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Sound velocity measurement of laser-shocked iron

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Sound velocity is one of the important properties of materials when we study the Earth's Interior. The Earth's outer core is mainly consisted of liquid iron. The sound velocity measurement of liquid iron under multi-mega bar and high temperature is technically difficult in static compression (e.g. diamond anvil cell: DAC). In contrast, shock compression is promising method to measure the sound velocity by using rarefaction wave which propagates target material. Some works on the sound velocity measurements of iron have been done by gas guns [e.g. Brown and McQueen,1986: Jeffrey and Neil,2004]. However, the available date for liquid iron has been limited.

We performed laser-shock experiments of iron at Institute of Laser Engineering, Osaka University (ILE) GEKKO-HIPER Laser system. The laser-shock compression in ILE can generate pressures over 1TPa, which is much higher pressure than previous works by gas guns. The targets were pure iron foils of 20-um thickness. The sound velocity of iron was measured by side-on radiography. This technique is that to record the time-variation of x-ray shadow of target by x-ray irradiated from the side of target. The shadow is obtained by x-ray streak camera. The sound velocity is obtained from the time variation of x-ray shadow because the rarefaction wave propagates target material with the sound velocity. In the same pressure with radiography, we also measured shock velocity and particle velocity by the VISAR (velocity interferometer system for any reflector).

In this experiment, the shock pressures were ~100GPa and iron didn't melt. But we confirmed an availability of sound velocity measurement by the side-on radiography. We will get the data of the sound velocity of liquid iron.