LINKING ACCELERATING LABORATORY TEST WITH OUTDOOR PERFORMANCE RESULTS FOR A MODEL EPOXY COATING SYSTEM

by

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ABSTRACT

Laboratory and outdoor exposure results have been mathematically linked for a model epoxy coating system using a reliability-based methodology. Accurate and time-based measurements on both exposure environments and degradation properties for epoxy specimens exposed to accelerated laboratory weathering device and outdoor environments were performed. Laboratory weathering tests were conducted on the NIST SPHERE (**S**imulated **P**hotodegradation via **H**igh **E**nergy **R**adiant **E**xposure), a device in which spectral ultraviolet (UV) wavelength, spectral intensity, temperature, and relative humidity (RH) can be precisely and accurately controlled over time. A factorial design consisting of 4 temperatures, 4 RH levels, 4 UV spectral wavelengths, and 4 UV spectral intensities was used in exposing the epoxy samples on the SPHERE to assess the effects of critical environmental factors on chemical degradation of this material. Outdoor exposure experiments were carried out on the roof of a NIST laboratory located in Gaithersburg, MD. Panel temperature and ambient RH of the outdoor exposure and the solar spectrum were used to characterize the roof environment at 12 minute intervals. The chemical degradation for specimens exposed on the SPHERE and in the outdoor environments was quantified by transmission FTIR and UV-visible spectroscopies. Tests using FTIR absorbance ratios showed that the mechanisms of chemical degradation for samples exposed outdoors and in the laboratory were similar. Two approaches, a model-free heuristic approach and a mathematical predictive model, were used in linking field and laboratory exposure results. Successful linkages have been made using both approaches. The study strongly demonstrated that the reliability-based methodology is capable of linking laboratory and field exposure data and predicting the service life of this type of polymeric material.