§63. Study on Hydrogen Retention and Its Existing State in Boron Film Exposed to Hydrogen Glow Discharges

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1) Introduction

For the future D-D discharge experiments in LHD, it was important to estimate the desorption behaviors and retention of tritium trapped in boron films formed by boronization for first wall conditioning. In this study, the analyses of atomic composition and chemical states were performed for three kinds of boron films by XPS (X-ray photoelectron spectroscopy).

2) Experimental

The boron film deposited on the Si substrate in LHD (Sample A), and the oxygen-contained boron film (Sample B) and the pure boron film (Sample C) deposited on the Si substrate using P-CVD (Plasma-chemical vapor deposition) in Shizuoka University were prepared. After the heating treatment was performed at 993 K for 10 min and subsequent surface sputtering by 3 keV Ar^+, atomic compositions and chemical states were evaluated by XPS (ULVAC-PHI ESCA 1600 System) at Shizuoka University

3) Results and discussion

The results of atomic composition analyses for Samples A, B and C are shown in Table. It was found that Sample A contained 12% of oxygen and 10% of carbon. In Sample B, the oxygen and carbon concentrations were 10% and less than 1% (impurity level), respectively, while, both of them in Sample C were not almost contained.

The analysis of chemical states of boron was performed for Samples A, B and C by means of XPS. Figure shows the B-1s XPS spectra. The B-1s binding energies of Samples A and B were shifted toward higher energy side compared to Sample C. The chemical shift of B-1s spectrum for Sample A was larger than that for Sample B. The shoulders of the spectra of Samples A and B were located at 191 eV. As these shoulders approximately corresponded to the binding energy contributed to boron oxide [1], it was suggested that boron oxide was formed in Samples A and B. The FWHM (Full Width of Half Maximum) of Sample A was larger than those of Samples B and C. It was suggested from these results that the B-C bond was formed as carbon concentration in film increased.

In future, the desorption behavior, retention and chemical states of hydrogen should be elucidated in the boron film exposed to discharge in LHD.

Table The atomic composition analyses for each sample (%)

	B	C	N	O
Sample A	73	10	5	12
Sample B	85	3	2	10
Sample C	96	2	1	1

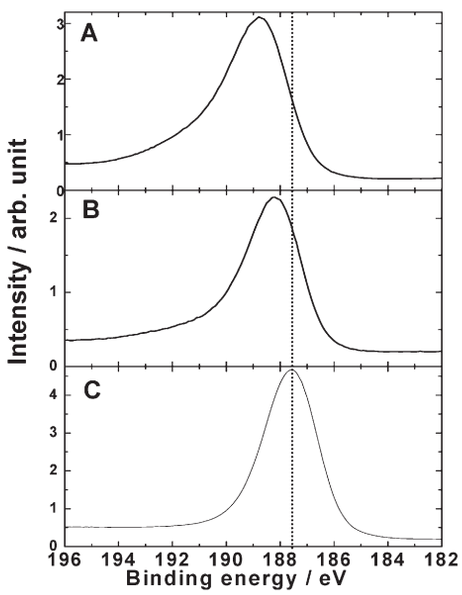

Figure The B-1s XPS spectra for each sample

4) Conclusion

To evaluate hydrogen isotope behaviors in the boron thin film, three kinds of samples, the ones prepared at NIFS and Shizuoka University, were prepared and the analyses of atomic composition and chemical states were studied by means of XPS. Concentrations of impurities, oxygen and carbon, for NIFS sample were higher than those for Shizuoka sample. These facts suggest that these impurities can be made large effects on the implanted hydrogen isotope retention and trapped states in the boron thin film.

[1] O. M. Moon, B.C. Kang, S.B. Lee, J.H. Boo, *Thin solid films*, **464-465** (2004) 164-169.