College of Engineering
Department of
Mechanical & Industrial Engineering

The Sidney E. Fuchs Seminar Series

3:00-3:50pm, Friday, September 16th, 2016
Frank H. Walk Design Presentation Room

Shock Loading of Reactive Solids—Modeling the Effect of Microstructure on Ignition and Burn

by Keith A. Gonthier*

**Associate Professor, Mechanical and Industrial Engineering,
Louisiana State University**

Accurately predicting the shock response of reactive solids (pyrotechnics, propellants, and explosives) remains elusive despite a century-long research history due to the influence of microstructure on ignition and burn. Continuum theories routinely used to model shock-induced combustion of reactive solids only describe homogenized behavior and do not resolve the formation, growth, and interaction of reactive hot-spots at the particle-scale which establishes their shock sensitivity. This talk will briefly address computational characterization of stress and temperature fields within shocked porous explosives (60-90% TMD) and their dependence on shock strength and microstructure. The computational technique is based on a finite and discrete element method that combines conservation principles with a hyperelastic-viscoplastic and friction constitutive theory to account for particle motion and deformation within shock loaded ensembles containing 2000-4000 particles. This information is used to formulate a microstructure-dependent multiphase continuum theory that describes transition to detonation. The model is conceptually similar to conventional ignition and burn models but accounts for ignition in terms of parameters that are explicitly based on computed hot-spot fields. The thermodynamically consistent model, which accounts for non-equilibrium interactions between the solid reactant and gas product, reasonably predicts both the time and distance to detonation over a range of input shock strengths and the corresponding transition mechanisms.

* Keith Gonthier obtained his BS in Biochemistry from Louisiana State University (LSU), BS in Aerospace Engineering from Auburn University, and PhD in Mechanical Engineering (ME) from the University of Notre Dame, graduating in 1988, 1990, and 1997, respectively. Prior to joining the ME faculty at LSU in 2001 where he is currently an Associate Professor, he was a Post-Doctoral Research Associate with the Group DX-2 (High-Explosive Physics) at Los Alamos National Laboratory (LANL), and Assistant Professor with the ME Department at Lamar University. He has also been a Visiting Scientist with LANL, and a Faculty Fellow, Visiting Scientist, and Senior Research Associate with the U.S. Air Force Research Laboratory. His expertise is in the theory, modeling, and computation of gas phase and multiphase combustion involving self-propagating detonation in energetic solids, explosively and pyrotechnically driven actuators, and advanced propulsion technology. He is a member of the American Society of Mechanical Engineers (ASME), the American Institute of Aeronautics and Astronautics (AIAA), and the American Physical Society (APS).