PURDUE
UNIVERSITY **School of Aeronautics and Astronautics**

The AAE Spring 2013 Colloquium Series

Shock Compression and Strain Rate Effect in Semi-crystalline Polymers

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ARMS 1103

COLLOQUIUM

Abstract

High strain and high strain-rate applications in aerospace, defense, and automotive industries have led to interest in utilizing the ability of many polymers to withstand extensions to failure of several hundred percent, often without localization or necking and their strong rate dependence. A broad range of characterization techniques will be presented for semi-crystalline polymers including elastic-plastic fracture, split Hopkinson pressure bar, plate impact and Taylor Impact. Temperature and strain-rate dependence will be reviewed in terms of classic time-temperature superposition and an empirical mapping function for superposition between temperature and strain-rate. The recent extension of the Dynamic-Tensile-Extrusion (Dyn-Ten-Ext) technique to probe the dynamic tensile responses of polymers will be discussed, including probing incipient damage at very high strain-rate by linking in situ and post mortem experimental observations with high-fidelity simulation. Plate impact experiments have been performed on momentum-trapped shock assemblies with impact pressures above and below the phase II to phase III crystalline transition in polytetrafluoroethylene (PTFE) to probe subtle changes in the crystallinity, microstructure, and mechanical response. Building on a history of shock and Diamond Anvil Cell data it has long been know that PTFE exhibits a pressure induced phase transition at 0.7 GPa. The transition has historically been assumed and reported to be dependent on the hydrostatic pressure. However, studies employing neutron diffraction have suggested the phase transition is driven by only the principle stress applied to the compliant direction of crystalline domain. A multiphase model was developed to include the stress deviator to drive potential martensitic transition and time to reflects the kinetic nature of the transitions demonstrating the need to account for both to capture subtle experimental observables.

Bio

Dr. Eric N. Brown manages the Neutron Science and Technology Group of the Physics Division at Los Alamos National Laboratory (LANL), which conducts a broad program of fundamental and applied research in physics. The group performs internationally recognized programs in dynamic behavior of materials under extreme conditions, nuclear physics, particle astrophysics, atomic physics, and science-based stockpile stewardship. Eric leads an ongoing research program studying structure-property relation in polymers and polymer composites focusing on linking fracture, high strain-rate, and shock behavior to atomic-level material evolution. His early work included much of the pioneering work into self-healing materials. He has published over 50 peer-reviewed archival works that have received more than 2700 citations. He has received awards for his technical achievements in solid mechanics and materials science from the ASC, DOE-NNSA, LANL, MRS, SEM, TMS and the University of Illinois. He presently serves as an Associate Technical Editor for Experimental Mechanics and a Key Reader for Met Trans. A. He also serves on committees for TMS, APS and SEM. From 2007 to 2009 Dr. Brown served as the Technical Advisor for the Joint Department of Defense/Department of Energy Munitions Program in the Office of the Secretary of Defense at the Pentagon. Eric received a B.S. in Mechanical Engineering in 1998 and a Ph.D. in Theoretical and Applied Mechanics (TAM) in 2003, both from the University of Illinois at Urbana-Champaign. Dr. Brown joined LANL as a Director's Postdoctoral Fellow and has since held a number of titles in the Materials Science & Technology Division, the office of the Associate Director for Weapons Physics, and Physics Division.

An informal coffee & cookie reception will be held prior to the lecture at 1:00 p.m. in the Hostetler Student Lounge (directly in front of ARMS 3rd floor elevators).