Reflecting quasi-stationary laser-driven shocks in Diamond in the Mbar pressure range

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Laser driven dynamic compression allows reaching high pressures in planar geometry [1]. It is used as a standard method for studying the equation of state (EOS) of matter in extreme states. In our experiment, we used the laser PHELIX to generate a strong shock in polished diamond monocrystals of type Ib with 100 orientation, and study shock dynamics. PHELIX in GSI is a Nd: glass system converted to 2ω, with energy $E_L > 100J$ and pulse duration of $1ns$. We used multilayer targets with a plastic ablator (5 μm) followed by a nickel pusher (20 μm) and the diamond monocrystal (~250 μm). Finally, on half of the diamond rear side we placed a 20-μm Ni step. This geometry allows to measure shock velocity in Nickel and in diamond simultaneously. As diagnostics, we had two VISAR (velocity interferometer system for any reflector [2]), using a seeded probe laser at 660nm, synchronized with the main beam. VISARs allow to measure the shock transit time in the various materials trough the jumps in reflectivity and fringe jumps, from which we get the average shock velocity in each material. In addition, the fringe shift provides the instantaneous velocity of the reflecting surface. Therefore, we can measure the shock transit time in Ni and in diamond but also continuously follow shock evolution in time from the fringe shift in the VISAR. In our experiment, we generated pressures up to 9 Mbar, getting evidence that the probe laser is reflected by the shock front traveling in transparent diamond, and inducing a phase transition to a reflecting state. This instantaneous shock velocity measured by VISAR is very close to the average velocity measured by the shock transit time, proving that our shock is quasi-stationary. Results from preliminary analysis are compatible with the predictions of hydrodynamics simulations performed using MULTI 1D radiative hydrodynamic code [3] with known EOS table (SESAME 7830 [4]) for Diamond.

References

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