Abstract/Summary:

In the last years, because of the higher irradiation, an increase of installed PV systems situated close to the equator line could be observed. As these regions are often characterized by an arid climate, sand and dust deposition on the solar modules can reduce significantly the predicted energy yield. Closer to equator the soiling effect becomes also more incisive because of the lower tilt angle of the installed modules. Therefore, in desert regions, several cleaning procedures are implemented. The cleaning is generally performed by mechanical systems, which may affect the lifetime of the modules. For the investigation of the specific impact of different cleaning procedures on the module performance, in this work different accelerated cleaning tests are performed. The impact on the modules is then evaluated through performance and electroluminescence measurements. Moreover, reflectance measurements are performed in order to test the effect of the cleaning on the antireflection coatings and on the glass surface of the modules. Accordingly, the suitability of the investigated coatings for desert applications is also tested. The resistivity of different coatings on glass is then compared through an abrasion test.

For more Information on the topic please contact the R&D Team of PI Berlin.

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Thermal Stress Analysis on Encapsulation and Backsheet Materials for PV-Modules

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Approach

World wide there are over 177 GW pv-modules installed. The performance ratio (PR) of the pv-modules / systems can be reduced by different influences. Systems installed in the 80s reach PR values of 0.7 and newer systems show typical values of around 0.8. If the PR values is or become reduced by the time the infrared scan is a powerful method to detect solar cells or modules with relative higher temperatures during field inspections. The reasons for the temperature differences can be a cell mismatch, shadowing or isolated fracture (reduction of the active cell area). The temperature differences can be a cell mismatch, shadowing or isolated fracture (reduction of the active cell area). The financial stress analysis at different back sheets has shown that the sample 4 ("TPO") has the highest degradation rate. The other investigated materials show only negligible transmission losses. The angle-dependent measurements at 160° C show that the sample 4 ("TPO") has the highest degradation rate. The other investigated materials show only negligible transmission losses.

Encapsulation materials and methods

Name | Type | Temperature / ° C
--- | --- | ---
BS 1 | PVF / PET / PVF (manufacturer 1) | 160
BS 2 | Polyamide | 160
BS 3 | PVDF / PET / LE (manufacturer 2) | 160
BS 4 | PVF / PET / PVF (manufacturer 2) | 160

Back sheet (BS) property | Characterisation method
--- | ---
Visual | Visual inspection
Optical | Spectral reflection

BS: Electrical isolation effect

Fig. 1: The thermal stress decreases the electrical isolation voltage. The back sheet BS1 shows highest degradation. It comes under 1 kV after two weeks thermal stress of 160°C. The three other foils come under that value after eight weeks at 160°C.

Encapsulation materials and methods

Name | Type | Temperature / ° C
--- | --- | ---
E 1 | EVA (manufacturer 1) | 200, 160
E 2 | EVA (manufacturer 2) | 200, 160
E 3 | PVF | 200, 160
E 4 | TPO | 200, 160

Encapsulation (E) property | Characterisation method
--- | ---
Visual | Visual inspection
Optical | Angle dependent

E: Angle dependent analysis (160°C)

Fig. 2: In the initial state all foils show a relative constant reflectance over the wavelength. The polyamide material ("BS2") shows the highest reflection, but it also has the highest reflectance degradation followed by sample "BS1" (PVF / PET / PVF; manufacturer 1).

E: Energy yield losses (200°C)

Fig. 4: At the 200°C investigation all samples show higher transmission degradation compared to the 160°C samples. The PVF material has here the highest degradation rate followed by the EVA2.

Fig. 5: The simulation shows that the PVF sample has the highest energy yield losses with 88%. The yield losses of sample “EVA2” increase to 16% after 10 weeks thermal stress while the other samples show losses of < 5%.

E: Angle dependent analysis (200°C)

Fig. 3: The angle-dependent measurements at 160°C show that the sample 4 ("TPO") has the highest degradation rate. The other investigated materials show only negligible transmission losses.

Conclusions

- Benchmarking of the thermal stress at back sheet foils
  - Back sheet property: BS 1, BS 2, BS 3, BS 4
  - Darkest color: highest stress
  - Lightest color: lowest stress

- The thermal stress analysis at different back sheets has shown that the PVF / PET / PVF material combination has got the highest thermal resistance. Also it can be concluded that there are quality differences between the manufacturers.

- Benchmarking of the thermal stress at encapsulation foils
  - Encapsulation property: E 1, E 2, E 3, E 4
  - Darkest color: highest stress
  - Lightest color: lowest stress

- The thermal stress analysis at the encapsulation foils has shown that the EVA in general shows the highest thermal resistance. A faster degradation rate has been determined at higher temperatures. It was also shown that there are quality differences between the manufacturers.

"++: highest stability, --: lowest stability"