Understanding Differences in Induced Stresses to Improve Variation in Light Soak Response

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Introduction

Understanding the impact of induced environmental conditions on fully encapsulated PV modules is critical for modeling and predicting stimulus response and performance under field conditions. Significant differences in results have been noticed in light soak tests conducted with equipment from different manufacturers beyond the differences resulting from testing modules of varying construction. Through specially constructed thin-film modules, the semiconductor temperature was mapped through various back-of-module setpoint temperatures, at various irradiance levels. Using this approach, the p-n junction temperature was modeled. The equipment setpoints were adjusted to match estimated p-n junction temperature, and test results confirmed.

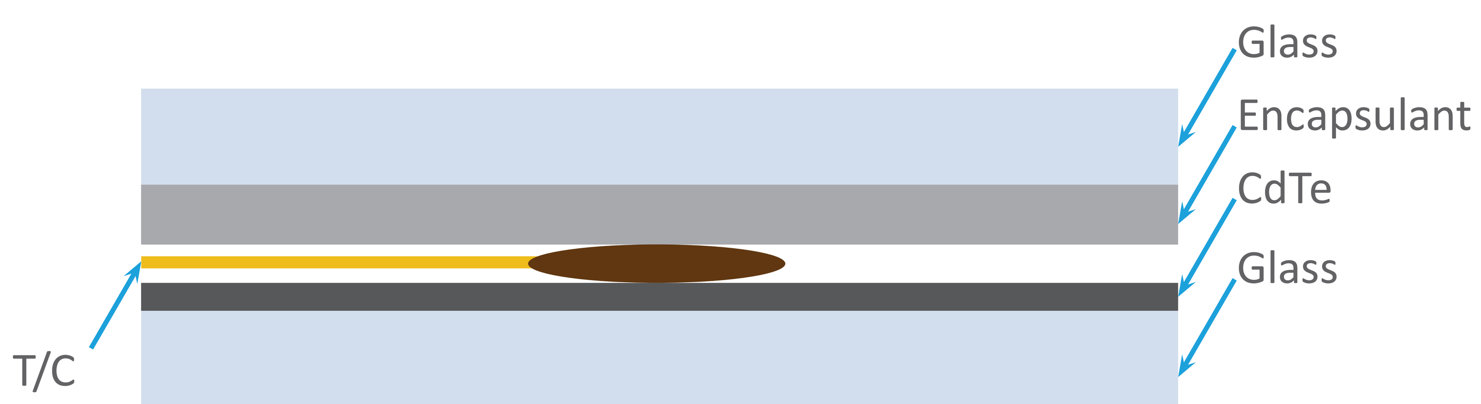

Figure 1: Side view of placement of thermocouple in module stack.

To investigate this issue, we developed a tool to measure the critical temperature and map it across VLS types. The tool we developed was a standard First Solar module with K-type thermocouples laminated inside.

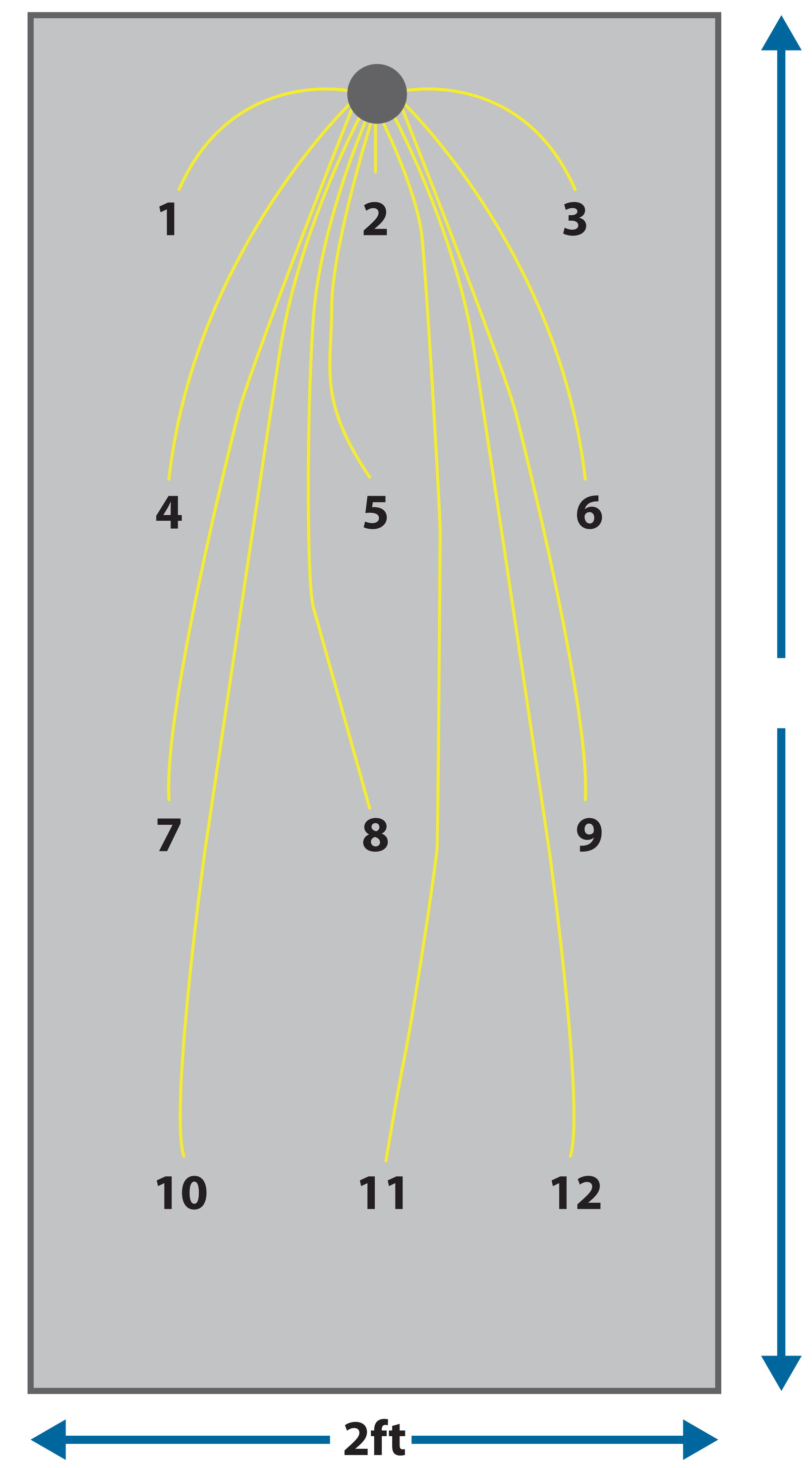

Figure 2: Diagram of T/C placement throughout module.

Results

As a result of extensive temperature mapping between units based on setpoint temperature, irradiance and other factors, a guide was developed to determine equivalent conditions between manufacturer A and manufacturer B. (Figure 5) Once conditions were matched, light soak test results were also well matched. (Figure 6)

This study has highlighted that this issue is relevant throughout the entire industry. As a collective, we need to understand the effective induced stresses to appropriately analyze stress test results.

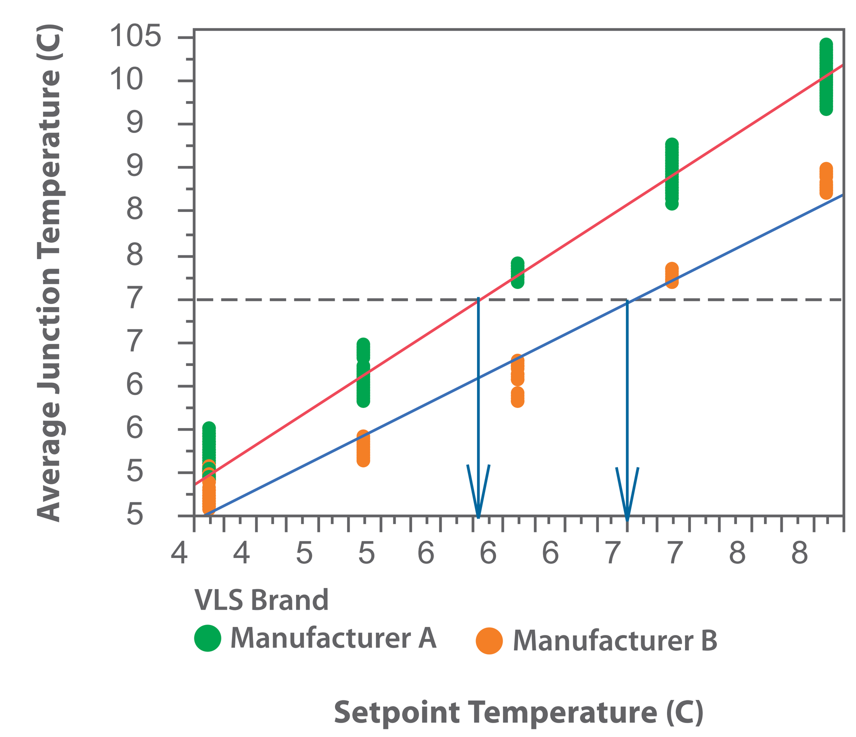

Figure 5: A guide has been developed for use within the company to determine proper setpoint temperatures to obtain accurate critical temperatures.

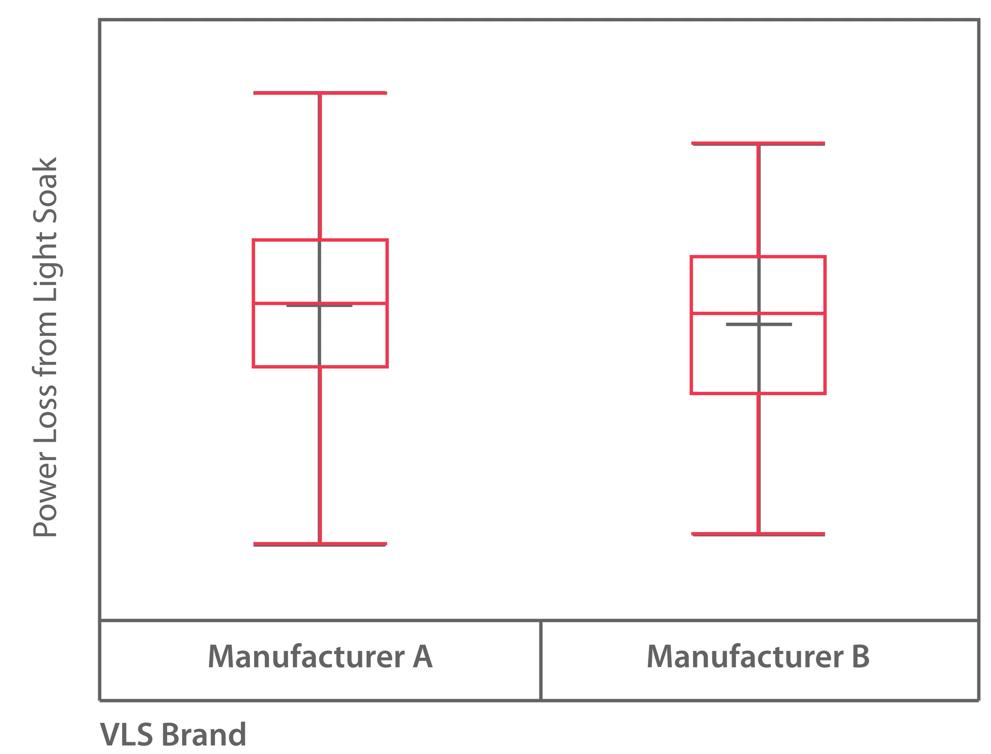

Figure 6: Test results showed critical conditions are now well matched.

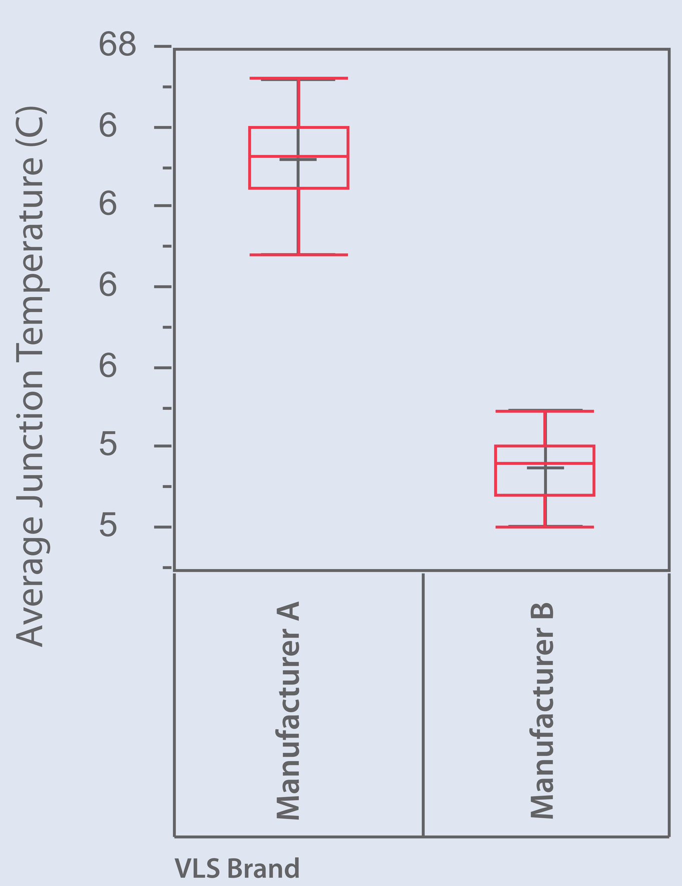

Figure 3: Identical conditions between VLS manufacturer A & manufacturer B, produced very different critical temperatures.

An initial survey in manufacturer A and B showed very different critical temperatures at identical setpoint conditions (irradiance & temperature). **This difference produced a 25% difference in results.**

The distribution of temperatures throughout the module was also quite different. Manufacturer A had a much larger standard deviation than the other.

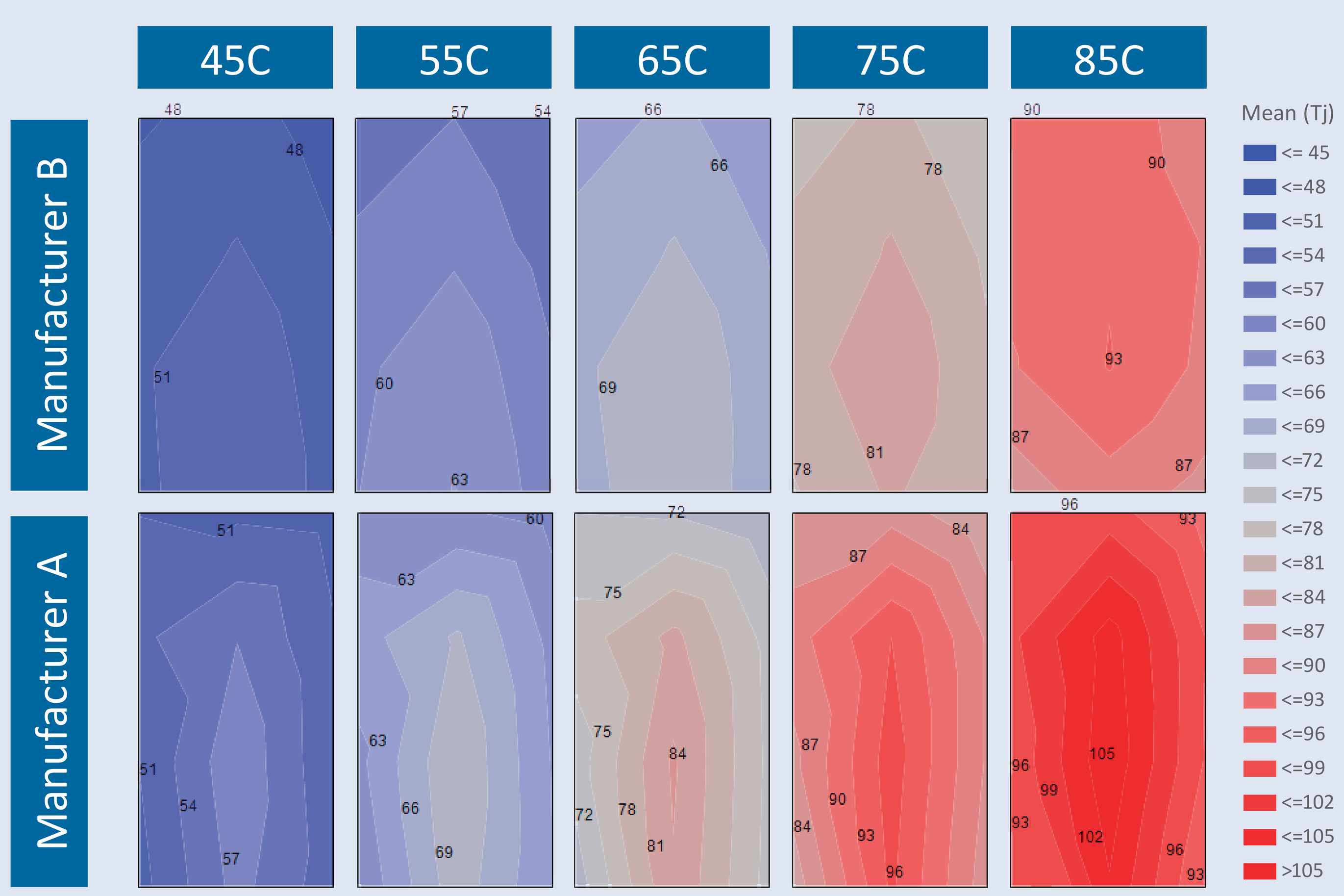

Figure 4: Contour Plots of temperature distribution throughout the module at five setpoint temperatures in both VLS types.

Conclusion

With this poster, First Solar aims to share its understanding that not all stress equipment induce stress in a similar fashion. **Equipment characterization is necessary to ensure predictable and accurate modeling.** Specified conditions need to be standardized in terms of critical temperature. Testing standards should define test conditions similarly (ambient temperature, backsheet temperature, junction temperature, etc.)