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Laser driven shockless compression for extracting near-isentrope equation-of-state measurements[1]

RAYMOND SMITH, Lawrence Livermore National Laboratory

Laser produced x-ray drive was used to shocklessly compress solid Al to a peak longitudinal stress of 110 GPa within 10 ns. Interface velocities versus time for multiple Al thicknesses were measured and converted to stress-density ($P_x - \rho$) for near isentrope conditions using an iterative Lagrangian analysis. These are the most rapid shockless compression P_xo(ρ)p data ever reported. P_xo(ρ)p are stiffer than expected from models that are benchmarked against both static and shock experiments, suggesting a larger than expected time dependent viscoelastic response. In addition, we present the first results of a laser driven dynamic loading technique used to map out phase boundaries in Bismuth over ultra fast compression rates. Multi-grain Bi foils 20μm thick were shocklessly loaded to peak stresses of ∼11 GPa over 30ns. This time dependent compression causes the Bi sample to traverse several phase boundaries (I→IV, Liquid) during a single shot. A time resolved velocity interferometer is used to measure the effects of new phases on a transmitted wave velocity profile. Ramp compression over several nanoseconds with initial temperatures spanning 410K to 521K results in over-driving of the Bi I-Liquid equilibrium phase boundary. A Bi multi-phase equation-of-state (EOS) for Bi I→IV and Liquid together with a kinetics model give insights into the transition rates for different phase transitions.

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