Shock Compression Seminar Series
APS GSCCM Announcement

Tuesday, December 7, 2021 at 12:00 PM Eastern Time

Talk 1: Observing and Modeling Hot Spots in Individual Explosive Crystals with Shock Compression Microscopy

Dr. Belinda Pacheco Johnson
University of Illinois at Urbana-Champaign / Los Alamos National Laboratory

Experimentally interrogating the chemistry and physics of plastic-bonded explosives (PBXs) requires detection techniques which span multiple time and length scales (fs-μs, nm-μm). We aim to better understand the underlying, microstructure-induced sensitivity of PBXs by, 1) conducting tabletop experiments on individual explosive crystals to elucidate hot spot dynamics and temperature, and 2) comparing results to microstructurally informed, reactive simulations. We have developed a tabletop apparatus which employs laser-driven impactors to impart initiating shocks to the explosive sample. Multiple optical and spectroscopic probes are coupled to the apparatus which image explosive emission with μm spatial resolution and resolve hot spot temperatures down to several ns. The explosive samples consisted of 1,3,5,7-tetranitro-1,3,5,7-tetrazoctane single crystals embedded in multiple transparent polymers and shocked at several input pressures. Simulations were conducted using conducted using interface-resolved reactive simulations using a sharp-interface Eulerian framework. This new methodology provides the means to evaluate the influence of microstructural energy localization and predict mesoscale behavior of PBXs.

Talk 2: Direct Proof of *Inelastic* Shear Release in Silicon under Laser-Driven Shock Compression

Dr. Silvia Pandolfi
SLAC National Accelerator Laboratory

The deformation of materials under dynamic compression is critical for a variety of phenomena, ranging from planetary science to shielding engineering. However, a precise understanding of the atomistic mechanisms driving structural changes at these ultra-fast timescales remains largely elusive. Here, we focus on the characterization of silicon, which deformation mechanism is still an open question despite decades of research. Simulations suggested that, in silicon, the shear stress generated during shock compression is released *inelastically*, i.e., via a high-pressure phase transition, challenging the classical picture of relaxation via defect-mediated plasticity. However, direct evidence supporting either deformation mechanism is still lacking. Using sub-picosecond highly-monochromatic x-ray diffraction to measure (100)-oriented silicon under laser-driven shock compression, we are able to provide the first direct evidence of silicon peculiar *inelastic* deformation. Our results resolve a longstanding controversy, demonstrating silicon's strain rate-dependent response. Particular care should be thus taken when using dynamic compression data to interpret static phenomena, such as phase equilibria at planetary interiors conditions.

For more information, or to recommend future speakers contact Seminar Organizer, Tracy Vogler at tjvogle@sandia.gov or the GSCCM Secretary/Treasurer Matt Lane at jlane@sandia.gov.