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Hydrogen in the core inferred from high P-T reaction of Fe-Ni-Si-H2O

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Iron-nickel alloy containing some light elements is considered to be main constituent of the Earth core. We have reported the effect of nickel on iron-water reaction under high pressure and temperature at the Joint Meeting in 2010, which suggests a significant extending of oxyhydroxide phase to higher pressure than pure iron?water system. We have further studied the reaction of iron-nickel alloy and water by adding silicon which is one of the most plausible light elements of the core using a laser-heated diamond anvil cell combined with X-ray diffraction measurements at KEK-PF:AR-NE1A. The starting material of iron-nickel-silicon alloy was prepared in an arc furnace in a pure Ar atmosphere. The foiled iron-nickel-silicon alloy was loaded into the sample hole of Re gasket, with distilled water. Pressures were calculated using the equation of state of ice VII phase. The sample was heated with Nd:YAG laser using a double-sided heating techniques. The temperatures were determined by the thermal radiation from the heated sample. The experimental conditions were up to about 40GPa and 2000K. In situ observation at pressures and temperatures is essential to identify the reaction phase because the iron rich hydride produced in the reaction is unquenchable to the ambient condition. We observed the reaction between the iron-nickel-silicon alloy and water and phase transition of each phase at high pressure and temperature. In the present study, oxyhydroxide and metal hydride were stable to 38GPa and 1000K, while oxide and metal hydride was produced at higher pressure and 1650K. The stability field of oxyhydroxide expands more than Fe-Ni-water system to higher pressure of 42GPa. The produced hydride phase with a dhcp structure transformed to an fcc structure at higher temperature at 1900K 42GPa. The results indicate that hydrogen was much partitioned to mantle phase by silicon and nickel in the core material.

Keywords: Earth’S core, hydrogen, iron alloy, synchrotron X-ray, high pressure