§78. The Study of Hydrogen Retention and Existence States in Boron Thin Film Exposed to Hydrogen Glow Discharge

Okuno, K., Yoshikawa, A., Miyauchi, H., Oyaidzu, M. (Fac. of Sci., Shizuoka Univ.)
Oya, Y. (Radioisotope Center, Univ. of Tokyo)
Ashikawa, N., Nishimura, K., Sagara, A.

1) Introduction

Boronization as wall conditioning has been performed on a lot of fusion test devices and remarkable improvement on the plasma performance has been achieved. By gettering oxygen remained in vacuum vessel into boron thin film deposited on plasma facing wall, high plasma performance can be achieved. On the other hand, it is anticipated that energetic tritium, deuterium, helium and neutron are implanted from D-T plasma into the boron coating film. Therefore, hydrogen isotope behavior including tritium in the boron thin film should be elucidated from a viewpoint of fusion safety. To simulate actual hydrogen isotope behavior on the first wall in fusion reactors, the boron thin film boronized in LHD was prepared and compared to that prepared by PCVD at Shizuoka University. The chemical composition and depth profile of hydrogen isotopes were studied by X-ray Photoelectron Spectroscopy (XPS) and Secondary Ion Mass Spectroscopy (SIMS).

2) Experiment

Two kinds of boron thin films were prepared as follows. One was deposited on a Si substrate by a glow discharge using B_2H_6 and thereafter this sample was exposed on hydrogen glow discharge in LHD at NIFS, which named NIFS sample. The other was done in PCVD device using $B_{10}H_{14}$ at Shizuoka University, named Shizuoka Sample. The chemical composition of these samples was analyzed by XPS (ULVAC-PHI ESCA 1600 System) at Shizuoka University and depth profile was evaluated by SIMS (ULVAC-PHI ADEPT 1010 Dynamic SIMS System) at Japan Atomic Energy Research Institute (JAERI). AlKα (1486.6 eV) was used as a X-ray source for XPS analysis. For SIMS measurement, 5 keV Cs^+ ion was used as a primary beam and the sputtered ions were observed by quadrupole mass spectrometer. The beam current was set to be 100 nA. The beam size was about 32 μm and the rastering area was set to be 400 x 400 μm^2. The sputtered depth was estimated by a Dektak profilometer.

3) Results and Discussion

From XPS analysis, it was found that the boron concentration was reached up to 75% for the NIFS sample and 96% for the Shizuoka sample. Around 9% of carbon and 12% of oxygen and small amount of nitrogen was also contained for the NIFS samples. Figs. 1 and 2 show the depth profiles for the NIFS and Shizuoka samples. It was found that the thickness of boron for NIFS sample was about 200 nm and that for the Shizuoka sample, 250 nm. For the NIFS sample, large amount of oxygen was trapped by boron and the profile of oxygen was almost coincident with that of boron. It was also noted that the more impurities were contained for the NIFS sample compared to the Shizuoka sample, indicating that the some impurities, which will come from the first wall materials and residual impurities in vacuum vessel, would be contained into the boron thin film. These facts indicate that the impurities effects will make a large influence on the hydrogen isotope retention in the boron thin film.

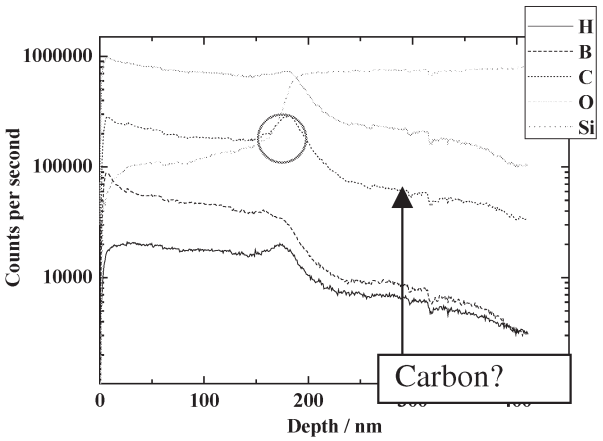

Fig. 1 SIMS results for the NIFS sample

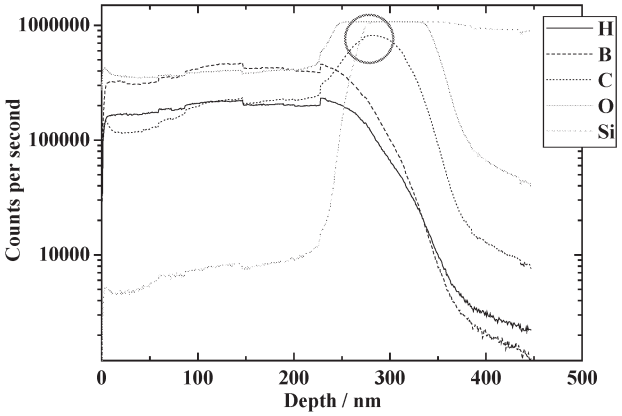

Fig. 2 SIMS results for the Shizuoka sample

4) Conclusion

To evaluate hydrogen isotope behaviors in the boron thin film, two kinds of samples, the NIFS sample and the Shizuoka sample, were prepared and chemical compositions and depth profiles were studied by means of XPS and SIMS. The experimental results show oxygen was trapped by boron for the NIFS sample and the more impurities were contained for the NIFS sample compared to the Shizuoka sample. These facts indicate that these impurities make a large fluence on the hydrogen isotope retention in the boron thin film. Further study will be required for understanding detailed mechanism.