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Rankine-Hugoniot experiments with unsteady waves: A new technique to measure the material sound speed and Gruneisen parameter[1]

DAYNE FRATANDUONO, Lawrence Livermore National Laboratory

Recent development of transparent shock wave standard materials, such as quartz, enables continuous tracking of shock waves using optical velocimetry, providing information on shock wave steadiness and pressure perturbations in the target. From a first order perturbation analysis, we develop a set of analytical formulas that connect the pressure perturbations at the drive surface to the shock velocity perturbations observed in measurements. With targets that incorporate a calibrated transparent witness material, such as quartz, and with the analytical formulas describing the perturbation response, it is possible to determine the sound speed and Gruneisen coefficient of an unknown sample by using evolution of the non-steady perturbations as a probe. These formulas are used to improve the accuracy of traditional shock wave impedance match Hugoniot experiments of opaque samples driven with non-steady waves. The method is well suited for use in laser-based Hugoniot experiments where the shock waves can be unsteady, with fluctuations and/or accelerating or decelerating trends. We apply this technique to recent laser-based Hugoniot measurements and the results are presented. The sound speed of deuterium and ICF ablators has been measured using this technique and are presented

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