SIN PIN SHADOWS

SUMMARY

Solar cells are coated with a blue Anti-Reflection Coating (ARC). For mono- and multi-crystalline silicon solar cells this coating is typically made of Silicon Nitride (SiNx) which is applied in a tube furnace. Since the cells have to be fixed in place during the process there are small regions with missing SiNx coating or different colour. Any effect that these "SiN pin shadows" might have on the cell properties are subject of the final cell quality test in the cell production. Therefore, they are not considered to be a defect – they are simply the effect of contact pins in the SiNx process.

INTRODUCTION ABOUT SINX

Silicon Nitride (SiNx) is an insulator material which is normally transparent like glass. However, the very thin SiNx layer (about only 0.1 µm) lets the cell appear blue because of optical interference effects. This layer behaves similar to a film of oil on a puddle: depending on the layer thickness and observation angle it appears in a different colour.

For best light-to-energy conversion yield in the cell, the cell must not reflect red light. This is why the anti-reflection SiNx coating shifts the reflection of the cell to the blue part of the visible spectrum. For thinner layers the colour will be violet or brown, and for very thin layers it would not be visible at all. For thicker layers even more colours are possible (see Figure 1 below).

Although for an optimum electricity yield and appearance the cell should be homogeneously blue there are positions on the cell where no or only very thin SiNx coating is applied. These positions are shadowed during the SiNx process by contact pins which fix the wafer in the process tube. The regions of SiN pin shadows on the cell are typically quite small and hardly visible without special attention.

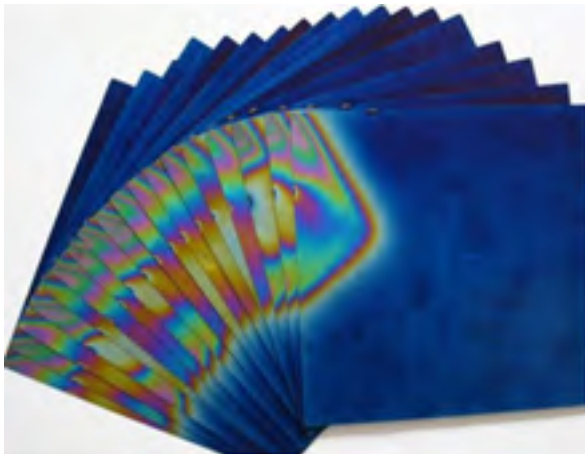

Figure 1: Out-of-spec colors due to SiNx process deviation – color variation due to different SiNx layer thicknesses.

SIN PIN DEFECTS

If there are contact problems or other process deviations during the SiN process the SiN pin shadows might become more obvious.

As already described above the different colours are the result of different layer thicknesses of the (transparent) SiNx layer. Therefore, such deviations in the result typically only effect the optical appearance of the cells.

If other cell properties are affected by the process deviation this will be detected during the final cell quality and power testing.

- If the discoloured area is larger than allowed by the Optical Sorting Criteria (OSC) the cells will be sorted as "off spec".
- Effects on electrical power are directly measured and used for cell classification.
- Other effects which might be the result of an interaction with the SiNx layer (e.g. local shunts) will also be measured and used for classification at the cell tester.

"HOT-SPOT PROTECT"

Cells used in Hanwha Q CELLS modules are 100 % inspected for Hot-Spots, i.e. local shunts in the cells that might heat up significantly if the affected cell is shadowed during full irradiance.

Such Hot-Spots can arise from material defects in the silicon wafers as well as deviations in the cell manufacturing process. Therefore "Hot-Spot Protect" is an intrinsic part of the outgoing cell quality testing at Hanwha Q CELLS.

Figure 2: Hanwha Q CELLS Tripple Yield Security

CONCLUSION

SiN pin shadows are optical deviations without effect on the cell functionality or reliability. Any other change in cell properties (e.g. power loss, local shunts) which might be accompanied by this deviation will be tested during the final quality test at the cell line.

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