§43. Evaluation of Wall Surface Conditions using Long-term Samples in the LHD

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Long term sample is a useful tool to study plasma surface interactions in fusion devices. In the LHD, long-term samples mounted on plasma-facing wall have been analyzed in each experimental campaign since the first experimental campaign. In the early experimental campaigns, long-term samples mounted on the first wall were mainly analyzed. In the 17th experimental campaign, in order to evaluate the plasma-surface interactions in more detail, long-term samples were mounted on more locations and depositions and fuel hydrogen retention was investigated.

Stainless steel and silicon substrate were selected as the material of long-term sample. Sample positions are shown in fig.1. Samples were located at lower side of torus and outer torus in each toroidal sector. The outer torus samples were located close to the graphite divertor tiles. Also, at the toroidal sector 7, samples were mounted on the outer flange. These samples were extracted from the vacuum vessel after the campaign. Depth profile of atomic composition was analyzed with Auger electron spectroscopy (AES). Hydrogen retention behavior was evaluated with thermal desorption spectroscopy (TDS).

In the first wall samples, no deposition was observed except the samples mounted at the sectors 1, 6 and 10. For the samples at the sector 1, a thick (~150 nm) boron layer was observed. This deposition was responsible for boronization conducted in the early phase of the campaign. For the samples at the sectors 6 and 10, a carbon layer with a thickness of 70-140 nm was observed. This deposition would be due to the redeposition of carbon eroded at the graphite divertor tiles or NBI armor tiles during main discharges. The carbon deposition was also seen in the sample mounted at the outer flange, indicating that eroded carbon at the graphite divertor tile could be transported to remote area. In the outer torus, carbon layer with a thickness of 1-2.5 μm was observed. This is due to redeposition of carbon eroded on the divertor tiles.

Toroidal dependence of hydrogen retention in the first wall and outer torus samples is shown in fig.2. For the first wall samples (Fig.2 (a)), hydrogen retention tended to be large in the vicinity of glow discharge anodes used for glow conditioning located at the sectors 4.5 and 10.5 and seemed to have no relation with deposition. For the outer torus samples, much larger retention was observed compared to the first wall samples. This is responsible for a large amount of carbon deposition on the samples.

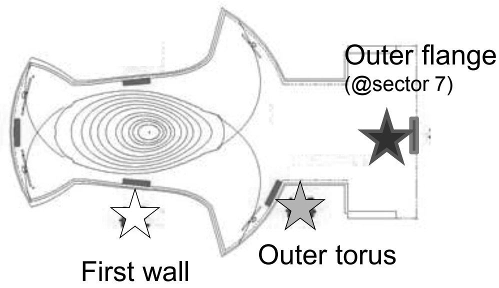
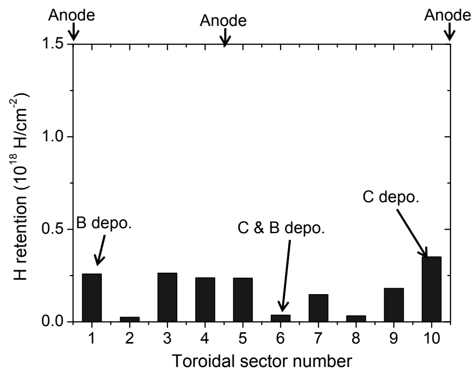


Fig.1 Schematic diagram of poloidal cross section of LHD. Samples were mounted at lower side of the torus ('First wall' sample) and at outer torus. At toroidal sector 7, samples were also mounted on the outer flange.

(a)



(b)

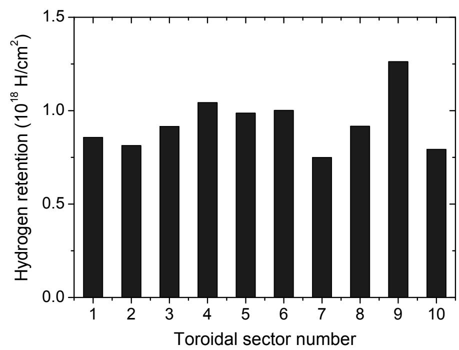


Fig.2 Hydrogen retention for the first wall samples (a) and outer torus samples (b).