INTEGRATED COMPUTATIONAL MATERIALS ENGINEERING (ICME) DEVELOPMENT OF CARBON FIBER COMPOSITES FOR LIGHTWEIGHT VEHICLES

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ABSTRACT

Automotive manufacturers use lightweight materials to meet the increasing demands of fuel efficiency. The Carbon Fiber Reinforced Polymer (CFRP) composites, with a density of 1.55 g/cm3 and a tensile strength of 2000 MPa in the fiber direction, are among the most promising candidates to replace the metals currently used for structural components. It is important to note that the performance of carbon fiber composites is determined not only by the component design, but also the manufacturing processes. In this talk, the focus is on the application of an Integrated Computational Materials Engineering (ICME) approach to the structural composite design. A suite of predictive models is developed to link materials design, manufacturing process and final performance to enable optimal design and manufacturing of CFRP components for automotive vehicles.

One of the greatest challenges for successful applying the ICME approach to CF composites is how to accurately simulate the different failure modes during crash scenarios. Especially, the traditional thin shell model in finite element simulation has difficulty in capturing the delamination behavior during complex loading conditions. Recently, a discontinuous Galerkin weak form for bond-based peridynamic models is developed for composite modeling through the collaboration among ORNL, LSTC and Ford. The accuracy and computational efficiency of the developed model for delamination modeling is demonstrated through simulating a dynamic bending test of a laminate structure.