SHOCK15-2015-000510

Abstract for an Invited Paper
for the SHOCK15 Meeting of
the American Physical Society

High Energy Density Studies at the OMEGA laser facility

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The primary emphasis of the scientific program at the Laboratory for Laser Energetics is laser-driven inertial confinement fusion. We report on high-energy-density (HED) experiments that use the OMEGA laser to produce multi-megabar shocks in materials of interest to the national fusion effort and the associated HED sciences. We present measurements of the behavior of shocked diamond, in both the single-crystal and ultranano-crystalline forms used as an ablator material in fusion capsules. Using the impedance-matching technique both the Hugoniot and release behaviors are measured with respect to multiple reference materials. The release of shocked diamond into liquid deuterium is also measured. We present the results of sound-speed measurements in shocked quartz which is also used as a reference for sound speed measurements in CH and fused silica. This is done using an unsteady wave analysis that tracks the propagation of small perturbations in shock pressure as they traverse the shocked material from 'piston' to shock front. The arrival times of these perturbations, as compared to the same in a reference material, provides the sound speed in the shock material. We also present results of optical and x-ray probing of shock waves in foam targets and solid targets, as well as the release plumes of shock material after shock breakout. The import of these measurements to the fusion program and basic HED science will be discussed and plans for future work presented. This work was supported by the U.S. Department of Energy Office of Inertial Confinement Fusion under Cooperative Agreement No. DE-FC52-08NA28302.