



2009 Mechanical Engineering Distinguished Seminar Series



The Department of Mechanical Engineering is pleased to host

Prof. Charles Tucker III

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Predicting Process-Induced Microstructure in Molded Composites

Abstract: Long-fiber thermoplastic (LFT) composites consist of an engineering thermoplastic matrix, together with glass or carbon reinforcing fibers that are initially 12 to 25 mm long. LFTs balance good mechanical properties with low-cost processing, so they are attractive materials for producing lightweight structures for fuel-efficient automobiles. When an LFT part is manufactured by injection molding, the flow during mold filling orients the fibers and can degrade the fiber length. In order to do effective engineering design with LFTs it is essential to be able to predict this process-induced microstructure. Models for flow-induced fiber orientation have been available for more than a decade, but have some deficiencies when treating LFTs. We extend the popular Folgar-Tucker fiber orientation theory by incorporating anisotropic rotary diffusion, and show that this new theory produces better orientation predictions for molded LFT composites. We also present the first quantitative model for changes in the fiber length distribution. The fiber orientation and fiber length models are developed according to the same pattern: choose variables to quantify the microstructure, identify conservation laws that these quantities must obey, and develop "constitutive" models for the remaining dynamical aspects of microstructure development. This pattern forms a useful template for approaching all problems in predicting process-induced microstructure.

Biography: Professor Charles Tucker's research interests include processing of polymers and composite materials, modeling and simulation, numerical methods, fluid mechanics, rheology, and heat transfer. He developed some of the first computer simulations of compression molding and liquid composite molding. His model for flow-induced fiber orientation is used worldwide to design injection molded composite parts. His recent research interests include microstructure development in polymer blends, particularly in chaotic mixing flows, and he continues to work on injection- and compression-molded composites. Prof. Tucker earned BS, MS, and Ph.D. degrees in mechanical engineering from the MIT in 1975, 1977, and 1978, respectively. He joined the University of Illinois in 1978. He was named the W. Grafton and Lillian B. Wilkins Professor in 1998, and the the Alexander Rankin Professor in 2004. He is a an ASME Fellow, a recipient of the Ralph R. Teetor Award from the Society of Mechanical Engineers, the Union Oil Young Faculty Award, the Presidential Young Investigator Award from the National Science Foundation, and the Outstanding Young Manufacturing Engineer Award from the Society of Manufacturing Engineers.

Date: October 30, 2009 at 2:00 pm

Place: DeWalt Seminar Room, 2164 Glenn Martin Hall

Host: Dr. Tucker will be hosted by Associate Professor David Bigio of Mechanical Engineering (dbigio@umd.edu)