

Temperature Dependent Permeation of Water Vapor through Barrier Foils

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Polymeric materials are used as water vapor barriers, or substrate materials for barrier coatings in food packaging, photovoltaic devices or OLEDs and as embedding materials for solar cells or as containers for vacuum isolation materials. Their permeation properties determine the level of water in the polymers and inside the devices. The water can cause corrosion and/or deterioration of functional properties of the devices. The temperature of solar devices and the ambient water vapour concentration vary over time according to the solar radiation and the ambient climate. Temperature dependent permeation and diffusion properties are needed for modeling the water concentration over time in order to predict the long-term behaviour and the service life of such devices.

The paper describes the measurement of the temperature dependent permeation coefficient for polymeric foils, different combinations of polymeric foils and inorganic barrier coatings enforced by additional sol-gel based ORMOCER® coatings, or inorganic barrier coatings and initial results of modeling the service lifetime by integrating time-series of in-use conditions.

We used a set-up based on a mass-spectrometer for the measurement of the water-vapour permeation. The sample film is mounted on ultra-high-vacuum flanges of up to 300 mm diameter by means of a butyl sealant and UHV-metal sealant and is exposed to controlled temperatures between 20 and 90 °C and a fast increase of the humidity until a set partial pressure is reached. The progress of the humidity content in the volume behind the sample film, which is initially filled with argon under atmospheric pressure is monitored by a quadrupole mass spectrometer and is used for evaluation of diffusion and permeation coefficients. The results are used for modeling the humidity concentration by means of commercial software-packages and numerical models based on FEM algorithms with time-dependent border-conditions resulting from long term climate monitoring.