layer which makes contact across the full area of the back of the cell. REC's PERC technology first coats the backside of the cell with a special dielectric layer that has tiny holes made by a laser. The aluminum metallization is then applied on top of the dielectric layer and contacts the silicon wafer only through the microscopic holes (fig. 1).

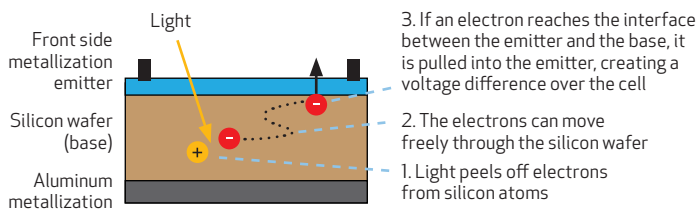
Fig. 1: The structure of a conventional cell (l) compared to a cell with PERC technology (r)



How does PERC technology improve performance?

PERC technology increases the overall panel performance by increasing a cell's ability to capture light. A regular solar cell consists of two layers of silicon with different electrical properties – known as the base and the emitter. A strong electrical field is generated where the two layers meet, which pulls negatively charged particles (electrons) into the emitter when they reach this interface. The electrons are generated by light entering the cell and releasing electrons from the silicon atoms. Electrons travel freely through the cell and contribute to the electrical current only if they are able to reach the interface (fig. 2).

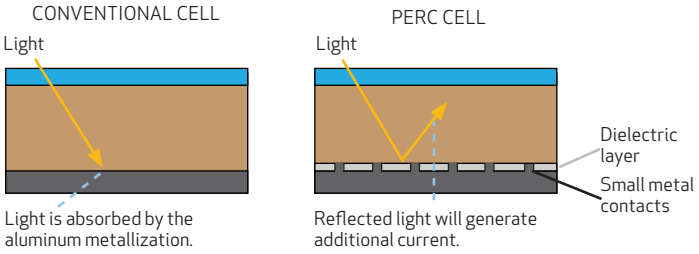
Figure 2: Working principle of a silicon solar cell.



Different wavelengths of light generate electrons at different levels of the cell structure, shorter wavelengths (blue light) will generate more electrons near the front of the cell, compared to longer wavelengths (red light) which will generate electrons at the back of the cell or even pass through the wafer without generating current.

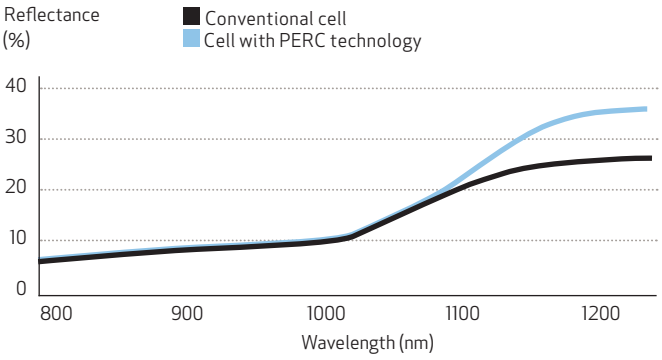
The introduction of PERC technology increases the cell efficiency through the dielectric layer that reflects back into the cell any light that has passed through to the rear without generating electrons. Through this reflection, the photons are essentially given a second chance to generate current (fig. 3).

Fig. 3: A cell with PERC technology will generate more current due to the reflection of light at the backside of the cell.



The extra energy yield of cells with PERC technology is added to by the improved ability to capture light at longer wavelengths, e.g., when the sun is at an angle (early mornings and evenings) or under cloudy conditions. At such times a higher quantity of blue light (wavelengths between 450 to 495 nm) is absorbed by the atmosphere as it has a longer path to travel to the Earth's surface than when the Sun is directly overhead. Blue light is generally converted to energy near the top of the cell, whereas red light (wavelengths between 620 to 750 nm) penetrates further through the cell and is converted to energy near the bottom. Red light is less easily absorbed by the Earth's atmosphere and as a result, cells which capture more red light are generally more powerful (fig. 4). The 'reflective' properties of the PERC technology ensure increased absorption of red light, even in weak or diffuse light conditions, delivering better energy yields.

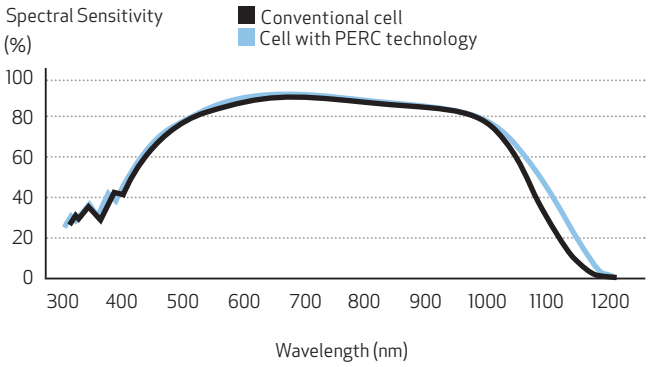
Figure 4: PERC technology improves the internal reflection of light at long wavelengths.



Wavelengths above 1180 nm are not absorbed by the silicon wafer. Instead, in standard cells, such wavelengths are merely absorbed into the backside metallization, generating heat which increases the temperature of the cell and reduces its conversion efficiency. As the PERC layer reflects this light back through the cell and out of the panel, it reduces the amount of absorption by the aluminum metallization layer and therefore heat build up internal to the cell. This reduction in absorption helps the cell to work at a cooler temperature and has a positive effect on energy yield.

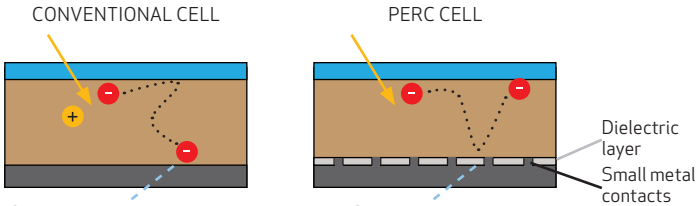
The increase in sensitivity to light produced by the use of PERC technology is seen in the spectral response of a PERC cell (fig. 5). As the graph shows, PERC technology increases the absorption of infrared light (wavelengths of between 1000 and 1180 nm) with this additional sensitivity resulting in increased current and cell efficiency.

Fig. 5: PERC technology increases cell sensitivity to wavelengths between 1000 & 1180 nm.



The second way in which the PERC layer adds to performance is by passivating the rear of the cell (fig. 6). In simple terms, the principle works in the same way as for light, where the dielectric layer 'limits' the attraction of electrons to the aluminum metallization layer, meaning any electrons generated near the rear of the cell are free to move up towards the emitter and the likelihood that they will reach the interface between the base and emitter and contribute to the current of the cell is greatly increased.

Fig 6: PERC technology prevents electrons being captured by the rear surface, resulting in increased cell current and voltage.



If an electron reaches the back surface, it is frequently captured and can no longer contribute to the current.

PERC technology stops the electron from being captured, and gives it a 'second chance' to reach the emitter and contribute to the current.

How much does PERC technology improve panel performance?

REC panels based on 60 cells with PERC technology exhibit 4 Wp more at Standard Test Conditions than a standard REC Peak Energy Series solar panel. This enables REC to push its panel production to higher levels of power and in conjunction with other technology enablers, reach watt classes of up to 275 Wp while still using the cost-effective polysilicon platform.

How will the consumer benefit from the new cell technology?

Given the increased sensitivity to different wavelengths of light and the increased capture of electrons, cells using PERC technology, or more specifically, panels using PERC cells, provide a higher energy yield throughout the day when compared to those using standard cells. A higher energy yield, means a higher rate of return on a solar installation.

The use of PERC technology in the manufacture of higher power solar cells and panels helps reduce the overall balance of system costs and boosts energy yield over the same surface area. This is of particular importance to the C&I and residential market segments where rooftop space is limited, allowing customers to get the most power out of their installation. These use of PERC technology in REC solar panels is of course in addition to REC's industry-leading product quality, the fact that REC panels are 100% PID free, and the reliability of a strong and established European brand.

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NE-11-05-05 RevA - 09.2014