Assessment of Material State in Composites Using Global Dielectric State Variable

By

Vamsee Vadlamudi

Thesis Advisor: Prof. Kenneth Reifsnider

2:00 – 3:30 pm, Friday, November 22\textsuperscript{nd}

WH, Room 200

Abstract

Composites are heterogeneous in nature and a fundamental understanding of the material response to applied mechanical, thermal, electrical and other multi-physical fields is required to efficiently design and synthesize the material system and demands attention to long-term behavior in particular. Unlike metals, composites are designed to develop distributed damage and initiation of a single microscopic crack does not individually affect the strength/life of these materials. Therefore, the primary interest is not in single local events but in the process of interaction of multiple events that have a collective global effect on the material behavior. The interaction of these local events are interpreted using ‘state’ of the material by the means of ‘state’ variables e.g. strength, stiffness etc. However, it was observed that the evolution of these state variables are not uniformly progressive in nature even though the damage progression is progressive.

The primary objective of this research is to identify a unique state variable that can assess the material state during service and provide warning of impending failure. This work is focused on in-situ monitoring of material state during quasi-static, fatigue (low cycle and high cycle) loading for different material systems, stacking sequences. This work also develops a finite element based multiphysics model that attempts to explain the variation of the in-situ response during damage development. Finally, the shortcomings, challenges of the multiphysics model and recommendations for future work are discussed.