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大型レーザーを用いた地球核条件下の鉄の音速計測

Measurement of sound velocity of laser-shocked iron under Earth's core condition

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When we consider the structure of the Earth's interior, the sound velocity is one of the important physical properties of the interior materials because it can be directly compared with the seismological data which can yield the physical properties of the Earth's interior. Although it needs to measure the sound velocity of the interior material under high pressure and temperature, the sound velocity measurement of the materials on the condition over 200 GPa and 4000 K, such as the Earth's core condition, is technically difficult in static compression technique (e.g. diamond anvil cell: DAC) [1-3]. Therefore, in such higher pressure and temperature, dynamic compression technique, such as gas gun, is used. Although some works about the sound velocity of pure iron have been done by gas gun [4-6], it is not enough to discuss about the Earth's core which consists mainly of iron.

We performed laser-shock experiments of iron at HIPER system of GXII laser in Institute of Laser Engineering, Osaka University (ILE) [7]. The laser-shock compression can generate pressures over 1TPa, which is much higher pressure than previous works by gas gun.
The sound velocity of iron was measured by side-on radiography [6]. The laser-irradiated target (Fe) is backlit with an x ray emitted from a high-Z foil (Ti) that is located along the side of the target and that is irradiated by a separate laser. The intensity distribution of the x ray transmitted through the target is imaged onto an x-ray streak camera. When the motion of the front surface and rear surface of the target is obtained from the radiograph, we can obtain the velocity of the shock and rarefaction wave. The rarefaction wave propagates the target with the sound velocity. The pressure generated by the laser-shock compression is obtained from the shock velocity and particle velocity of the target. The particle velocity is obtained from the time revolution of the front surface in the radiograph.

In this experiment, we confirmed an availability of sound velocity measurement by the side-on radiography. We measured the sound velocity of pure iron on the pressure over 400 GPa. We will present the method of our experiment and the results of the sound velocity measurement.

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Reference
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