POLYMER COMPETENCE CENTER LEOBEN GMBH

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**

Experimental

Materials

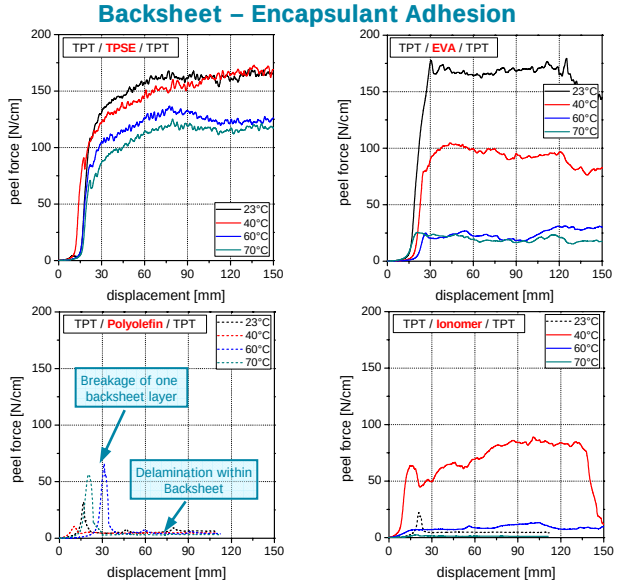
- Lamination of glass/ encapsulant/ backsheet and backsheet/ encapsulant/ backsheet specimen using
  - EVA (Photocap 15420P/UF, STR)
  - TPSE (Tectosil 177, Wacker)
  - Ionomer (Jurasol FBS9, Juraplast)
  - Polyolefin (Z68, DNP)
- Standard TPT (Icosolar 2442, Isovoltaic) film used for backsheet
- Lamination conditions according material data sheets

Peel Testing

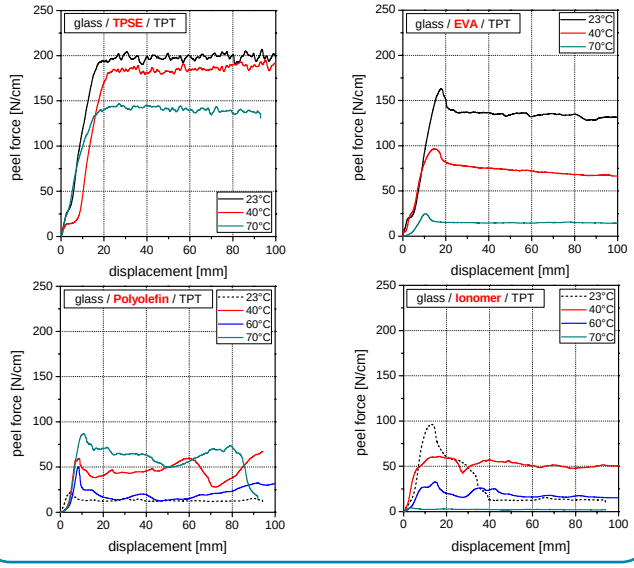
- Test geometry
  - T-Peel test for backsheet/ encapsulant/backsheet specimen
  - 180° peel test for glass/ encapsulant/ backsheet specimen
- Test speed: 50 mm/min
- Temperature levels: 23, 40, 60, 70°C

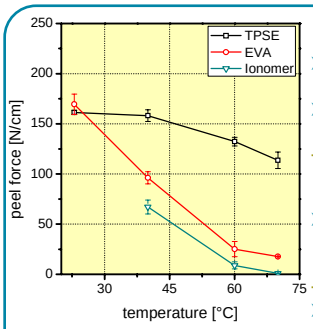
Results: Peel Tests

Backsheet – Encapsulant Adhesion



Glass – Encapsulant Adhesion





TPSE

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

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

TPSE

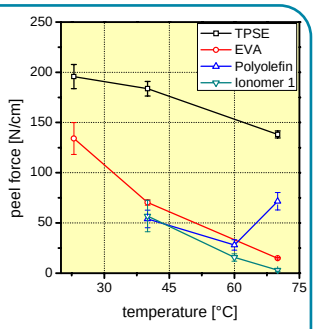
- Excellent adhesion to glass, also at high temperatures
- Adhesive fracture up to 60°C - mix of adhesive and cohesive fracture at 70°C
- → *Little temperature dependence*

EVA

- Excellent adhesion to glass at room temperature – decreasing adhesion with increasing temperature
- → *Significant temperature dependence*
- Adhesive fracture up to 60°C - mix of adhesive and cohesive fracture at 70°C

Ionomer

- 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*



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
- Mix of adhesive and cohesive fracture
- → *Significant temperature dependence*
- Increasing peel force at 70°C

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**

COMET Competence Centers for Excellent Technologies

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