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Quantifying Adhesion and Debonding of Encapsulations for Solar Modules

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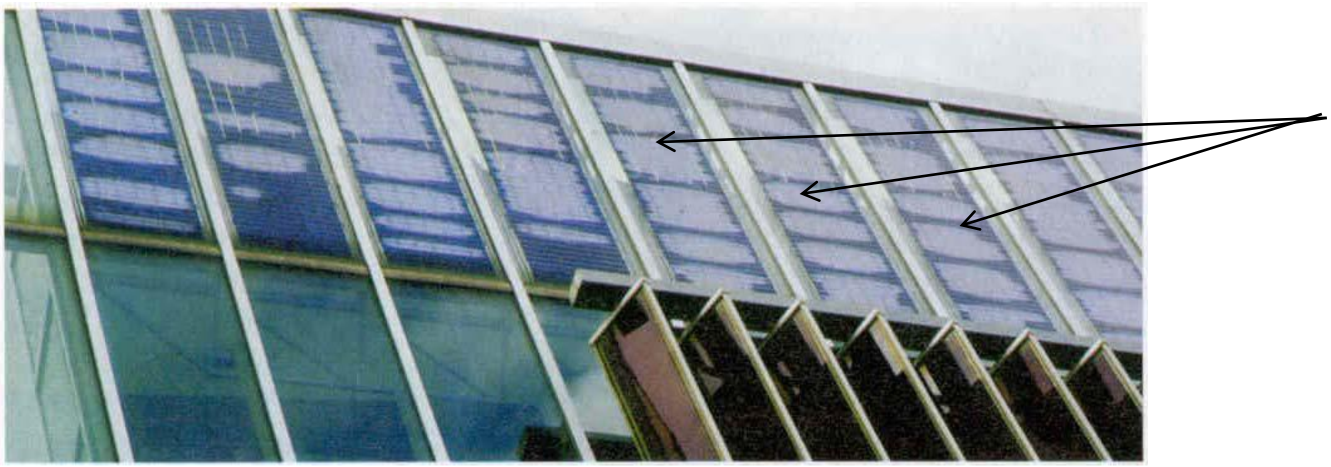
Encapsulant Debonding in Field Modules

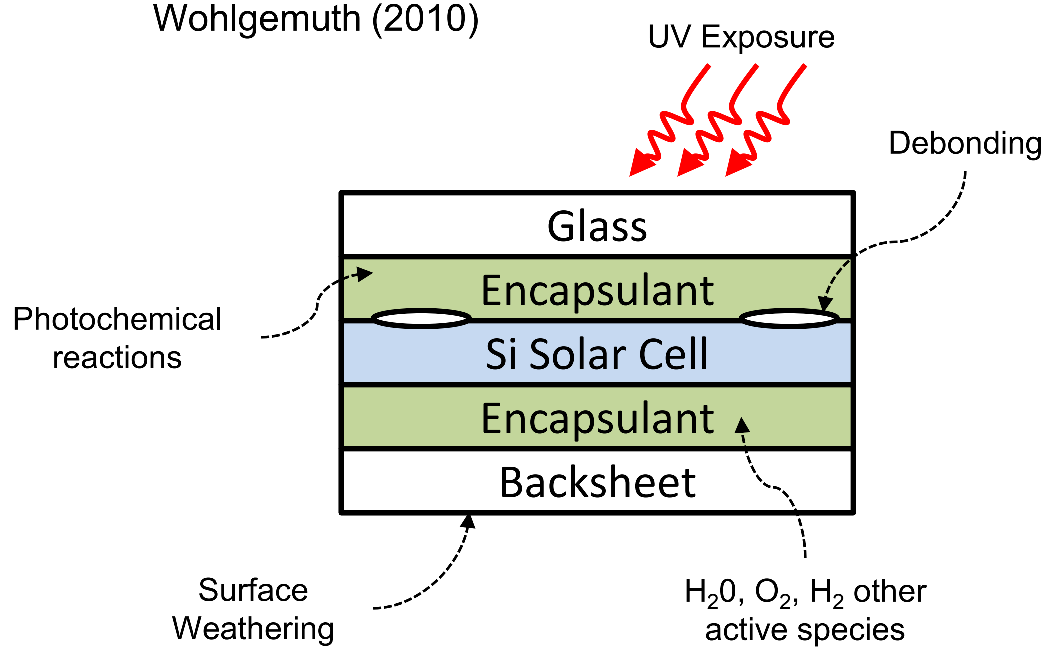


Wohlgemuth (2010)

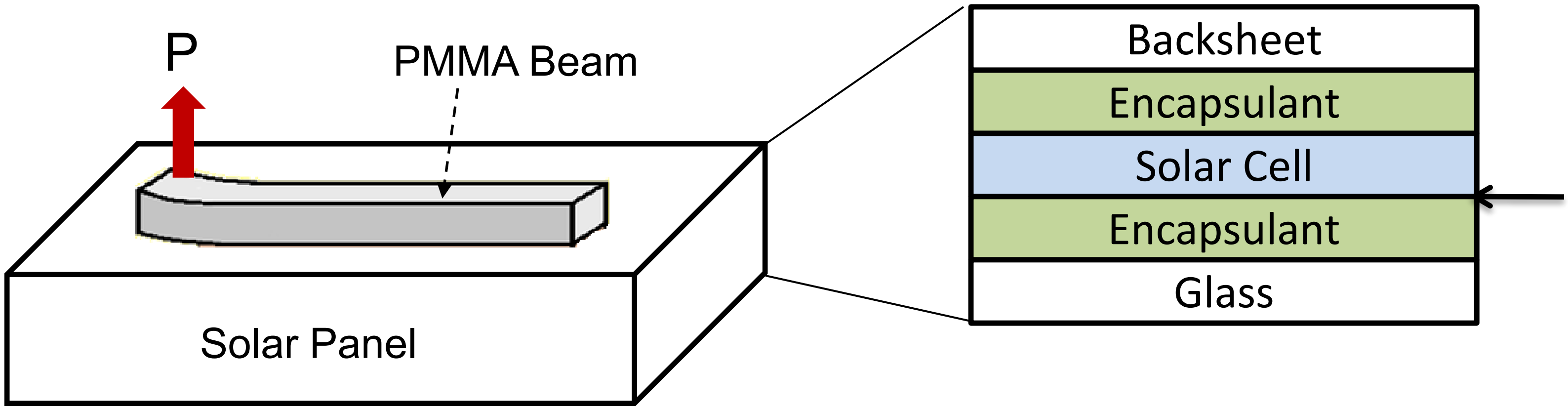
Severe operating environments.

Exposure to thermal cycling, stress, moisture, chemically active environmental species, and UV.

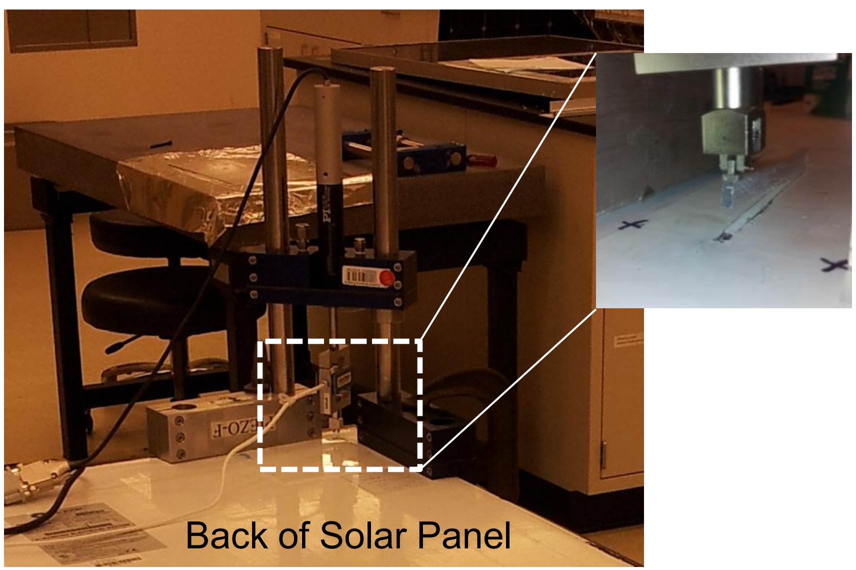
Uncertain degradation kinetics and reliability models.



Quantifying Adhesion in Field-Aged Panels



Delaminator Setup



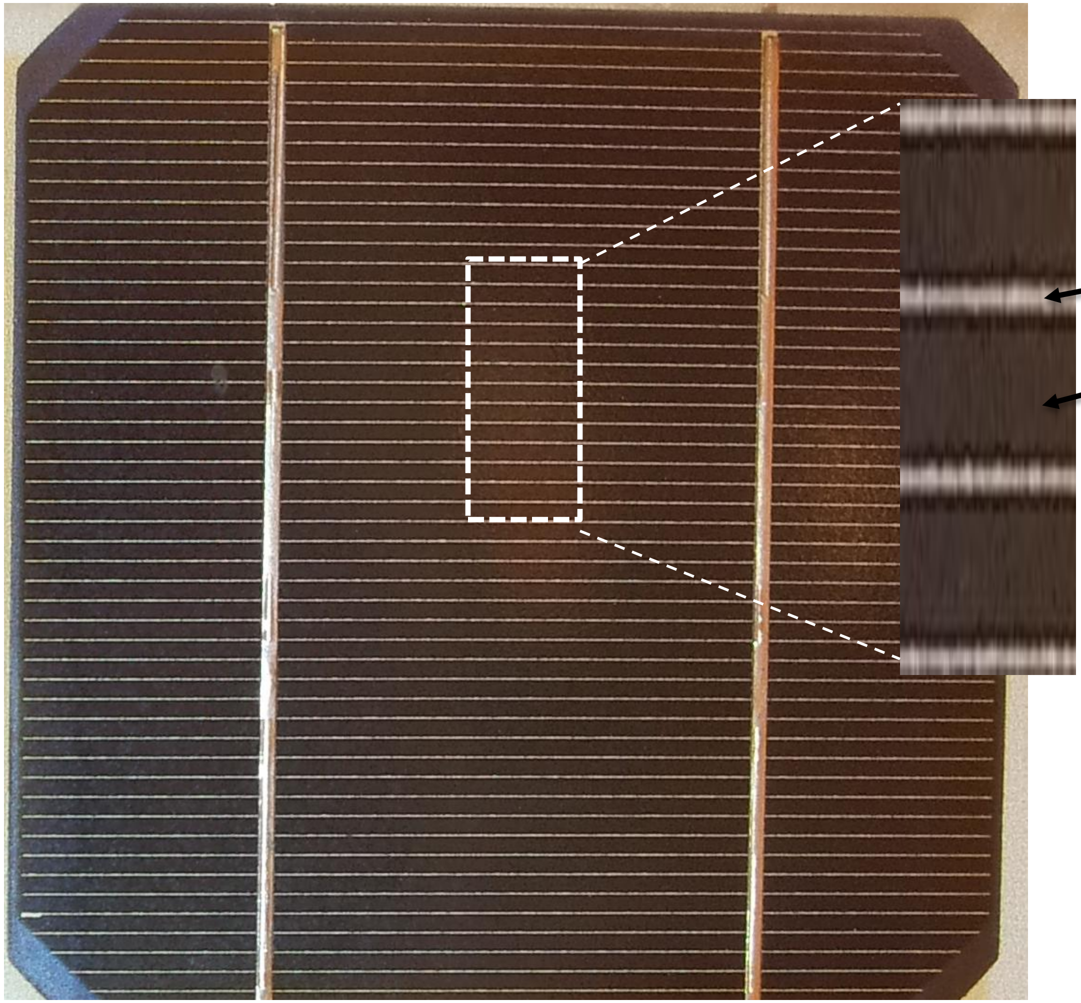
Adhesive Energy

$$G = \frac{6P^2a^2}{EB^2h^3}$$

P = load
a = crack length
E = Young's modulus
B = beam thickness
h = beam height

Encapsulant Delaminates from Si and Electrodes

Encapsulated Solar Cell



Metal electrode

Si

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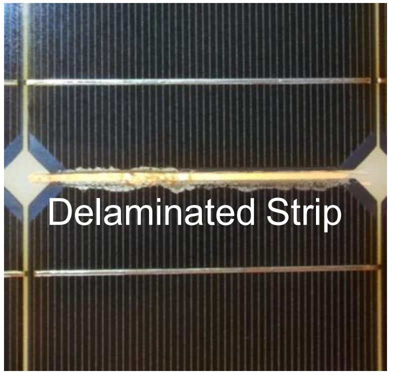
Adhesive Energy is Strongest in the Electrodes

Adhesion Test on
EVA Encapsulant –electrode



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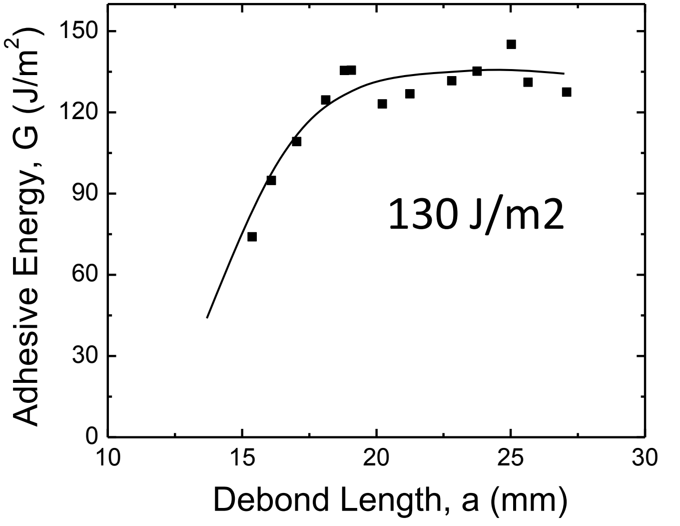
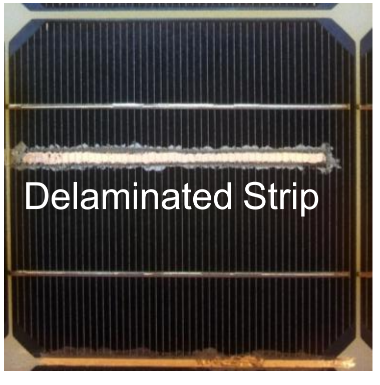
Encapsulant-electrode
Adhesive Energy



Adhesion Test on
EVA Encapsulant – Silicon+electrode



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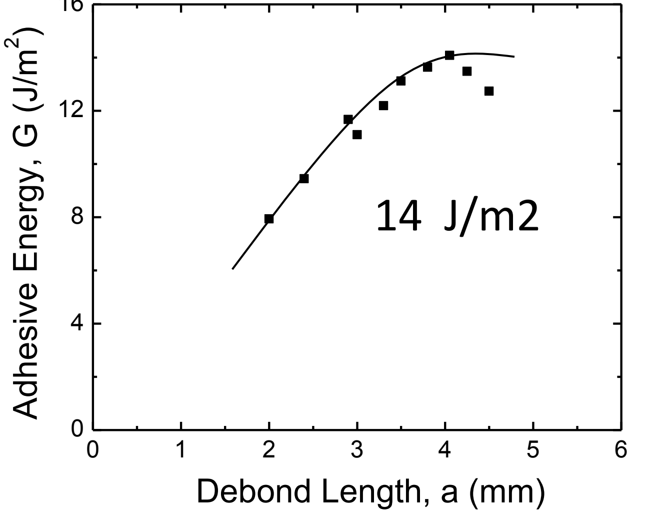
Encapsulant-Si+electrode
Adhesive Energy



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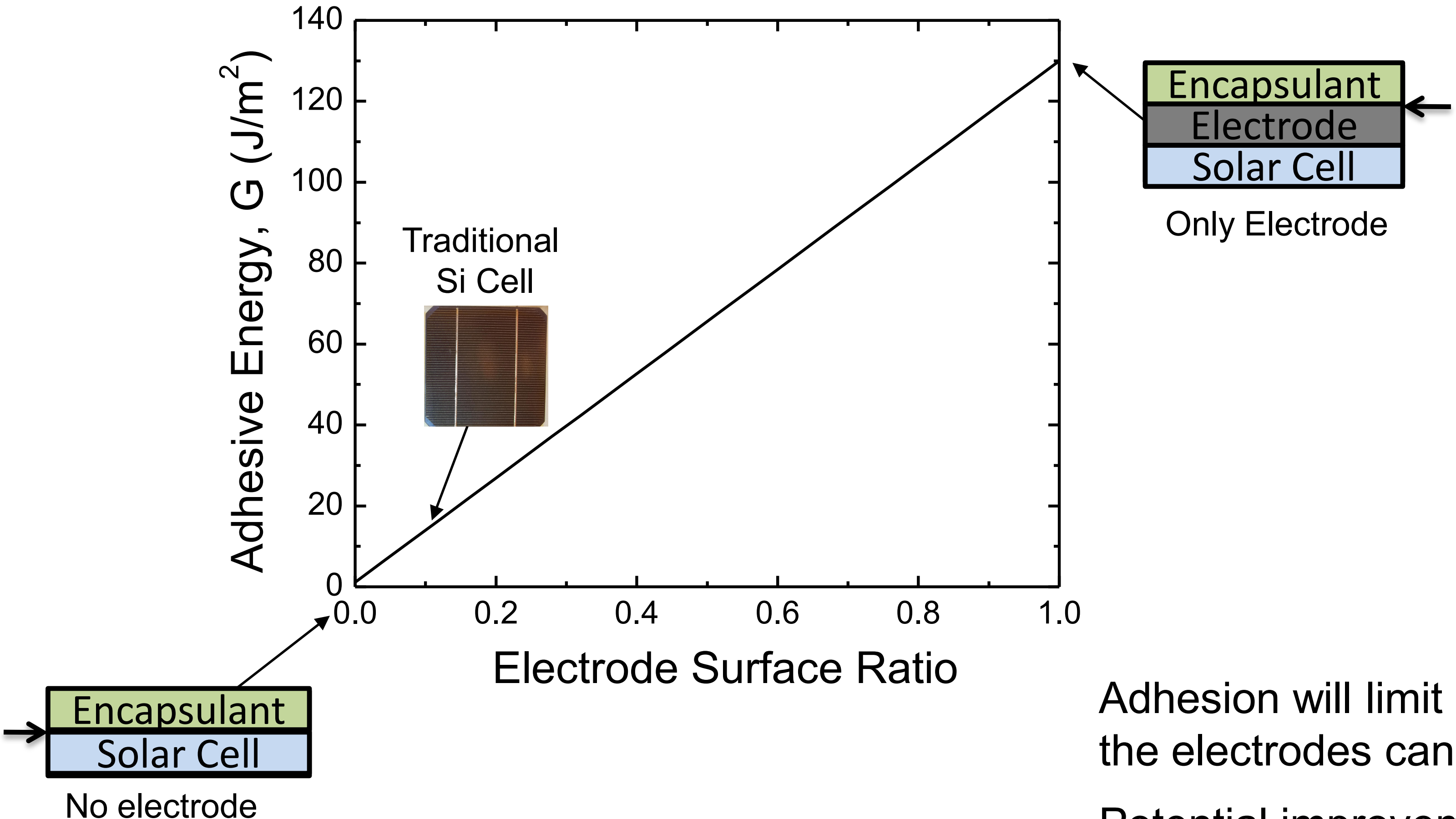
Adhesive Energy Increases with Electrode Surface



Adhesion will limit how thin the electrodes can be.

Potential improvements on EVA-Si adhesion will reduce delamination.

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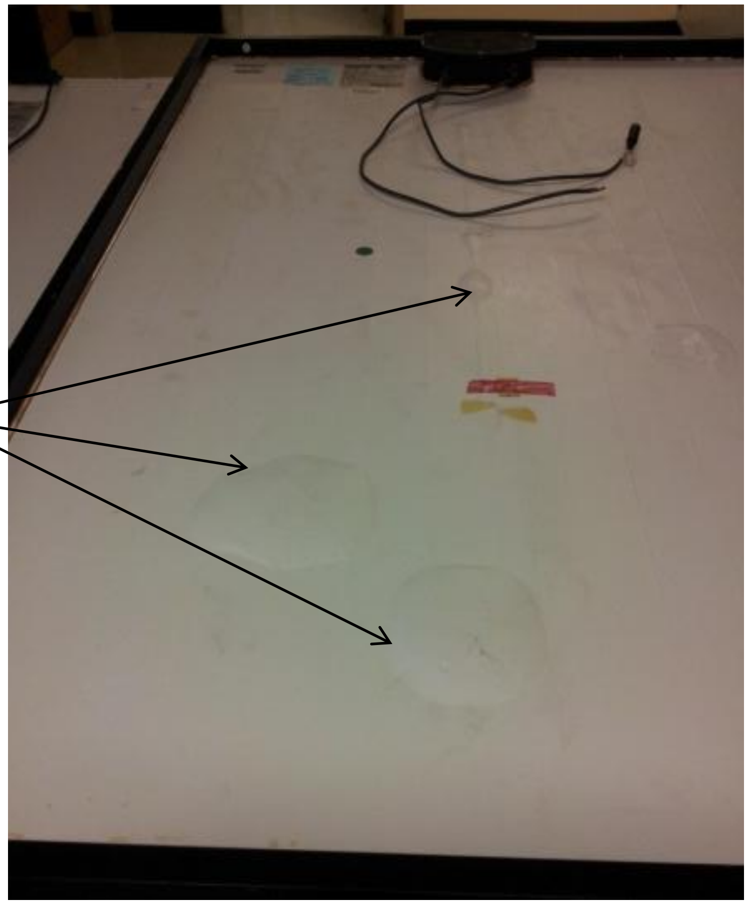
Backsheet Delamination in Field Modules

Backsheet Delamination



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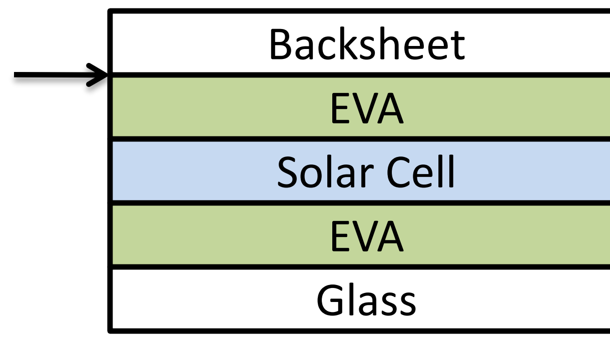

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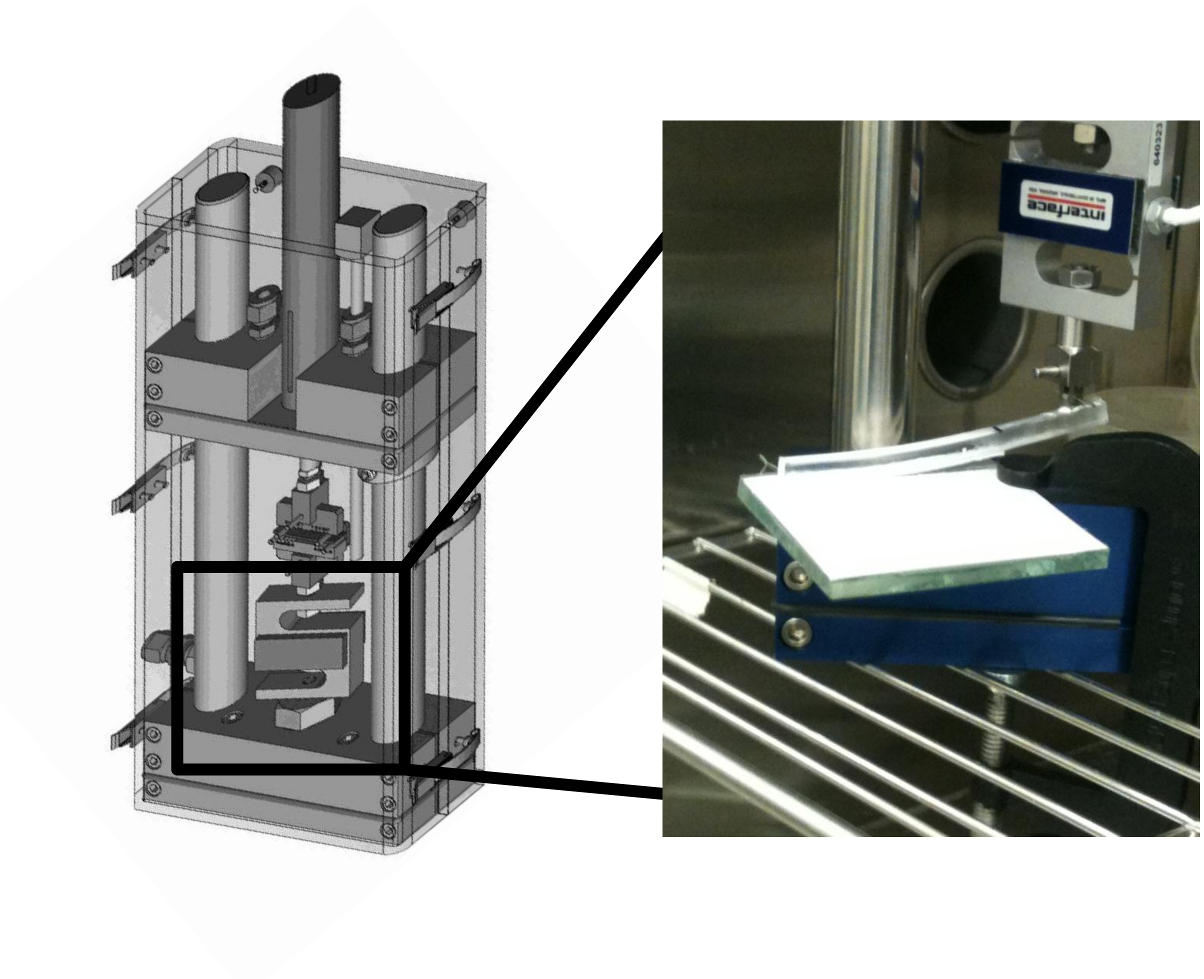
Quantifying Backsheet Delamination



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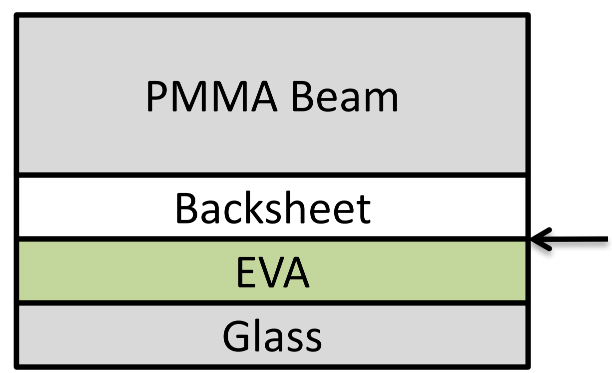

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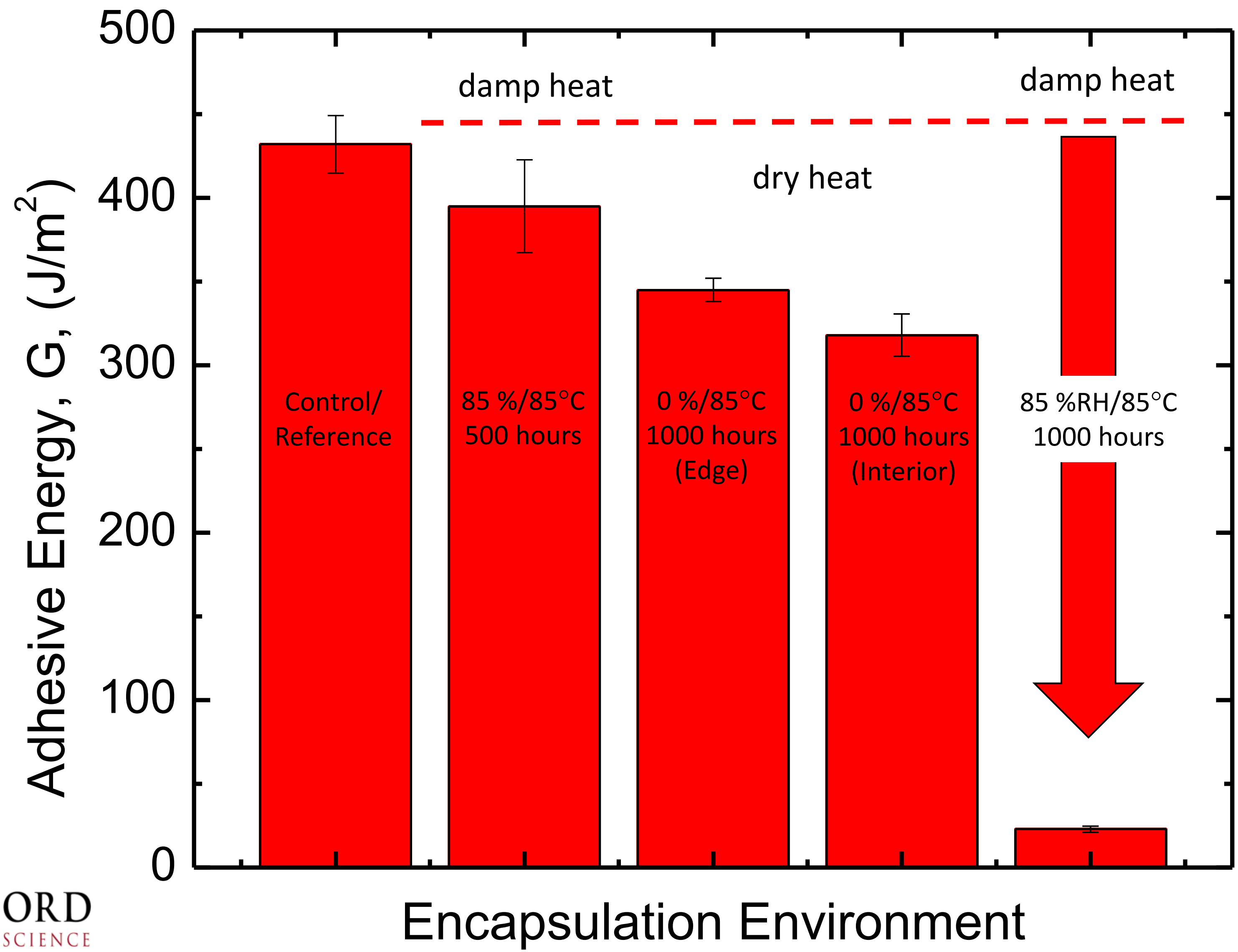
Anneal Treatment Effect on Backsheet Adhesion



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