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Sound velocities of $Fe^{75}Ni^{15}Si^{10}$ alloys up to 800GPa by laser-shock compression

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The Earth's outer core is considered to be composed of iron (Fe) with few percent of nickel (Ni) and light elements (such as silicon (Si), sulfur (S), oxygen (O), hydrogen, and carbon etc.) The sound velocity of Fe alloy is important to consider the composition of Earth's outer core because it can be directly compared with seismic data. The sound velocity measurement of liquid Fe-S-O using gas gun has been reported [1]. As a result, the effect of O for the sound velocity is stronger than that of S. Although Si and Ni are very important elements in Earth's outer core, the effect of Si and Ni for liquid Fe on the outer core conditions has never been reported. In this study, we have measured the sound velocity of laser-shocked $Fe^{75}Ni^{15}Si^{10}$ up to 800 GPa. Comparing to the sound velocity of liquid Fe at same density, the sound velocity of $Fe^{75}Ni^{15}Si^{10}$ is higher about 20%.

We performed laser-shock experiments at the GEKKO-HIPER Laser system in Institute of Laser Engineering, Osaka University. The laser-shock compression can generate pressures of 400-800 GPa which are much higher pressures than previous works by gas guns [1, 2].

The sound velocity of the alloys was measured by side-on radiography [3]. In this technique the time variation of the X-ray shadow of target is recorded on X-ray streak camera by using x ray irradiated from the side of target. The sound velocity is obtained from the time variation of the X-ray shadow because the rarefaction wave propagates target material with the sound velocity (See experimental details [3]).

Reference

[1] H. Huang et al., Nature 479 (2011) 513-516.
[2] J.M. Brown & R.G. McQueen, J. Geophys. Res. 91 (1986) 7485-7494.
[3] K. Shigemori et al., Rev. Sci. Instrum. 83 (2012) 10E529.

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