Sound velocity measurements in the liquid Fe-S system up to 20 GPa using ultrasonic pulse-echo method

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Abstract

To understand the structure and composition of the molten core of the terrestrial planets such as Mars, it is important to know the physical properties of liquid Fe alloys at high pressure and high temperature. Sound velocity is a key physical property because it can be directory compared with seismic observations. However, longitudinal sound velocity (Vp) measurements of liquid Fe alloy by ultrasonic methods combined with multi anvil apparatus have been limited to below 8 GPa. Here, we report the latest results of sound velocity measurements in the liquid Fe-S system up to 20 GPa corresponding to the core mantle boundary of the Mars.

High-pressure and high-temperature experiments were conducted at BL04B1 of SPring-8 and NE7A of PF-AR using Kawai-type multi anvil apparatus with a 10/5 cell assembly. We used ultrasonic pulse-echo overlap method to measure sound velocity. The sample lengths were determined by X-ray radiography. Chemical analyses of the recovered samples were conducted using an FE-EPMA-WDS.

The present Vp in the liquid Fe-S system were consistent with those determined by our previous study up to 7 GPa (Nishida et al. 2016). The Vp of liquid Fe-43 at.% S were lower than that of liquid Fe-20 at.% S in all of the conditions of up to 20 GPa. The temperature dependence of Vp was negligibly small, similar to that at low pressures (Nishida et al. 2013; Jing et al. 2014). The experimental P-Vp-T data were well fitted simultaneously to third order Birch-Murnaghan thermal equation of state (Anderson et al. 1989) with large dK/dP. These results suggest that dissolved S decreases the Vp of liquid Fe under martian core conditions.

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