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Author: Ms. Laura Chen
Imperial College London, United States, l.chen11@imperial.ac.uk

INVESTIGATION OF THE DYNAMIC STRENGTH OF IRON-RICH METEORITIC MATERIAL

Abstract

The strength of meteoritic material plays a key role in the understanding the atmospheric breakup and impact behavior of meteorites, and is crucial in making quantitative assessments of the threat from Earth-crossing objects. Recent events have asserted the global relevance of understanding this phenomenon. There have been remarkably few systematic studies of the dynamic strength of meteoritic material, and none of which include strength measurements at temperatures relevant to atmospheric entry. Break-up altitudes of meteorites as predicted by current models are not consistent with actual observations, with a discrepancy equivalent to a factor of 10 in increased strength in meteoritic material. Ongoing experiments are being done to understand the dynamic strength characteristics influenced by a material's initial temperature and the presence of impurities or precipitates within the host microstructure. Using the a high-powered laser at the Jupiter Laser Facility (Lawrence Livermore National Laboratory), laser-driven shock waves were employed up to 50 GPa on thin foil targets composed of iron and 0-25% atomic composition of nickel and at temperatures ranging from 77-800 K. Diagnostics evaluate strength of a material by determining the stress and strain it experiences during compression by examining the compression of the lattice. Diagnostics will also be able to assess the kinetics of a phase transition if one occurs. In this paper, we present results of our study of the effect of temperature and impurity content on the strength of iron-nickel alloys under laser-driven shock compression and make connections to the strength of meteoritic material.