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In Situ Investigation of Mesoscale Mechanics of Energetic Materials Using X-ray Diffraction. KYLE RAMOS, FRANCIS ADDESSIO, CLAUDINE ARMENTA, JOHN BARBER, CINDY BOLME, MARC CAWKWELL, ARIANNA GLEASON, ADAM GOLDER, ERNEST HARTLINE, BRIAN JENSEN, DARBY JON LUSCHER, TIMOTHY PIERCE, RICHARD SANDBERG, KEN WINDLER, Los Alamos National Laboratory, CHRISTOPHER MEREDITH, Army Research Laboratory, LEORA COOPER, Massachusetts Institute of Technology, NICHOLAS SINCLAIR, PAULO RIGG, Dynamic Compression Sector, HAE JA LEE, INHYUK NAM, MATT SEABURG, Matter in Extreme Conditions Instrument — Weak impacts on high explosives (HE) can give rise to either violent reactions or harmless fracture and material dispersal. Predicting this response or the state of damage in the material remains an unsolved technical challenge. *In situ* mesoscale insights to anisotropic dislocation-mediated plasticity, phase transitions, and damage are needed to quantify fundamental structure-property relationships, inform theory, and enable high fidelity simulations. Time-resolved, *in situ* X-ray diffraction during dynamic loading, spanning multiple orders of strain rate, using synchrotron (Advanced Photon Source) and X-ray free electron laser (Linac Coherent Light Source) radiation has been performed for single crystal and plastic bonded formulations of cyclotrimethylene trinitramine (RDX). For the first time, diffraction patterns quantify the average lattice response during elastic-plastic and phase transition and allow for direct comparison of experiments and simulations through measured and computed diagnostics.

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