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Quantitative Equation-of-State Results from Isentropic Compression Experiments to Multimegabar Pressures

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Isentropic ramp-wave loading of condensed matter has long been hailed as a possible experimental technique to obtain accurate equation-of-state (EOS) data in the solid phase at relatively low temperatures and multimegabar pressures. In this range of pressure, isothermal diamond-anvil techniques have limited accuracy due to reliance on theoretical EOS of calibration standards, thus accurate isentropic compression data would help immensely in constraining EOS models. An isentropic compression technique developed using the Z Machine at Sandia as a magnetic drive has been extended to the multimegabar regime by recent advances in current-pulse shaping. Diagnostics typically consist of time-resolved velocity interferometry to monitor the back surfaces of samples having different thickness but subjected to the same magnetic loading. Extraction of a stress-density curve from such data requires that the experiment has been designed to avoid coupling (during the time of interest) between the back surface and the joule-heated region where the stress wave is generated. Uncertainty in the result at multimegabar pressure is dominated by uncertainty in the transit time, or difference in arrival times for a particular velocity, between samples of different thickness. After a brief discussion of experiment design issues, a detailed analysis of data on aluminum to 240 GPa will be presented, followed by some results from recent experiments on other materials.

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