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Laser-driven Shockless Compression

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Laser produced x-ray drive was used to shocklessly compress solid Al, Ta, W, V and C targets to high peak longitudinal stresses over nanosecond timescales. Interface velocities versus time for multiple thicknesses were measured and converted to stress-density for near isentrope conditions using an iterative Lagrangian analysis. These are the most rapid shockless compression stress-density data ever reported. Stress-density are stiffer than expected from models that are benchmarked against both static and shock experiments, suggesting a larger than expected time dependent viscoelastic response. This time-dependent compression applied to Bi, Si and Fe samples results in multi-structural phase transformations. A time resolved velocity interferometer is used to measure the effects of new phases on a transmitted wave velocity profile yielding insights into the transformation kinetics. With different experimental techniques, it is now possible to vary the dynamic compression rise time applied to a given material by over 10 orders of magnitude. This capability of varying the ramp compression timescales enables the study of time-dependent material behavior associated with structural changes and deformation in solids subjected to extreme compressions.