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Obtaining off-Hugoniot equation of state data on solid metals at extreme pressures via pulsed-power driven cylindrical liner implosions[1]

RAYMOND LEMKE, Sandia National Laboratories

The focus of this talk is on magnetically driven, liner implosion experiments on the Z machine (Z) in which a solid, metal tube is shocklessly compressed to multi-megabar pressure. The goal of the experiments is to collect velocimetry data that can be used in conjunction with a new optimization based analysis technique to infer the principal isentrope of the tube material over a range of pressures. For the past decade, shock impact and ramp loading experiments on Z have used planar platforms exclusively. While producing state-of-the-art results for material science, it is difficult to produce drive pressures greater than 6 Mbar in the divergent planar geometry. In contrast, a cylindrical liner implosion is convergent; magnetic drive pressures approaching 50 Mbar are possible with the available current on Z ($\sim$ 20 MA). In our cylindrical experiments, the liner comprises an inner tube composed of the sample material (e.g., Ta) of unknown equation of state, and an outer tube composed of aluminum (Al) that serves as the current carrying cathode. Internal to the sample are fielded multiple PDV (Photonic Doppler Velocimetry) probes that measure velocity of the inner free surface of the imploding sample. External to the composite liner, at much larger radius, is an Al tube that is the return current anode. VISAR (velocity interferometry system for any reflector) probes measure free surface velocity of the exploding anode. Using the latter, MHD and optimization codes are employed to solve an inverse problem that yields the current driving the liner implosion. Then, the drive current, PDV velocity, MHD and optimization codes, are used to solve another inverse problem that yields pressure vs. density on approximately the principal isentrope of the sample material. Results for Ta, Re, and Cu compressed to $\sim$ 10 Mbar are presented.

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