

Sound velocity Fe₃S at high pressure and high temperature based on inelastic X-ray scattering

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Mars, the 4th planet from the sun, has been investigated since 1960s. In spite of the investigations, the interior of Mars have not been understood well. Although the surface of Mars has been investigated by Opportunity and Curiosity in the project of NASA, the structure and seismic properties of the Martian core have not been understood well. The core of Mars have been thought to include sulfur as a light element. Sohl and Spohn (1997) proposed the seismic wave velocity and density profiles of the interior of Mars. However, there were almost no data of seismic wave velocity of the Martian core materials such as FeS and Fe₃S. Therefore, we have measured sound velocities of Fe₃S under high pressures and temperatures in order to discuss the Martian core. In addition, the InSight project of NASA will observe seismic wave velocity and probably be able to give some information of the Martian core.

There have been only a limited number of works for V_p of Fe and Fe alloys with light elements, especially Fe alloys with sulfur. Recently, sound velocities of Fe, Fe-Ni, FeS, FeS₂, FeO, Fe₃C, Fe-Ni-Si alloys have reported based on an inelastic X-ray scattering (IXS) (Fiquet et al., 2001; Antonangeli et al., 2004; Fiquet et al., 2004; Badro et al., 2007; Fiquet et al., 2009; Antonangeli et al., 2010). In the Fe-S system, V_p of FeS, the end member of the Fe-FeS system, and FeS₂, more sulfur-rich compound, have been studied but these compounds are not appropriate for the core materials of Mars because Fe-S system has a lot of intermediates such as Fe₃S₂, Fe₂S, Fe₃S under high pressures (Fei et al., 1997, 2000). In addition, Fe₃S coexists with ϵ -Fe as a subsolidus phase from 20 GPa to at least 200 GPa (Kamada et al., 2010, 2012). Therefore, it is essential to study the V_p of Fe₃S to understand seismic properties of the Martian core. We have measured sound velocities of Fe₃S under high temperature and pressure at BL35XU of SPring-8.

In this study, a synthesized Fe₃S was used as a starting material. A symmetric diamond anvil cell was used to generate high pressures. IXS and XRD experiments were performed at the beamline 35XU of SPring-8, Japan (Baron et al., 2000). V_p of Fe₃S were measured up to 45 GPa and 1900 K. We will discuss temperature effect on V_p of Fe₃S and the Birch's law and seismic wave velocity profile of the Martian core.

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