Modeling Time-dependent Response of Polymers and Polymeric Composites due to Mechanical and Non-mechanical Stimuli

ABSTRACT

Polymers and polymeric composites are widely used in many engineering applications such as civil infrastructures, machine elements, aircraft structures, wind turbine blades, medical devices and implants. The above applications could subject the polymers and polymeric composites to continuous cycles of mechanical loadings in addition to exposure to hostile environments. Our aim is to understand the life performance of polymers and composites under coupled mechanical and non-mechanical effects. We first consider the modeling responses of various viscoelastic polymers under different temperatures and/or moisture conditions. We then consider responses of polymers due to conduction of heat or moisture diffusion, in which we have to account for different time histories from the mechanical loading and diffusion process. An attempt is also made to include the degradation in the polymers due to external stimuli and the heat generation due to the energy dissipation of the viscoelastic polymers. Next, we integrate the viscoelastic constitutive models for polymers to micromechanics models for analyzing the overall performance of polymeric composites. We consider several polymeric composites: unidirectional fiber reinforced composites, functionally graded materials, and active fiber composites. The active composites consist of ferroelectric fibers dispersed in epoxy matrix, which possess electro-mechanical coupling behaviors. The micromechanics model is implemented in finite element (FE) and used for analyzing time-dependent responses of composite structures under coupled mechanical and non-mechanical effects.

BIO

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