§4. Study on Hydrogen Retention/desorption Behavior Using Long-term Samples Mounted on the Plasma-facing Surface in LHD

Nobuta, Y. (Hokkaido Univ.),
Masuzaki, S., Tokitani, M.

It is important to understand plasma-wall interaction (PWI) in fusion devices. The surface of plasma-facing wall is modified by PWI phenomenon, such as erosion, redeposition and irradiation damage. Long-term samples mounted on plasma-facing surface in fusion devices are useful to investigate the modification of plasma-facing surface. The modification of the wall surface significantly influence the retention/desorption behavior of discharge gases, such as H_2 and He. The purpose of this study is to understand the gas recycling behavior of the modified wall surface using long-term samples.

Changes of wall surface are quite different for each location in vacuum vessel due to the different plasma-facing interaction at each location. Thus, many samples are needed to be mounted at a lot of locations to precisely understand the wall conditions. The location of long-term samples in the 17th experimental campaign is shown in Fig.1. In each toroidal section, samples (stainless steel and silicon substrate) were mounted on the top of the helical coil and close to the outer divertor tiles. In the toroidal sector 7, samples were mounted on the frange located at outside of vacuum vessel. After the 17th experimental campaign, the samples were extracted from vacuum vessel and sample analysis was conducted.

In this study, first, impurity deposition and gas retention in toroidal direction were investigated. Figure 2 shows the depth profile of atomic composition for stainless steel sample located on the top of the helical coil at toroidal sector 1. This depth profile was obtained by a technique of Auger electron spectroscopy (AES, Hokkaido Univ.). In this sample, a thick boron film containing a little amount of carbon and oxygen was observed. An anode and diborane inlet nozzle used for boronization is located at toroidal sector 10.5 and 1.5, respectively. This is the reason for a large amount of boron deposition at toroidal sector 1. Boron film containing carbon was also observed at toroidal sector 6 and 10. In other toroidal sectors, no deposition was observed on the samples. Figure 3 shows the depth profile of deposited elements for stainless steel sample located at toroidal sector 5 obtained by a technique of glow discharge optical emission spectroscopy (GDOES, NIFS). A thick carbon film was observed and the thickness was approximately 2 micro meters which was estimated by measuring the depth of etching crater produced during GDOES analysis. This carbon deposition is due to redepostion of carbon sputtered on the graphite divertor tile during main discharges. These results indicated that the situation of deposition and erosion in LHD is significantly different on each location.

Investigations on retention/desorption behavior of H_2 and He and irradiation damages and additional ion irradiation for the LHD samples are now ongoing. Also, the crystal structure of the carbon film and chemical bonding state of hydrogen in deposition film will be analyzed with Raman spectroscopy at Toyama University and X-ray photoelectron spectroscopy at Shizuoka University, respectively. Based on these results, hydrogen and helium recycling behavior of the modified surface will be discussed.

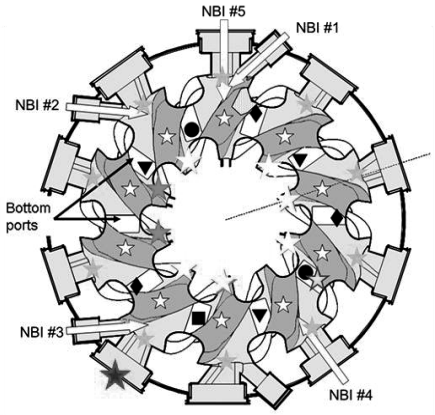

Fig.1 Sample locations mounted in vacuum vessel of LHD. This schematic diagram is a top view of LHD and sample locations are indicated by asterisks.

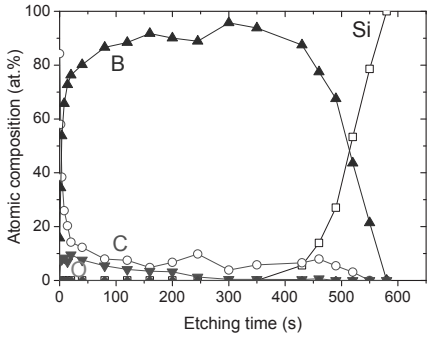

Fig.2 Depth profile of atomic composition for sample located on top of helical coil at toroidal sector 1.

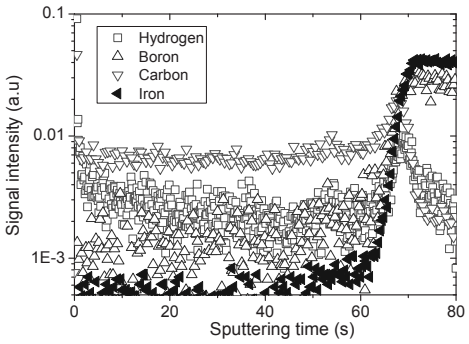

Fig.3 Depth profile of deposited elements for the sample located at outer torus in toroidal sector 5.