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Quantifying Adhesion Within The PV Module Laminate

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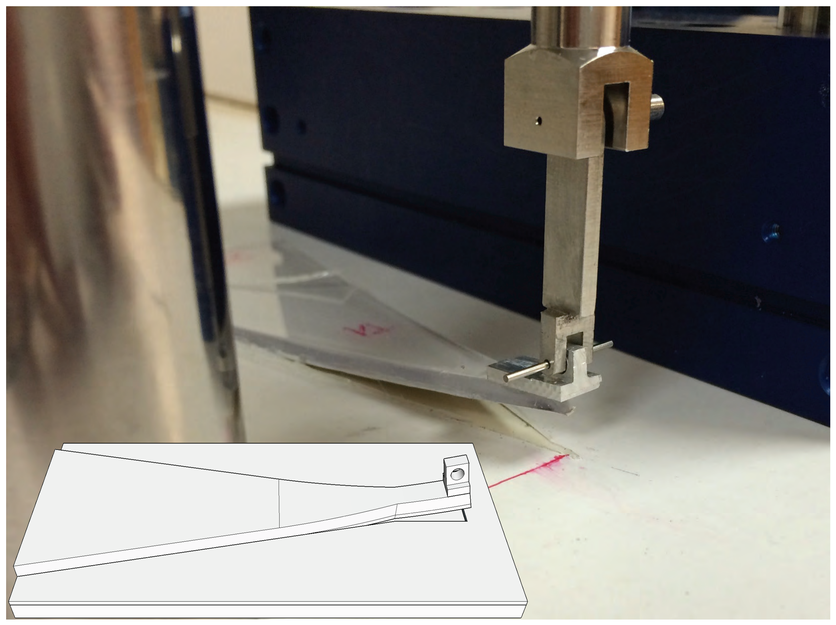
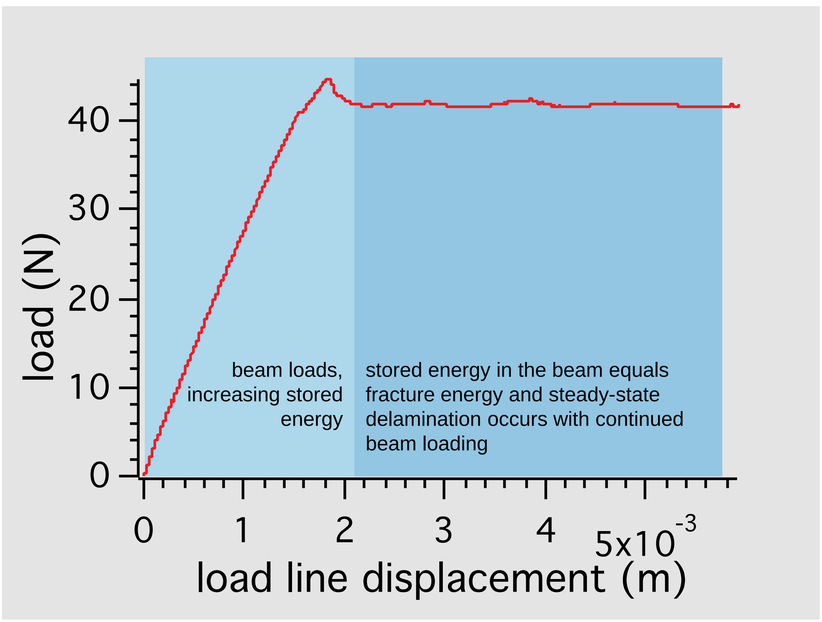
A fracture mechanics based approach has been developed to quantify the material property of adhesion at every interface within the PV module laminate.

This measurement will provide manufacturers with a tool to quantify their materials reliability even during its development, the ability to confirm the reliability of a material before incorporation into a module, and a module's service life prediction.



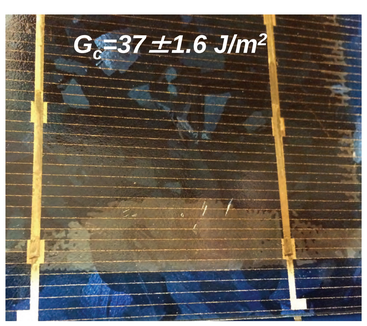
Width-tapered SCB measurement on the backsheet of a full-sized photovoltaic module. Inset cartoon shows the width-tapered SCB.



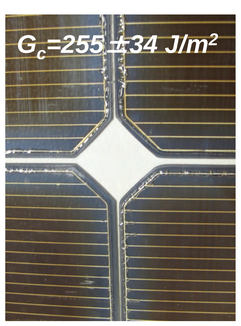
Typical response from a width-tapered SCB measurement. The steady plateau load achieved during delamination is used to calculate the adhesion, G_c, of the system.

- **The developed metrology, a width-tapered single cantilever beam, may be applied at both the module and coupon level to yield an identical, quantitative measurement.**
- **This new capability can even probe the adhesion at interfaces between the cell and front sheet of glass; critical areas for module reliability that, up to this point, have not been evaluated.**
- **The metrology involves adhering an elastic beam to the layers of interest and mechanically measuring the energy stored and released from that beam during the delamination process. This stored and released energy represents the material property of the critical strain energy release rate, G_c, or adhesion.**

Currently, this metrology is being employed to survey the encapsulant adhesion of legacy photovoltaic modules:

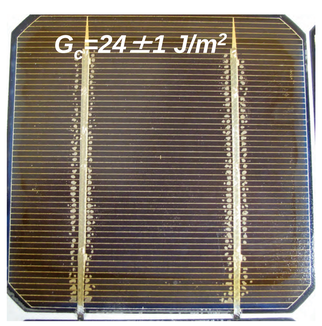


Solarex module deployed 27-years in CA with severe delamination

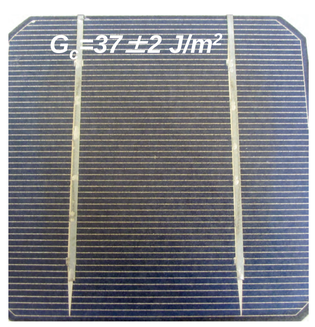


Arco module deployed 27-years in CA with no delamination

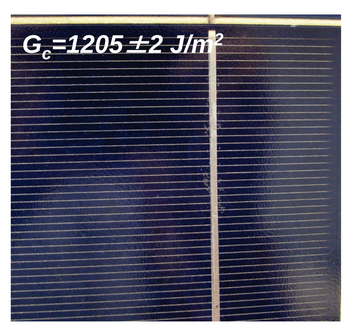
BP module deployed 11-years in Ohio with no delamination



Arco module deployed 26-years in Mexico City with delamination



Siemens module deployed 18-years in Pheonix with no delamination



Module deployed in Mediterranean for 5-years with delamination

This and similar studies will define threshold adhesion values required to ensure module reliability. This information will be utilized in designing and interpreting accelerated tests for lifetime prediction.

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