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Phase diagram of Fe-H system at high pressure: In-situ X-ray experiments using single crystal diamond capsule

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Earth's outer core is approximately 10% less dense than pure iron. Hydrogen is considered to be one of the light elements which cause the density deficit of Earth's core. Fukai (1984) suggested that hydrogen can dissolve into metallic iron under high pressure. We have determined the melting temperature of FeH between 10 and 20 GPa under hydrogen saturated condition and proposed that the melting temperature is more than 1773K lower than that of pure Fe at CMB condition (Sakamaki et al., 2009). In this study, we performed Hydrogenation experiments of Fe that coexists with hydrous ringwoodite. The amount of hydrogen x in FeHx was calculated by X-ray diffraction pattern using multi anvil apparatus SPEED-Mk2 installed at BL-04 in SPring-8, Japan. Single crystal diamond and rhenium composite capsule were used as sample container. The amounts of hydrogen x (FeHx) were estimated by X-ray diffraction pattern. Hydrogen concentration in FeHx coexisting with hydrous ringwoodite is between 0.4 and 0.6 at 1273K and 14˜ 23 GPa. This value is significantly lower than those reported (x=1˜1.2) by Shibazaki et al (2009). The difference may be due to the difference in amount of water in the system. Our experiments were conducted under water under saturated condition while those of Shibazaki et al (2009) were probably water saturated. Although Shibazaki et al (2009) reported experimental results only at 1273K, we will show results between 1273K and 1823K at pressures between 14 and 23 GPa. In our experiments, for example at 16GPa, FeHx coexisted with FeHx melt above 1773K, and gamma-FeHx melted completely at 1823K. The amount of hydrogen in gamma-FeHx coexisted with FeHx melt should be plotted on solidus line. Using these result, melting temperature of pure iron and that of FeH, the phase diagram of Fe-H system are constructed.

Keywords: iron, hydrogen, phase diagram, core, hydrogenation