SHOCK13-2013-000263

Abstract for an Invited Paper
for the SHOCK13 Meeting of
the American Physical Society

Flash lamp integrating sphere technique for measuring the dynamic reflectance of shocked materials

GERALD STEVENS, National Security Technologies, LLC

Accurate reflectance (R) measurements of metals undergoing shock wave compression can benefit high pressure research in several ways. For example, pressure dependent reflectance measurements can be used to deduce electronic band structure, and discrete changes with pressure or temperature may indicate the occurrence of a phase boundary. Additionally, knowledge of the wavelength dependent emissivity (1-R for opaque samples) of the metal surface is essential for accurate pyrometric temperature measurement because the radiance is a function of both the temperature and emissivity. We have developed a method for measuring dynamic reflectance in the visible and near IR spectral regions with nanosecond response time and less than 1.5% uncertainty. The method utilizes an integrating sphere fitted with a xenon flash-lamp illumination source. Because of the integrating sphere, the measurements are insensitive to changes in surface curvature or tilt. The in-situ high brightness of the flash-lamp exceeds the sample's thermal radiance and also enables the use of solid state detectors for recording the reflectance signals with minimal noise. Using the method, we have examined the dynamic reflectance of gallium and tin subjected to shock compression from high explosives. The results suggest significant reflectance changes across phase boundaries for both metals. We have also used the method to determine the spectral emissivity of shock compressed tin at the interface between tin and a LiF window. The results were used to perform emissivity corrections to previous pyrometry data and obtain shock temperatures of the tin/LiF interface with uncertainties of less than 2%. This work was done under Contract No. DE-AC52-06NA25946 with the U.S. Department of Energy, and supported by the Site-Directed Research and Development Program.