Abstract Submitted
for the DPP20 Meeting of
The American Physical Society

Nonisentropic Release of a Solid Shocked via Laser-Plasma Ablation PATRICK HEIGHWAY, MARCIN SLIWA, DAVID MCGONEGLE, MATTHEW SUGGIT, JUSTIN WARK, University of Oxford, UK, CHRISTOPHER WEHRENBERG, JON EGGERT, AMY LAZICKI, HYE-SOOK PARK, ROBERT RUDD, RAYMOND SMITH, DAMIAN SWIFT, BRUCE REMINGTON, Lawrence Livermore National Laboratory, USA, CYNTHIA BOLME, Los Alamos National Laboratory, USA, ANDREW HIGGINBOTHAM, York Plasma Institute, UK, HAE JA LEE, BOB NAGLER, FRANZ TAVELLA, SLAC National Accelerator Laboratory, USA — Shock release is the fundamental process that takes place when a material rapidly decompresses from a high-pressure state. The conventional treatment of shock release assumes that the process is isentropic. To test this assertion, we performed an experiment at the Matter in Extreme Conditions instrument, wherein tantalum foils were compressed to a megabar shock state via laser-plasma ablation, and subsequently probed as they unloaded with an x-ray free-electron laser. From the resulting diffraction patterns, the post-release temperatures of the foils were deduced from their thermal expansion, and were found to exceed significantly the isentropic release temperature. These results are corroborated by large-scale molecular dynamics simulations of tantalum crystals in shock and release, which demonstrate that heating occurs due to the colossal plastic work that must be expended to overcome the crystal's extreme strength during rapid release.

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Date submitted: 29 Jun 2020 Electronic form version 1.4