§69. Study of Impurity Effects on Hydrogen Retention and Chemical States in Impurities-contained Boron Films Exposed to Hydrogen Glow Discharge

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1) Introduction

For the future D-D discharge experiments in LHD, it is important to elucidate the desorption behaviors and estimate the retention of tritium trapped in boron films deposited byboronization. In this study, the analyses of atomic composition and chemical states using XPS (X-ray photoelectron spectroscopy) were performed for the three types of boron films, boronized film in LHD and the 35% oxygen-contained boron and pure boron film prepared by P-CVD (Plasma-chemical vapor deposition) at Shizuoka University. The retention behavior of D_2 for each boron film was analyzed by TDS (Thermal Desorption Spectroscopy).

2) Experiments

For the prepared three types of boron films, heating treatment was performed at 1100 K for 10 min. After heating treatment, the atomic compositions were evaluated using the XPS. Thereafter, 1.0 keV D_2^+ was implanted into each sample at RT with the flux of 1.0×10^{18} D^+ m^{-2} s^{-1} and the fluence of 1.0×10^{22} D^+ m^{-2}. After D_2^+ implantation, TDS measurement was performed, subsequently. The range of heating temperature was set to be RT-1100 K and the heating rate was 0.5 K s^{-1}.

3) Results and discussion

From the result of atomic composition analyses by XPS, it was found that 12% of oxygen and 10% of carbon were contained in LHD sample. In 35% oxygen-contained sample, the impurity level (~4%), of carbon was also contained, while pure boron sample contained only impurities levels of oxygen and carbon.

TDS measurements were performed for all samples. Fig. 1 shows the D_2 TDS spectra for each sample. It was found that the D retention was decreased by containing carbon and oxygen as the impurities. For these TDS spectra, peak analyses were performed by Gaussian distribution function. Fig. 2 shows the results of peak analyses using Gaussian distribution function for the LHD sample. From Fig. 2, TDS spectrum was separated into four peaks and appeared at about 500, 700, 800 and 980 K,which were named as Peak1-Peak 4. In the four peaks, it was found that Peak 1 and Peak 2 were also appeared for the 35% oxygen-containd sample and the pure boron sample, and these peaks were corresponded to the B-D-B bond and B-D bond, respectively [1]. Peak 3 was only observed for the 35% oxygen-contained sample, and it was expected that this peak corresponded to the desorption of D from

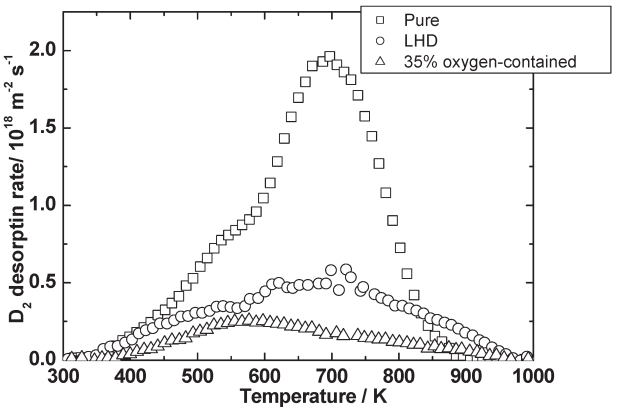

Fig. 1 The D_2 TDS spectra for each sample.

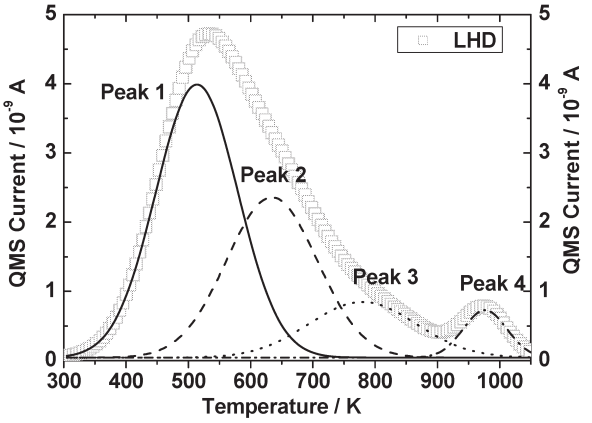

Fig. 2 Peak analysis for LHD sample.

B-O-D bond [1]. Peak 4 was not appeared for the 35% oxygen-contained sample and the pure boron sample. It was suggested that the Peak 4 was corresponded to that from B-C-D bond. Although the C easily traps the hydrogen isotopes and forms C-D bond, total D retention is the almost same that of 35% oxygen-contained boron. This result indicated that the D was released as the carbon deuteride during D_2^+ implantation. From this study, it was suggested that the B-C-T bond was formed, and as the desorption temperature was very high, tritium as the B-C-T bond would be continuously retained during the operation in fusion devices.

4) Conclusion

To evaluate hydrogen isotope behaviors in the boron thin film, three kinds of samples, the LHD sample, the 35% oxygen-contained sample and pure boron sample were prepared and the analyses of retention behavior TDS for each sample. The experimental results show that impurities as oxygen and carbon were reacted with boron and formed B-O-X bond and B-C-X bond (X is hydrogen isotopes). In particular, it was expected that the desorption temperature of X trapped as B-C-X was very high. These facts suggest that tritium would be continuously retained during the discharge in LHD.

[1] Y. Oya et al., *J. Nucl. Mater.*, 329-333, (2004) 870-873.
[2] A. Yoshikawa et al., *J. Nucl. Mater.,* In press.