Measuring Strength of Materials at High-Pressures using Pressure-Shear Plate Impact Experiments

Gurswami (Ravi) Ravichandran
Division of Engineering and Applied Science
California Institute of Technology
Pasadena, California 91125, USA

Abstract

Measurement of strength and the constitutive response of materials at high pressures is critical for applications ranging from aerospace to energy to geophysics. However, the experimental techniques available to investigate the strength of materials at high pressures are limited. Recent advances in extending the capabilities of the pressure shear plate impact (PSPI) technique beyond the Hugoniot elastic limit (HEL) to study material behavior at high pressures will be presented. A hybrid experimental-computational methodology for extracting the complete stress-strain behavior of materials at high pressures will be discussed. The results from experiments on OFHC copper and Armco iron at pressures ranging from 10 to 43 GPa and strain rates of ~10^5 s^{-1} will be presented. A strong pressure hardening in strength is observed in copper, which cannot be explained using existing models. The atomistic mechanisms responsible for pressure-dependent strength are explored using molecular dynamics (MD) simulations. For iron, the constitutive response of the α-phase (bcc) and ε-phase (hcp) are presented over a range of pressures. The strength of the ε-phase iron is significantly higher than that of the α-phase, but smaller than the previously reported strength at high pressures.

Biography

Guruswami (Ravi) Ravichandran is the John E. Goode, Jr. Professor of Aerospace and Mechanical Engineering at the California Institute of Technology. He received his Ph.D. in Engineering (Solid Mechanics and Structures) from Brown University. He is an elected member of the U.S. National Academy of Engineering, Academia Europaea, and the European Academy of Sciences and Arts. He is a Fellow of the American Society of Mechanical Engineers (ASME), Society for Experimental Mechanics (SEM), and American Academy of Mechanics. He was named Chevalier de l'ordre des Palmes Academiques by the Republic of France. His awards include the A.C. Eringen Medal from the Society of Engineering Science, Warner T. Koiter Medal from ASME, and William M. Murray Lecture Award from SEM. His research interests are in mechanics of materials, including deformation, damage and failure, wave propagation micro/nano mechanics, composites, active materials, biomaterials and cell mechanics, and experimental methods.