Iron-water reaction at high pressure and temperature

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It was proposed that the Fe-H2O reaction should have played a crucial role in the evolution of the Earth. So far the highest pressure investigated in the Fe-H system is 62 GPa at room temperature. The phase relation at high temperature in the Fe-H2O system has been studied at below 10 GPa. In the present study, experiments were carried out at high temperature and high pressure using a diamond anvil cell with both laser heating and external heating methods in the Fe-H2O system. In situ X-ray diffraction experiments using synchrotron radiation were performed at KEK. We observed the reaction to form FeO and iron hydride FeHx. The present results imply that the reaction at Fe and H2O to form FeO and iron hydride was important in the accretioned stage of the terrestrial planets.

It was proposed that the Fe-H2O reaction should have played a crucial role in the evolution of the Earth (e.g. Fukai, 1984). So far the highest pressure investigated in the Fe-H system is 62 GPa at room temperature (Badding et al., 1991). The phase relation at high temperature in the Fe-H2O system has been studied only at pressures below 10 GPa (Fukai et al., 1986; Yamakata et al., 1992; Hishinuma et al., 1995; Okuchi, 1997).

In the present study, experiments were carried out at high temperature and high pressure up to 33 GPa using a diamond anvil cell with both laser heating and external heating methods. The starting materials of fine iron powder, ruby (Al2O3) and distilled water were put into the sample room. In situ X-ray diffraction experiments using synchrotron radiation under high pressure and temperature were performed at the National Laboratory for High Energy Physics (KEK, BL-13B2 and BL-13A). In order to determine the accurate reaction boundary of the Fe-H2O system, we have developed the external heating diamond anvil cell that is suitable for the experiments below 1000C. No reaction between Fe and H2O was observed up to 500C at 11-20GPa. The laser-heated samples at 12, 15 and 33 GPa showed the reaction to form FeO and iron hydride FeHx. The present studies imply that the reaction at Fe and H2O to form FeO and iron hydride was important in the accretioned stage of the terrestrial planets.