

Aging Analyses of Polymer Composites Through Time-Temperature Equivalence

Abstract:

A fundamental problem of advanced airplane composite systems is the lack of understanding of the aging process and how it affects the material properties associated with degradation. The concept of Equivalent Property Time (EPT) was established and can be used to understand degradation of polymers and composites in a uniform manner, both for isothermal and dynamic elevated temperature exposures. In this work, bismaleimide neat resin and composite degradation was analyzed with isothermal and dynamic thermogravimetric analysis adapting a descriptive time-temperature concept originally developed for the curing of thermosets. The concept, defined as EPT, described the experimental data accurately for the experimental conditions tested. Thus, this methodology was demonstrated to be a useful tool in designing aging experiments and assessing the lifetime of composite systems. An extension of this concept was developed to include Equivalent Cycle Time (ECT), which involves the effects of cycling-heating, cooling, and holding, which can be used to understand degradation aging phenomena from repeated exposure. Collectively, this work focused on providing an understanding of cycling phenomena for polymers and composites as they relate to environmental influences and their accelerated aging behavior.