SHOCK13-2013-000709

Abstract for an Invited Paper
for the SHOCK13 Meeting of
the American Physical Society

In Situ Investigation of the Dynamic Response of Energetic Materials using IMPULSE at the Advanced Photon Source

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The mechanical and chemical response of energetic materials is controlled by spatial heterogeneity and crystalline mechanics that evolve during impact. Traditional methods use continuum measurements to infer the microstructure response whereas advances in synchrotron capabilities and diagnostics are providing new, unique opportunities to interrogate materials in real time and *in situ*. Recently the IMPULSE team has performed experiments on a gas-gun system (IMPact system for Ultrafast Synchrotron Experiments) using single X-ray bunch phase contrast imaging (PCI) and Laue diffraction at the Advanced Photon Source (APS) to examine shock-induced phenomena in energetic materials and other inert, molecular analogues. The low absorption of molecular materials maximizes x-ray beam penetration, allowing measurements in transmission using the brilliance currently available at APS Sector 32. The transmission geometry enables exciting possibilities for observing both average lattice response and spatially heterogeneous, continuum response (2 um spatial resolution, 60 ps exposure, 153ns frame-rate) in energetic materials ranging from single crystals to plastic bonded composites. This capability provides a means for linking mechanics with detonation initiation by resolving deformation mechanisms such as compaction, void collapse and jetting, cracking, dislocation-mediated plasticity and phase transformation. Representative data will be presented and discussed to illustrate current progress and future directions for this new technology.