Picosecond Acoustics : a way to Thermodynamical Properties of Solids and Liquids at Extreme Conditions

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Abstract

Based on the original combination of picosecond acoustics and diamond anvils cell, hypersonic sound velocities of liquids and solids under extreme conditions can be accurately measured [1]. Picosecond acoustics is a time-resolved optical pump-probe technique, contactless and non-destructive, analogous in many aspects to the classical ultrasonic pulse-echo technique. It permits the study of ultrafast phenomena in micrometric samples or thin films. In addition to time of flight measurements in the ps range, it can provide phonon surface imaging as a function of time, or time-resolved stimulated Brillouin scattering.
This laser acoustic technique can be applied to many materials and enables the determination over and extended pressure and temperature range of the melting curve and phase diagram, the equation of state for liquids, the complete set of elastic constants for single crystals.

To illustrate the capability of this technique, results will be presented for different types of studies and materials: complete elastic tensor on single-crystalline sample (Si) up to 10 GPa [2], longitudinal sound velocity on polycrystalline samples (Fe) at Mbar pressure [3], sound velocity and melting curve of metallic liquids (Hg[4], Ga [5], Rb, Cs) at high pressure and temperature, and Poisson ratio as a function of pressure for hydrogen [6].

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