Highly Accelerated Weathering of CIGS Photovoltaics

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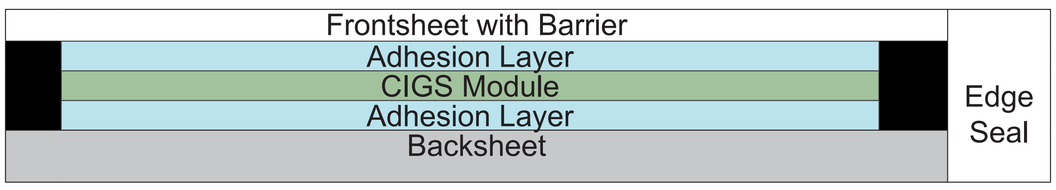
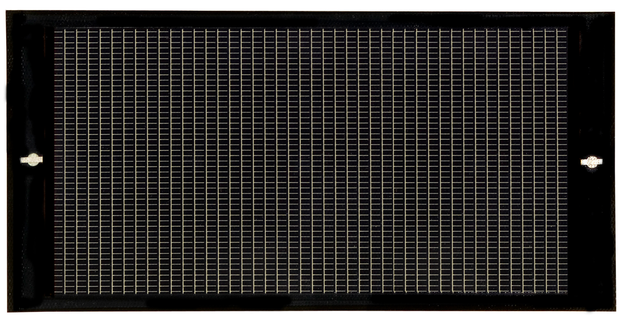
Introduction:

- Damp Heat (85°C/85% RH) is a widely accepted industry standard
- However, it is a very long test, taking up to 5 months
- Since WVTR increases exponentially with temperature, barrier layers can be evaluated more quickly by increasing the temperature and humidity beyond standard damp heat conditions
- Ascent Solar has developed a non-biased HAST (Highly Accelerated Stress Test) procedure to quickly evaluate lamination packages for flexible CIGS PV
- The HAST procedure was applied to flexible CIGS modules encapsulated using various package designs and material combinations and the results were compared to standard Damp Heat stressing

Test Sample Construction:

- Test samples consist of a backsheet, a front sheet with barrier, and two adhesion layers. An edge seal is applied around all four edges. Electrical feedthroughs are potted.





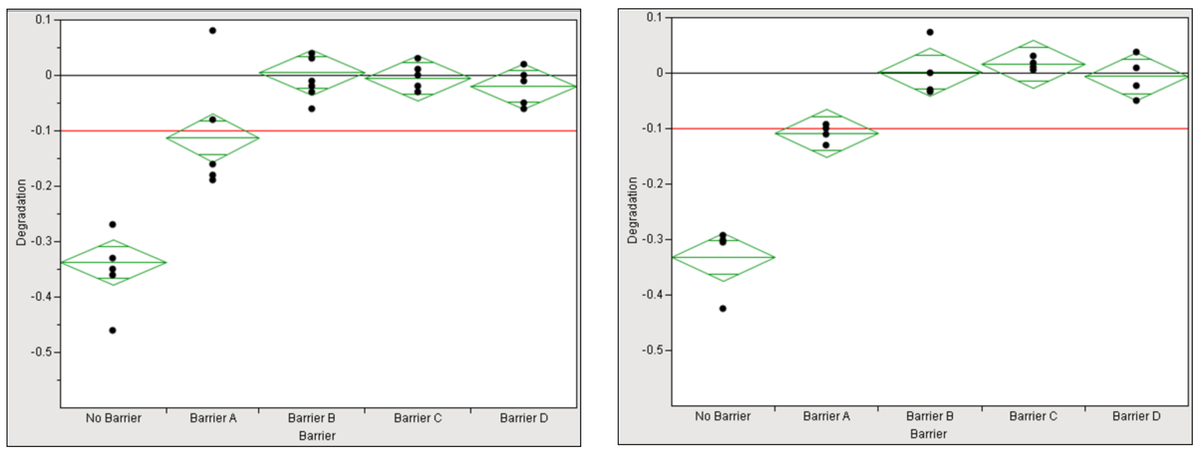
Summary:

- The HAST procedure was found to accelerate the effects of standard Damp Heat by a factor of around 15 for most of the package designs and material combinations evaluated
- Some modules experienced failure mechanisms which did not occur in standard Damp Heat, but these modules generally did not survive even 1000 hours in standard Damp Heat
- If modules performed well in HAST, the performance in standard damp heat was at least as good and often better
- Barrier layer performance can be evaluated in days with HAST instead of the weeks required with Damp Heat
- The HAST procedure also allows for rapid evaluation of a full package design including interactions of multiple materials
- Once a baseline for a module construction is established, it can be used to rapidly screen incoming material

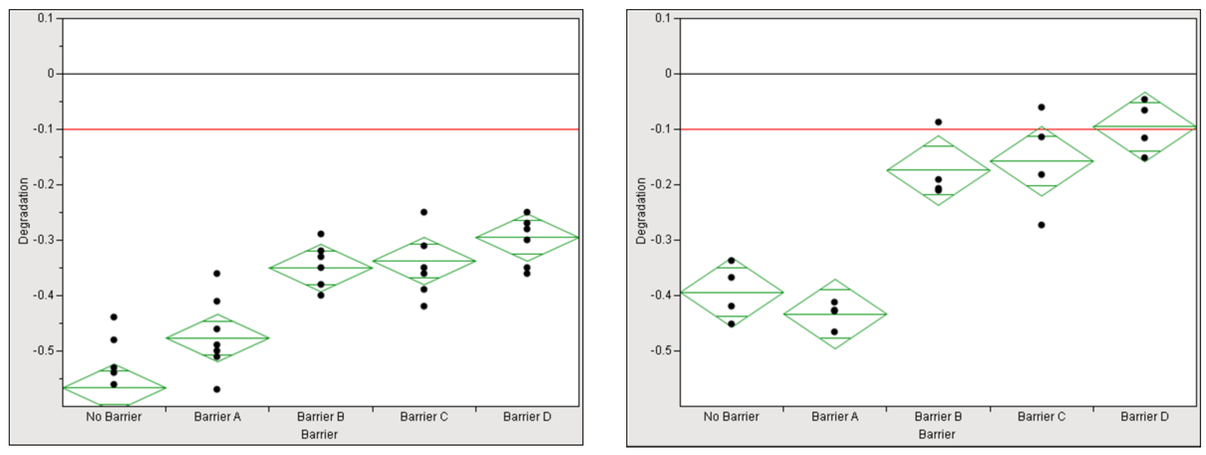
Results:

Power Degradation of CIGS Packaged using Various Barrier Frontsheets after 1 and 2 days of HAST Compared to 2 and 4.5 weeks in Standard Damp Heat

Highly Accelerated 48 hours → Standard 336 hours

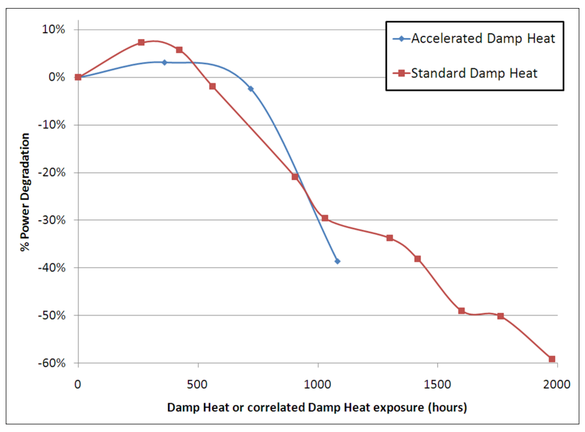


Highly Accelerated 48 hours → Standard 746 hours

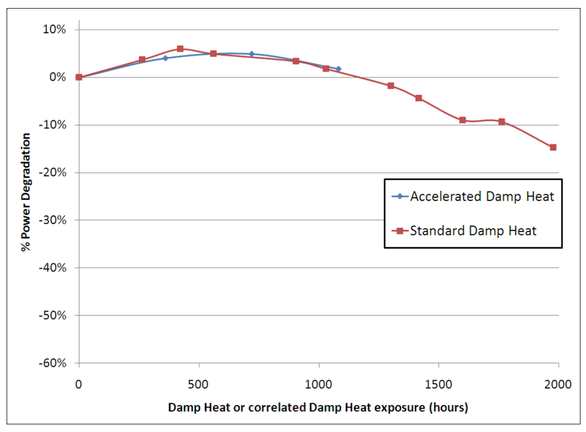


Correlation of HAST to Standard Damp Applying an Acceleration Factor of 15 to HAST

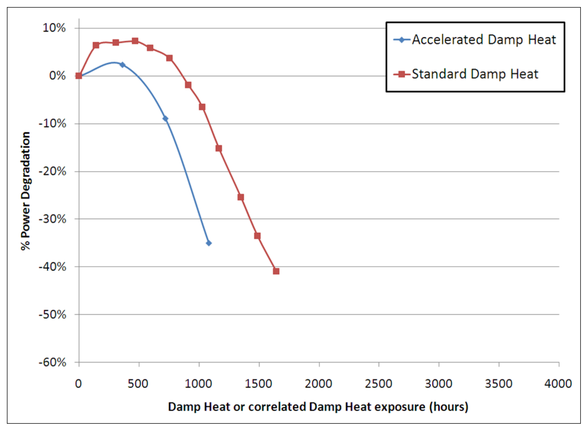
Backsheet A / Glass



Backsheet B / Glass



Backsheet C / Flexible Barrier E



Backsheet C / Flexible Barrier E