NAPLES, ITALY 30 JUNE - 4 JULY
ACEX2025 NAPLES
18th International Conference on Advanced Computational Engineering and Experimenting

ABSTRACT

Real-time Non-destructive Characterization of Epoxy Resin Curing Kinetics and Mechanical Response for Enhanced Manufacturing Quality Control

G. Seisdedos[1], E. Viamontes[2], E. Salazar[2], T. Rockward[1], C. Pantea[1], B. Boesl[2], and E. S. Davis[1]

[1]Los Alamos National Laboratory, Los Alamos, New Mexico, 87545, USA.
[2]Florida International University, Miami, Florida, Main, 33174, USA.

Controlling and monitoring the processing parameters during epoxy manufacturing is a challenging task and their variation impacts the curing process of the polymer and its final quality. To address this issue, destructive testing is typically performed for quality control and material characterization, which involves expensive lab-type equipment and instrument-specific sample preparation. Moreover, this type of testing cannot be taken in-field to perform an in-situ evaluation and produces a large quantity of non-recyclable material waste. This work presents a method to non-destructively evaluate the curing kinetics and viscoelastic properties of epoxy resin in real time due to variations in stoichiometry combining ultrasonics and Fourier Transform Infrared Spectroscopy. Samples with a different amine-to-epoxy ratio and cure temperatures were manufactured and tested. Changes in longitudinal sound speed were detected during the resin's curing process, resulting from variations in the polymer's chemical structure, and were correlated to the cure kinetics. The longitudinal and shear sound speeds were used to calculate the elastic properties of the material, including Young's modulus and Poisson's ratio. This approach has the potential to non-destructively characterize the properties of polymers in both an in-field and manufacturing setting, allowing for a sustainable tailoring process and ensuring their reliability in demanding applications.