§29. Investigation of Effective Cleaning Method Using Ion Cyclotron Conditioning in LHD

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As one of typical wall conditioning method in fusion devices, a glow discharge cleaning in non-magnetic field condition was operated such as the large helical device (LHD). But, future devices with superconducting coils will be needed a long time duration for increasing and decreasing the magnetic fields, and then magnetic field will be kept over a week such as operational plan in ITER. Therefore, for future devices, a wall conditioning method in strong magnetic field is required in general.

On the other hand, tritium inventory into deposited layers and bulk wall tiles is serious problem in future devices. For example, ITER has an operational limitation of tritium inventory of 350g in vessel. Then, development to obtain sufficient cleaning efficiency for tritium using wall conditioning is also important.

The ion cyclotron conditioning (ICC) is one of the conditioning methods to reduce impurities and to remove tritium from the plasma facing components. Advantages of ICC are to be operated under strong magnetic field for fully torus area and can be operated with high pumping efficiency. In particular, ICC in helical devices can be operated using the same magnetic configuration for of main plasma and a shot by shot operation is easy.

In LHD, two times of ICC experiment were operated in 2005 and 2006 using two sets of RF antennas with helium gas. The advantages of ICC in LHD are the durability of long-term operation and the flexibility of input power with pulse phases. The total operation time was 115 minutes with input phase of 3 sec and interval phase of 2 sec. Within the result obtained so far, a removal rate of hydrogen using He-glow discharge is ten times higher than ICC. And then, to enhance the advantages of ICC, an optimization of effective cleaning method has to be discussed.

Under ICC in 2006, Natural Diamond Detector measured a charge exchanged (CX) neutral particle flux about 1.6 - 3.2 x 10^5 [$s^{-1}cm^{-2}$] with high-energy upto 100 keV by Si Fast Neutral particle energy Analyzer (Si-FNA) at the net ICC input power of 287kW. In these operations, material probes were installed at the first wall level. For this material of stainless steel, saturated number of damages as helium babble is observed. Because ICC discharge in helical system is formed in the last closed magnetic surface as same as main plasma, it was concerned that an effect of wall interaction with CX particles was limited. But, this result on the material probe shows a sufficient or excess damage to measure the interaction.

This work was supported by the NIFS budget NIFS06ULPP515, the JSPS-CAS Core University Program in the field of"Plasma and Nuclear Fusion"and the Joint Research System of Research Institute for Applied Mechanics, Kyushu University. This work was undertaken by IEA/ITPA joint experiment of DSOL-8 “ICRF conditioning”.

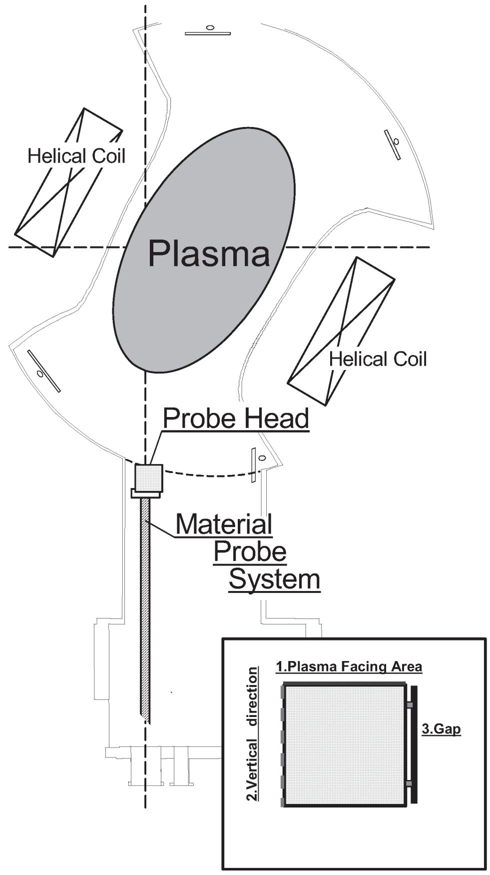

Fig.1 material probe system and sample holder.

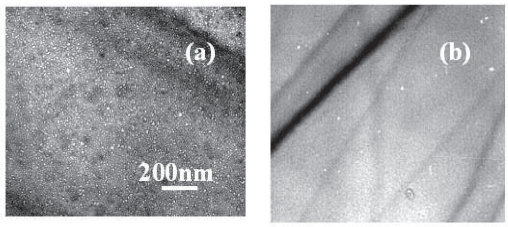

Fig.2 Bright field images by TEM, (a) on plasma facing are and (b) vertical area.