§24. Analysis for Plasma Wall Interactions Using Material Probes

Hino, T., Yagihashi, H., Yamauchi, Y., Nobuta, Y. (Hokkaido Univ.),
Ashikawa, N., Masuzaki, S., Sagara, A.

It is quite important to know the wall condition in LHD and the plasma surface interaction arising from the progress of plasma experiments. For this purpose, the wall condition data have been systematically accumulated by using material probes through 10 experimental campaigns since 1998.

This note presents the results obtained in the 10th campaign (2006-2007). The impurity deposition and the retained amounts of discharge gases and impurity gases on these probes were examined. In addition, the pre-coated boron film was also exposed to the plasma to evaluate the erosion depth after the campaign.

The material probes were installed at 10 toroidal positions as shown in Fig. 1. Major impurity species deposited on the probe were carbon, boron, oxygen and iron. Fig. 2 shows the thickness of deposited boron and carbon films at each sector. The carbon impurity deposited on the surface in all probes. The thickness of boron film significantly depended on the position of the anodes used for the glow discharge and boronization.

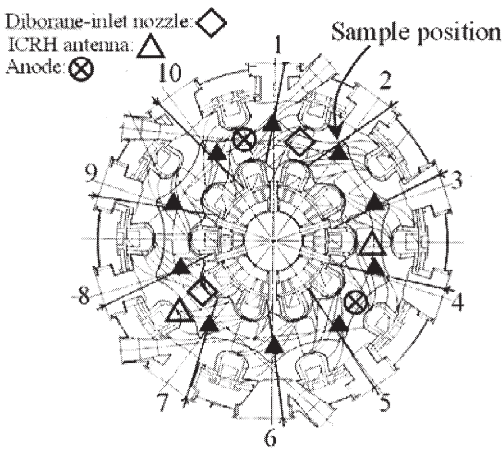

Fig.1 Toroidal locations of material probes and diborane-inlet nozzles, ICRH antennae and anodes.

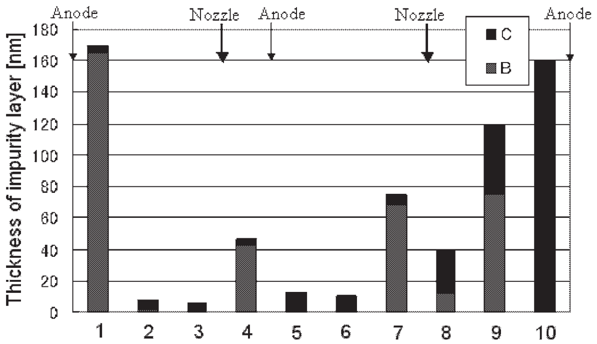

Fig.2 Thickness of impurity layer vs toroidal sector number.

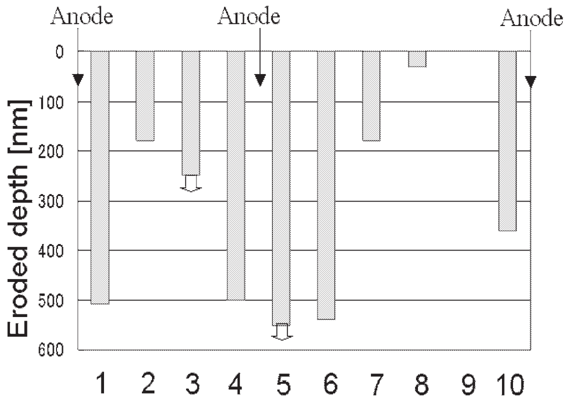

Fig.3 Eroded depth of pre-coated boron film vs toroidal sector number.

The thickness of pre-coated boron film in each toroidal sector is known. Thus, the eroded depth could be determined. Fig. 3 shows the eroded depth of pre-coated boron film. The boron film was significantly eroded at the sectors 1, 4, 5, 6, 10, which are close to the anodes. At the sector 5, the pre-coated boron film (550 nm) was entirely eroded. These results show that the wall erosion occurs mainly during the glow discharge, and the degree of erosion clearly depends on the anode position.

The amount of retained hydrogen was large in the vicinity of the anodes. The hydrogen retention corresponded to the current density of the glow discharge. These results show that the hydrogen implantation occurs mainly during the glow discharge. As the increase of the campaign number, it was seen that the total amount of retained hydrogen decreased. This result is related with the times of hydrogen and helium glow discharges. Namely, as the increase of campaign number, the time of the hydrogen glow discharge decreased (7th:700h, 8th:500h, 9th: 290h, 10th: 250h), and the time of the helium glow discharge increased (7th:100h, 8th:100h, 9th: 240h, 10th: 400h).

The retained helium in the stainless steel probe exposed to only helium main discharges desorbed mainly in the temperature region higher than 800-900 K. The retained helium in the sample exposed to only the glow discharges desorbed in the temperature region lower than 900K. The desorbed amount in the region higher than 900 K was large at the position near the ICRH antenna. The high energy helium ion with energy of several keV produced by the ICRH might have implanted. In the case of the glow discharge, the helium energy is as high as several hundred eV. The difference in the desorption temperature may be due to the implantation depth of helium.

In the 10th campaign, several new results on the plasma wall interaction were obtained as shown in the above.

1) Yagihashi, H. et al, Presented in the 5th International Conference of Plasma Physics, Fukuoka, 2008.