Comparative study of the temperature dependent delamination behavior of four solar cell encapsulants to glass and backsheet-laminate

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Introduction and Objectives

- Delamination within the PV module is one of the most critical failure modes during service life time
- So far, only EVA/glass and EVA/backsheet interfaces have been investigated at ambient temperature
- Determination of delamination behavior of new solar cell encapsulants to glass and standard backsheet at application relevant temperatures

Results: Peel Tests

Backsheet - Encapsulant Adhesion

- Excellent adhesion to TPT, also at high temperatures
- Cohesive fracture within the TPSE film at all temperature levels
- Little temperature dependence

TPSE
- Excellent adhesion to TPT at room temperature – decreasing adhesion with increasing temperature
- Significant temperature dependence
- Mix of adhesive and cohesive fracture for T≤40°C
- Adhesive fracture for T>40°C

EVA
- Excellent adhesion to TPT at room temperature – decreasing adhesion with increasing temperature
- Significant temperature dependence
- Mix of adhesive and cohesive fracture for T≤40°C
- Adhesive fracture for T>40°C

Polyolefin
- Excellent adhesion to TPT at all temperature levels
- No stable peeling of the polyolefin from the backsheet
- Breakage of one layer following delamination within the backsheet
- No temperature dependence observable

Ionomer
- Excellent adhesion to TPT at room temperature - no stable peeling
- Breakage of one layer following delamination within the backsheet
- Stable peeling for T≤40°C – decreasing adhesion with increasing temperature
- Significant temperature dependence
- Mix of adhesive and cohesive fracture

Glass - Encapsulant Adhesion

EVA
- Excellent adhesion to glass at room temperature – decreasing adhesion with increasing temperature
- Significant temperature dependence
- Mix of adhesive and cohesive fracture for T≤40°C
- Adhesive fracture for T>40°C

Polyolefin
- Excellent adhesion to glass at room temperature - no stable peeling
- Breakage of one layer following delamination within the backsheet
- Stable peeling for T≤40°C – decreasing adhesion with increasing temperature
- Mix of adhesive and cohesive fracture
- Significant temperature dependence
- Increasing temperature dependence
- Increasing peel force at 70°C

Polyolefin
- Excellent adhesion to glass at room temperature – decreasing adhesion with increasing temperature
- Significant temperature dependence
- Mix of adhesive and cohesive fracture

Ionomer
- Excellent adhesion to glass at room temperature – decreasing adhesion with increasing temperature
- Significant temperature dependence
- Mix of adhesive and cohesive fracture

Conclusion

- Every material showed excellent adhesion to glass and TPT at room temperature
- Significant temperature dependence was observed for EVA, Ionomer and to some extend for Polyolefin – strong decrease in adhesion to TPT backsheet and glass at temperatures > 40°C

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