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Laser induced sub-nanosecond ramp compression of Al and Zr

PAULIUS GRIVICKAS, MICHAEL ARMSTRONG, JONATHAN CROWHURST, JOSEPH ZAUG, HARRY RADOUSKY, RYAN AUSTIN, JON BELOF, Lawrence Livermore Natl Lab — Laser driven dynamic compression experiments aim to emulate mechanical impact experiments in producing shock waves for probing well-defined single points in Hugoniot space. Many scientific problems, however, require quasi-isentropic or ramp wave compression which produces different thermodynamic conditions and can span a wider range of the thermodynamic phase space than shock Hugoniot measurements. It is desirable from the laser energy and experimental throughput point of view to keep such ramps as short as possible. But so far laser driven ramps were typically limited to tens of nanoseconds due to a belief that shorter ramps become affected by the kinetics of material transformation which may generate sufficient dissipative energy and deviate significantly from an ideal isentrope. Sub-nanosecond laser driven shock wave experiments in Fe and Al indeed suggest that material transformations happen on 20-100 ps time scales. The role of these effects at the transition point into an isentropic compression, however, is not well understood. In this work we address these questions by compressing Al and Zr thin films with sub-nanosecond scale ramps and analyzing the results using the conventional Lagrangian method and other methods designed to extract strength information. Prepared by LLNL under Contract DE-AC52-07NA27344.

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