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

Yuh Ishida[1], Tadashi Kondo[1*]

[1]Graduate School of Science, Osaka Univ.

The iron-nickel alloy with light element is considered to be main constituent of the Earth's core. Hydrogen is one of the most important candidates as light elements considering the reaction between iron and water in the early and present Earth. In this reaction, FeH and FeOOH were produced up to 10GPa, while FeH and FeO were produced at high pressure. The density deficit of the core can be explained only by hydrogen because the density of FeH is about 15% lower than that of Fe. Hydrogen is important for such a reason. Although the reaction between pure iron and water or hydrogen has been studied so far, studies on iron-nickel-water system have not been done. We have studied the reaction of iron nickel alloy and water by a laser-heated diamond anvil cell conbined with an in-situ X-ray diffraction measurements at KEK-PF:BL-13A and AR-NE1A in order to evaluate the effect of nickel. The starting material of iron-nickel alloy with 20 mol% of Ni was prepared in an arc furnace in a pure Ar atmosphere. The foiled iron-nickel alloy was loaded into the sample hole of Re gasket, with distilled water. Pressures were calculated using the equation of state of ice VII. 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 87GPa and 1800K. We observed the direct reaction between the iron-nickel alloy and water. In this reaction, (Fe,Ni)OOH and (Fe,Ni)Hx were up to 20GPa and 1000K, while (Fe,Ni)O and (Fe,Ni)Hx was produced at 31GPa and 1200K. (Fe, Ni)OOH and (Fe,Ni)O were coexisted at the above conditions. The stability field of (Fe,Ni)OOH expands significantly to higher pressure region compared to the reaction of pure iron and water. Therefore, (Fe,Ni)OOH was produced in the early Earth. In that case, there is a possibility that hydrogen in (Fe,Ni)OOH was not carried to the core because (Fe,Ni)OOH may react with the surrounding mantle minerals.

Keywords: core, hydrogen, high pressure and high temperature, synchrotron