Acetic acid, which is formed during degradation of the most frequently used photovoltaic (PV) encapsulant ethylene vinyl acetate (EVA), is linked to several PV module failure mechanisms like corrosion of interconnectors, cells or potential induced degradation (PID). Several studies showed that backsheets with presumably high acetic acid permeation rates (AATR) reduce the sensitivity to PID. But so far only few data on permeation rates of acetic acid are published.

So, an evaluation of a new measurement technique and data analysis for acetic acid permeation through photovoltaic backsheet films is described. The influence of the layer composition of the multilayer backsheets on the acetic acid permeation rates was determined by investigating the permeation properties of the individual layers as well as the whole polymeric multilayer composites. Permeation rates were measured utilizing a gravimetric method. The samples were cut to size in order to fit into an open screw cup. Vials were filled with acetic acid and closed with the previously prepared screw cup containing the sample, which functions now as a membrane. The weight loss over 30 days was followed gravimetrically at standard laboratory conditions (23°C, 50% rel.H.)

An isostatic gravimetric method and data analysis routine was successfully set up for the measurement of the acetic acid permeation rate through polymer films. The obtained loss in weight over time for each specimen has to be evaluated carefully to eliminate measurement errors due to obvious leakage. Furthermore, the transient character of the permeation process – i.e. time of equilibration of the backsheet with the acetic acid - has to be taken into account when setting the evaluation range of the mass loss properly.

The results showed that the acetic acid transmission rate AATR strongly depends, as expected, on temperature (where it follows an Arrhenius type relationship) but also film thickness and layer composition. The lowest permeation rates were found for laminates containing a polyester (PET) core layer and the single PET layer with AATR values ranging from 0.1 to 1.0 g/m²*d. By comparison, co-extruded backsheets based on polyolefines, polyamide as well as the fluoropolymeric and polyamide single films exhibited significant higher values between 20 and 500 g/m²*d. Hence, the permeation rate of the PET core layer is determining permeation rate of whole backsheet, which is nearly exclusively due to the higher thickness of the PET layer compared to the outer layers of a backsheet. The highest AATR values were found for cured EVA, so it can be concluded that there will be no retention of acetic acid by the EVA layers in a PV module.

Interestingly, unlike to water vapour and oxygen permeation, an additional aluminium layer has no significant additional barrier effect. Corrosion of the aluminium layer has been shown with REM-EDX and FTIR-ATR spectroscopy, creating pinholes or micro-cracks which enhance acetic acid transport through the aluminium layer. Even more interestingly, acetic acid permeation behaviour shows a good correlation to oxygen permeation, but not to water vapour permeation. Finally, the results showed that “breathable” backsheets support diffusion of acetic acid out of the module and design matching with other PV module components may increase performance and reliability.