Area 7 Performance and Reliability of PV Modules

CONCEPTS FOR PV MODULES OPTIMIZED FOR DIFFERENT CLIMATIC CONDITIONS: BACKSHEETS AND ENCAPSULANTS

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The area of reliability and durability of PV modules and systems is accepted as crucial and important by industry and policy makers and has the highest priority. It has also been identified to be very challenging in terms of required research & development as the operating environment of PV systems is very different to that of other technologies and a complex interplay of life-time costs, power output, efficiency, material and component quality and durability as well as sustainability has to be considered. Without an understanding of life-time costs, inappropriate materials or components might be used, resulting in pre-mature failure and thus increased energy costs. Currently a “one module type fits all” approach, is commonly used in PV industry, where one standard module design and unified material quality levels composition is used for applications in widely varying all environmental and climatic conditions and setups around the world.
The right combination of encapsulant and backsheet materials are a main factor in order to achieve climate sensitive PV modules, as their properties and long term behavior influence the main PV module degradation modes like Yellowing, PID, corrosion or snail trails significantly. Of special interest are the interactions between the encapsulation materials and the interconnection system as well as the permeation properties of backsheets.

Hence, to better understand this material interactions and its influencing factors a comprehensive test plan was set up. Test modules with different combinations of material and combinations were produced to achieve the targets. On one hand, existing materials and components were used as a reference, on the other hand already newly developed materials and components were incorporated. Three different encapsulation materials were selected for the studies: standard ethylene vinyl acetate (EVA), a crosslinking polyolefin elastomer (POE) and a thermoplastic polyolefin (TPO). The materials were chosen in order to investigate especially the effect of acetic acid (which is a degradation product of EVA) and the added crosslinker on PV module degradation. Two different backsheets with different permeation properties were chosen in order to investigate the influence of selective permeability, especially regarding the permeation rates of water vapor (WVTR) and acetic acid (AATR). Here a standard PET based laminate (low WVTR; low AATR) and a co-extruded polyolefine based backsheet (low WVTR; high AATR) were selected.
The test modules were exposed to different accelerated aging tests (damp heat, irradiation). After a visual and electrical characterization the materials within the modules are characterized with Raman and UV/Vis/NIR spectroscopy before and after aging. In the end of accelerating testing additional destructive material characterization tests will be done when interesting effects are observed.

First results show that the type of exposure and the permeation properties of backsheet layers showed great influence on the formation and retention of acetic acid. Whereas glass is impermeable to acetic acid, AATR values of 43 (polyester based) and 400 g/m^2*d (polyolefin based) where found for the backsheets. EVA is more susceptible to degradation when exposed to UV light in comparison to temperature exposure, which results in higher formation of acetic acid. Due to an autocatalytic effect of the retained acetic acid on the interface EVA/backsheet, more acetic acid is formed, especially in modules containing an impermeable glass layer, which at the end causes higher degradation of EVA. The higher the barrier of the backside, the more yellowing but also a higher increase of the fluorescence background was observed. The test program is still under progress and expected to be finished in summer, so the overall results will be presented at the conference.