

# FLUX RESIDUES AND MODULE RELIABILITY

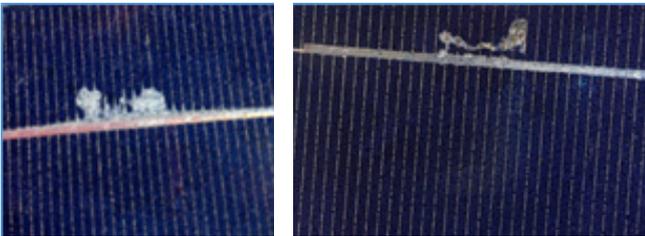
## SUMMARY

Flux facilitates reliable solder joints by preventing oxidation. Hanwha Q CELLS uses no-clean flux which can stay on the cell as it is non-corrosive also in the long-term. Our internal standard operating procedure requires regular cleaning to minimize the occurrence of flux residues. Bubbles induced by contaminations such as flux residues are strictly prohibited by the optical sorting criteria for final quality control. Flux residues that do not cause bubbles in the lamination process are considered as optical imperfection. Q CELLS modules have not had any claims regarding delamination which was provoked by flux residues.

## INTRODUCTION ABOUT SOLDERING AND FLUX

Soldering is used to connect cells in series as the first step of module assembly. In this process solder-coated copper ribbons are joined together by melting the solder which has a lower melting point than the copper itself. Flux is sprayed on top and bottom busbars of the solar cells right before soldering. This ensures reliable solder joints by preventing oxidation and improving the flow of the molten solder material.

Hanwha Q CELLS uses no-clean flux that is non-corrosive. Thus the flux does not need to be removed after soldering but can stay on the cell and in the laminate. This is a requirement as flux is deposited onto every busbar of each cell in a way that not only the about 1 mm wide busbar itself is covered but also about an additional 1 mm on each side of it. Consequently, flux is present in every module with and without visible flux stains throughout the 25-year lifetime of the module.



Figures 1 and 2: Flux residues from the solder process described above.

## FLUX RESIDUES AS A CAUSE OF BUBBLES AND DELAMINATION

Flux residues have reportedly been identified as a potential cause of delamination after years of operation in the field. Based on Hanwha Q CELLS assessment and experience, bubble formation during module lamination in the factory is the decisive factor whether there is a significant risk for later delamination.

Flux residues are well known for potential bubble formation. This bubble formation happens already during module assembly as it is induced by high temperatures of the lamination process. The temperature required for lamination is above 150 °C while module operating temperatures are typically well below 100 °C. Therefore, bubbles produce during lamination rather than during operation of solar PV modules. Such bubbles have to be detected in final quality inspection so that affected modules can be singled out.

This is why flux residues should be minimized for high production yield and general risk minimization purposes. As such, our internal procedures mandate regular cleaning in order to prevent stains from flux residues for optical reasons but also due to the risk of bubble creation during lamination.

## OPTICAL SORTING CRITERIA (OSC) PREVENT RELIABILITY ISSUES FROM FLUX RESIDUES

Flux residues themselves are not critical as long as they do not cause bubbles during lamination. Bubbles could potentially expand over time and cause delamination if not sorted accordingly. Consequently, bubbles are extensively covered in the optical sorting criteria. This is backed by Hanwha Q CELLS experience as Q CELLS modules have not had any claim for delamination caused by flux residues.

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