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Effect of hydrogen on the FeS phase diagram with in situ X-ray observation

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The Earth's outer core is 10% less dense than pure iron (e.g., Birch, 1952). Thus, it is considered to contain light elements such as hydrogen, carbon, oxygen, silicon and sulfur (Poirier, 1994). The Earth's core is likely to contain at least a few weight percent of sulfur (Hillgren et al., 2000), and about 1 weight percent addition of hydrogen could be enough to account for the density deficit of the core (Stevenson, 1977). Therefore, sulfur and hydrogen are the possible candidates of the light elements in the core. Although it is known that hydrogen changes the phase relation of iron and sigunificantly lowers the melting temperature of iron (e.g., Sakamaki et al., 2008), it has never been reported whether hydrogen affects the phase relation and the melting temperature of FeS.

In situ X-ray experiments were carried out using a Kawai type multi anvil apparatus installed at BL04B1 beamline, SPring-8 in Japan. The experimental pressure range was between 3 and 7 GPa. The FeS powder was packed into a NaCl container with $LiAlH_4$ which was separated from the sample by thin MgO disk. Hydrogen was supplied by thermal decomposition of $LiAlH_4$.

In this study, the volume of FeS, which was estimated from the diffraction peaks of FeS, was significantly larger than that of the pure FeS (Urakawa et al., 2004) at high pressure and temperature. In addition, at high pressure, we could observe the disappearance of the diffraction peaks of FeS and only the halo pattern was observed at the temperature 200 K lower than the melting temperature of FeS (Boehler, 1992). Therefore, hydrogen dissolved into FeS may affect density and melting temperature.