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非弾性 X 線散乱法を用いた高圧下における Ve3S の VP
Sound velocities of Fe3S at high pressures using inelastic X-ray scattering

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The structure and seismic properties of the Earth's inner core have not been understood well. The observation of compressional wave velocities through the inner core implied that the inner core is anisotropic (e.g., Creager, 1992) and layered (e.g., Ishii and Dziewonski, 2003). Observed compressional velocities are about 3 % faster along the polar axis than in the equatorial plane. The evidence of the layered inner core showed that there is a seismically isotropic or weakly anisotropic layer at the top of the inner core. Although the origins of these anisotropy and layered structure are poorly understood, it has been considered that the anisotropy is caused by the preferred orientation of the crystals in the inner core. The observation of shear wave velocities in the inner core raised an issue because the observed shear wave velocities were unexpectedly low (Cao et al., 2005). Due to lack of the knowledge about elastic properties of the core materials, it is difficult to interpret the observed seismic wave velocities.

There have been a lot of works about the density of Fe and Fe alloys with light elements. However, 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, French group has reported sound velocities of Fe, Fe-Ni, FeS, FeS2, FeO, Fe_3C, Fe-Ni-Si alloys 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 FeS_2, more sulfur-rich compound, have been studied but these compounds are not appropriate for the inner core materials because Fe-S system has a lot of intermediates such as Fe_3S_2, Fe_2S, Fe_3S under high pressures (Fei et al., 1997; 2000). In addition, under the core conditions, only Fe_3S coexists with hcp-Fe as a subsolidus phase (Kamada et al., 2010). Therefore, it is essential to study the V_P of Fe_3S to understand seismic and chemical properties of the Earth's core.

In this study, Fe_3S was synthesized from a mixture of powdered Fe and FeS using a muti anvil apparatus. A symmetric diamond anvil cell was used to generate high pressures. Inelastic X-ray scattering experiments were performed at the beamline 35XU of SPring-8, Japan (Baron et al., 2000; 2001). The present results follow the Birch's law. The slope of the law of Fe_3S (1.1) is smaller than that of FeS_2 (3.0) reported by Fiquet et al. (2004) and that of of FeS (1.7) reported by Vocadlo (2007) and Badro et al. (2007). The slopes of Birch's law for iron sulfides are decreasing with increasing a mean atomic mass of an iron sulfide. This suggests that sulfur might make the slope of Birch's law steeper with increasing the amount of sulfur.

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