§30. Study on Impurity Effects and Hydrogen Isotopes Retention Behavior in Impurities-contained Boron Films

Okuno, K., Oya, Y., Yoshikawa, A., Igarashi, E., Suda, T., Ishikawa, H., Kikuchi, Y. (Shizuoka Univ.), Ashikawa, N., Nishimura, K., Sagara, A.

i) Introduction

For the D-D discharge experiment in Large Helical Device (LHD), boronization will be carried out as wall conditioning to reduce the impurities in plasma. The evaluation of tritium retention in the boron film and its impurities effects are one of the key issues. In this study, two different boron films which were prepared at LHD and deposited by P-CVD at Shizuoka University were exposed to H-H main discharge in LHD. The retention behavior and chemical states of hydrogen in both films were estimated by means of Thermal Desorption Spectroscopy (TDS) and X-ray Photoelectron Spectroscopy (XPS).

ii) Experimental

The boron film was deposited on a silicon substrate at 373 K in LHD (Sample A). At Shizuoka Univ., the pure boron film was also deposited on a silicon substrate at 673 K using Plasma Chemical Vapor Deposition (Sample B). These samples were exposed to H-H main discharges of 123 shots (exposure time of around 246 s) in LHD. Thereafter, the chemical states were analyzed by means of XPS. After the XPS measurement, TDS experiments were performed with the heating rate of 30 K min^{-1} and the heating range from room temperature up to 1273 K.

iii) Results and discussion

From our previous studies [1], [2], it was found that the total H retention increased as the concentrations of impurities in boron film decreased. Especially, most of hydrogen in pure boron film was trapped by boron with forming B-H bond around 700 K. The H_2 TDS spectra for these samples were shown in Fig. 1(a). From this figure, total hydrogen retention for Sample B was larger than that for Sample A, which was consistent with our previous studies. The desorption stage above 800 K was also found for both samples. It was assumed that these stages were consisted of two peaks; the desorption stages of H bound to boron as B-O-H (850 K) and B-C-H (950 K) bonds. In addition, the amounts of methane and water desorption for Sample B were four times larger than those from Sample A. The XPS results showed that the boron, carbon and oxygen concentrations for Sample A were 53, 23 and 21%, respectively, and those for Sample B were 63, 20 and 12%, respectively. These results indicated that carbon and oxygen would be contaminated into Sample B during H-H main discharge. In addition, the major chemical states of oxygen and carbon in Sample A were O-B and C-O bonds [3], [4], respectively, and those in Sample B were free oxygen and C-C bond [5], [6], respectively. It can be said that the released methane and water related to the chemical states as C-C bond and free oxygen, respectively.

It was concluded that the carbon and oxygen would be contaminated into boron film and B-O, C-O and C-C bonds and free oxygen would be formed during the main discharge campaign even if pure boron film was obtained by boronization.

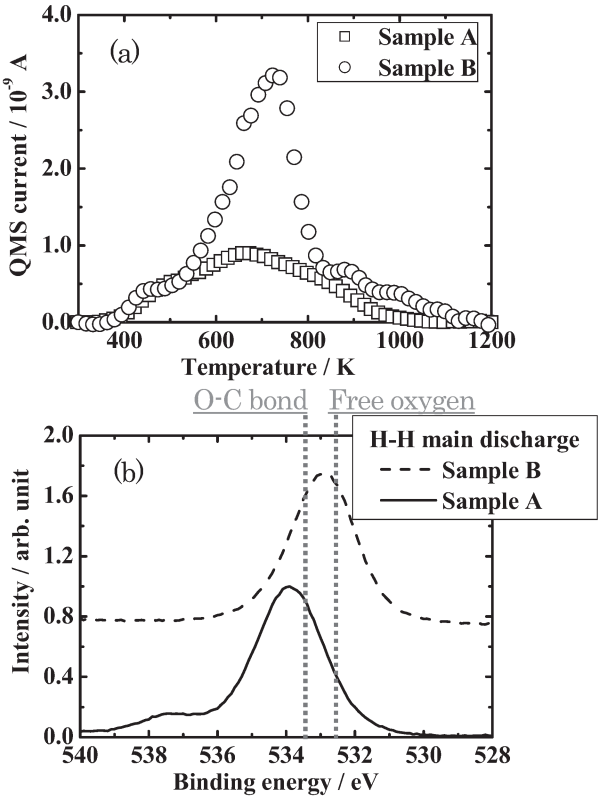

Fig. 1 (a)The H_2 TDS spectra and (b) the O-1s XPS spectra for the boron samples deposited in LHD and by P-CVD after H-H discharge exposure.

[1] A. Yoshikawa, et al., J. Nucl. Mater., **367-370** (2005) 1527-1530.

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

[3] B. F. Dzhurinskii, et. al., Russian J. Inorg. Chem., **20** (1975) 2307.

[4] F. Beguin, et al., Eur. Polym. J., **34** (1998) 905-915.

[5] H. Kemi, et al., J. Nucl. Mater., **266** (1991) 1108.

[6] S. Contarini, et al., Appl. Surf. Sci., **51** (1991) 177.