Abstract Submitted
for the SHOCK17 Meeting of
The American Physical Society

Low pressure shock response and dynamic failure of high density- and ultra-high molecular weight polyethylene JENNIFER JORDAN, DANA DATTELBAUM, BENJAMIN SCHILLING, CYNTHIA WELCH, JAMIE STULL, Los Alamos National Laboratory — Polyethylene exhibits mechanical responses tailorable to a given application based on its network and chain structures (crystallinity) and molecular weight. Earlier reports have provided Hugoniot data for polyethylene over a broad range of conditions to very high shock stresses, while others focused on the discontinuous low pressure Hugoniot of crystalline forms of polyethylene. Surprisingly little is known about the influence of crystalline structure, and associated crystalline phase transitions including melt, on its dynamic compression response. Two different materials – high density polyethylene and ultrahigh molecular weight polyethylene - were chosen for investigation of the influence of a high percentage of crystallinity (>40%) on the shock response and dynamic tensile failure (spall). We have applied in-situ electromagnetic gauges to measure the evolution of particle velocity wave profiles with propagation distance to elucidate the nature of the discontinuous Hugoniot at low pressures. The first evidence of a three-wave structure in highly crystalline polyethylene was measured above a shock stress of 0.5 GPa. Above this region of discontinuity in the principal Hugoniot, the transition is overdriven, and a single shock wave is observed to stresses exceeding 10 GPa. Details about the nature of the transition, including wave velocities and changes in density, will be presented. Further, a series of dynamic tensile (spall) experiments were performed on polyethylene and will be discussed.

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Date submitted: 27 Feb 2017 Electronic form version 1.4