JOHNS HOPKINS
Center for Environmental & Applied Fluid Mechanics

Weekly CEAFM Seminar: Spring 2012

Friday, April 20, 2012
11:00 a.m. – 12:00 p.m.
Gilman 50 (Marjorie M. Fisher Hall)

"MULTIPHASE HYDRODYNAMIC SIMULATIONS OF ENERGETIC MATERIALS UNDER INTENSE SHOCK CONDITIONS"

Presented by

Dr. Fady Najjar

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Abstract: We will present results from hydrodynamics simulations performed for various energetic materials (EM) under high shock loading conditions. One of the EM examples includes High Explosives (HE) where their shock sensitivity is controlled by a combination of mechanical response, thermal and chemical properties. A multiscale computational framework is being developed to investigate hot spot (void) ignition in a single crystal of an insensitive HE. Based on atomistic MD simulations, the key chemical reactions with these reaction rates are identified and used in multi-dimensional hydrodynamic computations. A single spherical air bubble is embedded in the insensitive HE and its collapse due to shock initiation is investigated numerically in time; while the ignition processes due chemical reactions are studied. Our current predictions showcase several interesting features regarding hot spot dynamics including the formation of a "secondary" jet. We will present the results obtained with hydro-thermo-chemical processes leading to ignition growth for various pore sizes and different shock pressures. In the second part of the talk, we will focus on metalized heterogeneous explosives (MHE) in intense shock environment. Such modern energetic materials have solid inert particles embedded in a matrix of explosive that can detonate. The detonation generates strong shocks in condensed phase materials that, unlike lighter gases, are strong enough to produce large deformation of the particles as the incident shock diffracts around the particle. A series of hydrodynamics simulations is performed where the particle-to-EM density ratio and impedance ratio are varied to consider heavier and lighter particles. Finally, we will showcase 3-D simulations of a full MHE system where the HE detonation accelerates metallized particles and the overall gas dynamics of the multiphase system is studied using an advanced Eulerian-Lagrangian computational framework.