Degradation in photovoltaic encapsulant transmittance: Results of the first PVQAT TG5 artificial weathering study

Abstract:

Reduced optical transmittance of encapsulants resulting from ultraviolet (UV) degradation is frequently identified as a cause of decreased performance through the service life of photovoltaic modules. However, the present module safety and qualification standards apply short UV doses, only capable of examining design robustness and “infant mortality” failures. Furthermore, essential information remains unknown that might be used to screen encapsulants through product lifetime. We conducted an interlaboratory study to provide the understanding that will be used toward developing a higher-fidelity, more-rigorous UV weathering test. Five representative known formulations of poly (ethylene-co-vinyl acetate) were studied, in addition to one thermoplastic polyurethane material. Replicate laminated silica/polymer/silica specimens were examined at seven institutions using a variety of indoor chambers (including xenon, UVA-340, and metal-halide light sources). Specimens were artificially weathered for 180 cumulative days at steady-state accelerated test conditions, predesignated relative to the default irradiance of 1.0 $W \cdot m^{-2} \cdot nm^{-1}$ at 340 nm, chamber temperature of 60°C, and chamber relative humidity of 30%. The solar-weighted transmittance, yellowness index, and the UV cut-off wavelength—each determined from the measured hemispherical transmittance—are examined to provide understanding and guidance for the UV light source (type lamp and filters), temperature, and humidity used in accelerated UV aging tests. The relative efficacy of xenon-arc and UVA-340 fluorescent sources and the typical range of activation energy for degradation is quantified from the experiments.

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