Quality and Reliability - sometimes the customer wants more …

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ABSTRACT

Quality and reliability of PV products, in particular PV modules, are recently attaining one of the top positions as brand-selection criteria for customers. Still, PV modules make an important contribution to the entire system cost. A key dilemma for customers (ultimately it is them / their banks / their insurance companies , who pay the bill) is “how to build a good concept for choosing the most reliable PV product”. Modules as-built offer very little possibilities to draw conclusions about reliability without further information (e.g. through production audits) or inspection more sophisticated compared to visual (e.g. by EL). Moreover, customers operating aged (e.g.: 10 years+) systems often can do their assessments on visual appearance of the modules, only. Power-wear-out and dysfunction of modules is taken for granted if only optical changes are visible. Malfunction of the inverter or insufficient O&M are sometimes not considered. In this contribution, an example is given for a series failure in solar modules built by third party. This frequent failure relates to not to energy output but to cosmetic appearance of the modules. Special safety issues are not reported.

IMPORTANT NOTE

All failures reported refer to modules that have neither been manufactured nor sold by SolarWorld.
Data have been acquired by a 3rd party service provider specialized in solar module claims handling.

Observation: failure (modules made & sold by 3rd party)

Customers claim „white spots“ and use the word „delamination“. Modules have been typically built and sold between 1999 and 2003 by a third party module & cell manufacturer

Claims are typically raised after 7+ years-in-field. It was reported that all warranty issued to customers does explicitly link to power loss, only (not cosmetic issues, workmanship …).

Three categories of delamination / white spots are observed:

- **Type A:** „white spot“: highly visible, white discoloration stops at each cell perimeter (compare Fig. 1 and 2)
- **Type B:** delamination in the edge region that violates creepage path towards aluminum frame and may be hazardous (Fig. 3) - reject
- **General delamination:** as widely known. A very bad example (resulting in voids and cell crack) is given in Fig. 4.

Fig. 1: Type A „white spot“ delamination. Center cells and edge cells affected

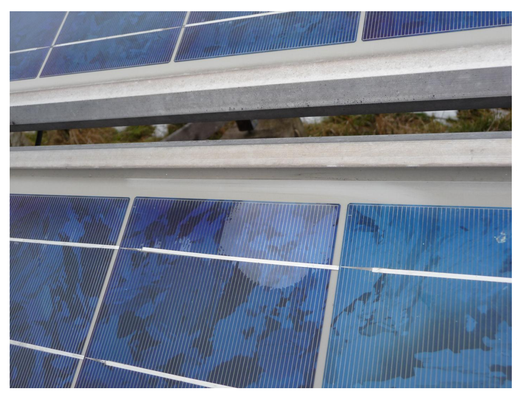


Fig. 2: Type A „white spot“ delamination. Delamination does not exceed perimeter of the cell

Fig. 3: delamination (bubble) extending to the aluminum frame. Creepage no longer given - reject

Fig. 4: very bad example of „general delamination that results in voids and even cell breakage – clear reject

First Analysis

The dataset is based on 22,328 returned modules. All modules have been classified by multiple failure possibilities.
More than 90% of the returned modules show “delamination”, whereas the overwhelming contribution is the “Type A” failure mode.
A statistical lot of 2,838 of modules out of the 22,328 modules has been flash tested and **only 13% of the tested modules had a power less than promised in the warranty document**.

Preliminary Root Cause Analysis for Type A white spots:

Production data for the modules under consideration are not available. However, a strong hypothesis could be established with two assumed factors:

1. ARC on solar cell is with TiO_2 which is known to be prone to hydrolytic distortion against the EVA. Typically, mechanical barriers like ribbons / bus bars or the cell‘s perimeter tend to stop the visible effect (comp. Figs. 1 / 2).
2. poor control of lamination process. The laminate construction consists of front glass EVA (unknown brand), crane glass (most likely to support the lamination process) and a backsheet containing an Al barrier layer.

Further Analysis

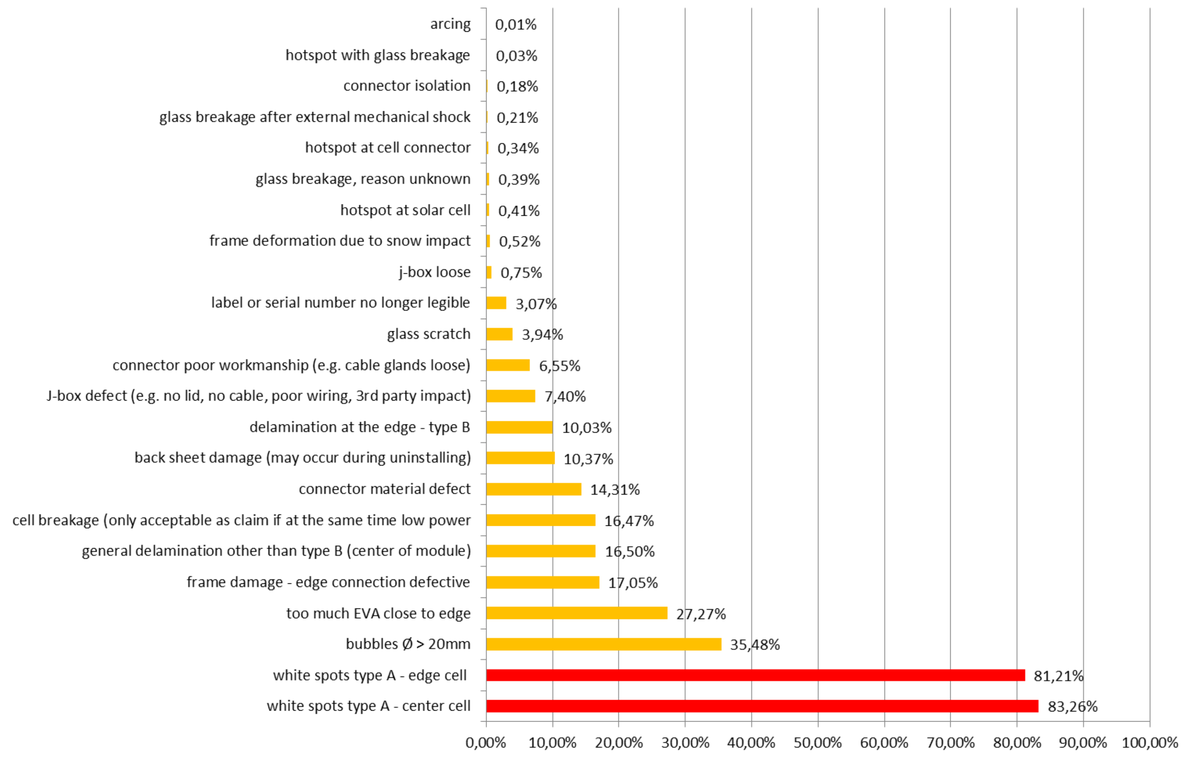
Further analysis about the behavior of Type A „white spots“ showed:

- No clear correlation between observed power loss (w.r.t. name plate) and the number of cells with the Type A signature could be established. A test aiming to correlate the delaminated (Type A) surface of n=9 modules to the power loss revealed a correlation as weak as $R^2 = 0.054$

- Stress tests according to the well known IEC cycles showed either no change in output power or the losses in output power could be made traceable to influences other than the Type A „white spots“. Though, especially DH1000 increases the size of Type A „white spots“ considerably.

- Thermal IR analysis showed that under short-circuit conditions and irradiance levels close to 1 sun, the observed average temperature tends to be slightly higher for Type A „white spot“ cells in comparison to unaffected cells within the same module. The observed temperature difference was in the low 1 digit Kelvin range. In particular not hot-spot problems have been seen.

Fig. 5: failure pareto of 22,328 returned modules. Multiple failures are possible: total of all failure modes is > 100%



Summary and Conclusion

Despite the fact, that in average 87% of the claimed modules fulfil the power warranty customers claim for cosmetic reasons (mainly „Type A“ failures).
Obviously, it was impossible for the manufacturer to communicate to customers that „Type A“ defects do not affect the power, are not observed to considerably shorten lifetime, and do not exhibit a safety problem.
The perception of the customer is simply „poor quality“.

Sometimes the customer wants more than …
… what is included in the warranty terms.

This presentation contains no confidential information