**CHARACTERIZATION OF DYNAMIC LOADS ON SOLAR MODULES WITH RESPECT TO FRACTURE OF SOLAR CELLS**

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**Results – 4-Point-Bending &**

- reduction of $P_f$ after lamination (Fig. 5) due to increased pressure load across cell (Fig. 4)
- PVB shows higher stiffness level and larger dependency on time (Fig. 6)
- visco-elastic behavior of encapsulant characterizes the load on solar cells (Fig. 7)
- generally at low temperatures strain rate dependency decreases (Fig. 8)
- but: glass transition increases damping (i.e. see loss factor for EVA)

**Discussion**

- time-temperature superposition important for definition test conditions at room temperature (Fig. 8)

**Results – Modules**

- IEC CD 62782 "Dynamic Mechanical Load Testing"

  - 1000 Pa
  - 7 sec dwell time at elevated load
  - 1 – 3 cycles/minute
  - room temperature
  - number of cycles / min crucial to applied load on cells

<table>
<thead>
<tr>
<th>Cycles / min</th>
<th>Dwell Time / sec</th>
<th>Time / sec</th>
<th>Ramp / Pa/sec</th>
<th>Ramp / N/sec</th>
<th>Ramp / mm/mm/min</th>
<th>$P_f$ Relative Change</th>
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<tbody>
<tr>
<td>0.02</td>
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<td>2.14</td>
<td>1-2</td>
<td>1.00 ± 0.65</td>
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</tr>
</tbody>
</table>

* Module size 1.6 m²
* Example from FE Simulation for 1.6 m² Module (100 Pa)

**Bibliography &**

