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The Shock and Release Behavior of Diamond Compressed to 25 Mbar

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The behavior of carbon at high pressure is important to the study of ice giants and white dwarfs, and because diamond is used as an ablator for inertial confinement fusion (ICF) targets at the National Ignition Facility (NIF). The adiabat of an ICF implosion is determined by a series of shocks that transit the ablator and fuel layer. To accurately model an implosion and design ignition targets, both the Hugoniot and the release behavior of the ablator material must be known. We report on experiments on the OMEGA laser that shocked diamond samples up to 25 Mbar, which then released into reference materials with known Hugoniots (quartz, 200-mg/cm^3 SiO_2 foam, liquid deuterium, and polystyrene). The impedance-matching technique with these reference materials provided data that constrains release models for diamond. This technique is applied to two forms of diamond: single-crystal and ultra-nanocrystalline diamond (UNCD); the latter is the NIF ablator material. Models for the release isentropes of both types of diamond will be developed using a Mie–Grüneisen equation of state. This study also provided Hugoniot data for UNCD using the impedance-matching technique with a quartz standard. The accuracy of these data was improved by implementing an unsteady wave correction[1] to determine instantaneous shock velocities in the opaque UNCD samples. This material is based upon work supported by the Department of Energy National Nuclear Security Administration under Award Number DE-NA0001944.

[1]D. E. Fratanduono *et al.*, J. Appl. Phys. **116**, 033517 (2014).