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Shock Wave Experiments to Examine the Multiphase Properties of Metals

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There is a scientific need to obtain new data to constrain and refine next generation multi-phase equation-of-state (EOS) for metals. Experiments are needed to locate phase boundaries, determine transition kinetic times, and to obtain EOS and Hugoniot data for relevant phases. The objectives of the current work were: (1) to examine the orientation dependence of the transition kinetics and stress for single crystal iron, and (2) to examine the multiphase properties for cerium including the dynamic melt boundary and the low-pressure solid-solid phase through the critical point. These objectives were addressed by performing plate impact experiments that used multiple experimental configurations including front-surface impact experiments to directly measure transition kinetics, preheat experiments to map out phase boundaries, and complex loading methods to obtain off-Hugoniot data. Data obtained on single crystal iron illustrate an orientation dependence of the transition stress as well as transition times that are dependent on the impact stress spanning values from picoseconds to hundreds of nanoseconds. Data obtained for cerium metal provide information on the melt boundary along with other phase boundaries such as the low-pressure solid-solid boundary. Details of the experimental methods and recent experimental results for both iron and cerium will be presented.