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Multi-Mbar Measurements of Shock Hugoniots and Melt in Beryllium and Diamond for ICF Capsule Physics[1]

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Both beryllium and diamond are being considered as ablator materials in the design of capsules for inertial confinement fusion as part of the National Ignition Campaign. Understanding the shock melting of these materials is key in the ability to design capsules and drive pulse-shaping that minimizes microstructure effects during the implosion phase. Recently, tri-laboratory experimental campaigns utilizing the flyer plate capability (7-34 km/s) at the Sandia Z accelerator have been performed to determine the Hugoniot and the shock melting properties of polycrystalline beryllium and micro- and nano-crystalline diamond. Composite aluminum/copper flyer plates were used to shock load beryllium and diamond samples to pressures ranging from 1 to 5 Mbar and 5 to 14 Mbar, respectively. The impedance mismatch at the aluminum/copper interface in the flyer resulted in a well defined release wave that followed the shock into the sample. Multiple sample thicknesses allowed for the measurement of the release wave velocity, which is sensitive to the phase of the material in the shocked state. Results of these experiments, including conclusions regarding the onset and completion of melt in both materials, will be discussed. The inferred melt properties will also be compared to various models for beryllium and diamond including models based on recent quantum molecular dynamics calculations.

[1]Sandia is a multidiscipline laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energys National Nuclear Security Administration under contract DE-AC04-94AL85000.