Sound velocity and density of liquid iron alloys under Earth’ s core pressures by laser-shock compression

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Sound velocity at Earth’ s core conditions are one of the most important physical properties in Earth science because it can be directly compared with the seismological Earth model (PREM: Preliminary Reference Earth Model) [1]. The composition of solid inner core is estimated from the comparison of the model [1] and the extrapolation of sound velocities as a function of density of iron and iron alloys obtained by the static compression experiment [2, 3]. Birch’ s law, a linear sound velocity–density relation [4], is used to extrapolate sound velocities to densities in the core condition. On the other hand, the composition of liquid outer core is estimated from the partitioning and solubility data in the inner core boundary condition for the composition of solid core. There has been some works for the sound velocity of iron and iron alloys on the Earth’ s core condition by dynamic techniques using explosive [5], gas gun [5-9], and laser [10-12]. Huang et al. estimated that the outer core composition is Fe with 0.5 wt.% O and 9.5 wt.% S by the comparison of PREM and sound velocities of Fe-S-O system [9]. In this study, we measure the sound velocity and density of liquid iron alloys by shock-compression method using high-power laser.
We conducted shock-compression experiments using a High Intensity Plasma Experimental Research (HIPER) system at the GEKKO-XII laser irradiation facility [13] at the Institute of Laser Engineering, Osaka University. The samples were Fe-Ni alloys, Fe-Si alloys, and pyrrhotite. The sound velocities and densities of shock-compressed iron alloys using the high-power laser were measured by x-ray radiography [10-12] at pressures up to 1000 GPa.
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