Measurement of the Temperature Distribution on the Surface of the Laser Heated Specimen in a Diamond Anvil Cell System by the Tandem Imaging Acousto-Optical Filter

Pavel Zinin*[2,1], Alexander Machikhin[2], Ivan Trojan[3], Kamil Bulatov[2], Alexey Bykov[2], Yulya Mantrova[2], Vladislav Batshev[2], Igor Kutuza[2], Vitali Prakapenka[4], and Shiv Sharma[1]

[2]Scientific-Technological Center of Unique Instrumentation, Russian Academy of Sciences – Russia
[1]Hawaii Institute of Geophysics and Planetology, University of Hawaii – United States
[3]Shubnikov Institute of Crystallography, FSRC Crystallography and Photonics, Russian Academy of Sciences – Russia
[4]University of Chicago – United States

Abstract

The laser-heated diamond-anvil cell (LH-DAC) is the only experimental tool able to create extreme static pressures (P > 100 GPa) and temperatures (T > 3000 K) and it has had a major impact in high-pressure research and geophysics.
The conventional way to determine the temperature of a laser-heated specimen is by measuring the radiation emitted from the heated specimen using a diffraction spectrometer. However, those measurements only provide the temperature of the heated spot averaged over its area. This a technique works perfectly only for a uniform temperature distribution. However, the temperature under a laser has significant non-uniformity. Recently, flat top laser heating was used to study the elastic properties of platinum alloy by measuring the velocity of the skimming acoustical wave in iron at at 2580 K and 22 GPa in a DAC. For such measurements it is important to use an area with a flat temperature distribution. Further progress in the development of the laser heating techniques requires knowledge of the 2-D temperature field in a material induced by laser beam radiation.
Conventional techniques for the measurement of 2-D temperature distribution based on calibration of the digital signal from the camera in the infrared or visible ranges are not applicable for DAC due to priori unknown and non-uniform emissivity distribution in the sample. Several techniques were proposed to measure temperature distribution in a specimen heated by a laser . Recently, a multispectral imaging radiometry (MIR) system for measuring temperature gradients of specimens under high pressure heated by laser in a DAC (LH-DAC) was developed by Campbell.We demonstrate that combining the laser heating system in a diamond anvil cell (LH-DAC) with a tandem acousto-optical tunable filter (LH-DAC-TAOTF) allows measurement of the temperature distribution under laser heating of a specimen under high pressure in a DAC. The main component of the system is an imaging TAOTF synchronized with a video camera. The use of the TAOTF also makes it possible to visualize the infrared (1064 nm) laser beam, which is invisible to the human eye. The distribution of the

*Speaker

temperature $T(x,y)$ was then determined on surface of two Pt plates loaded in DAT at high pressures by fitting the actual signal to Planck's equation at each point of the specimen's surface