§32. Investigation on Deuterium Retention and Desorption in Plasma Facing Wall Toward Deuterium Discharge in LHD

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The preparation toward the DD discharge has been progressed in the LHD project. A very small amount of tritium is produced by DD fusion reactions and retained in the plasma facing walls. Therefore, it is of importance to evaluate the tritium retention and reduce the tritium inventory. The DD discharge is conducted to improve the plasma confinement, so that the control of fuel hydrogen recycling is also required. For these purposes, the simulation experiments have been conducted using the glow discharge apparatus as shown in Fig.1. In order to simulate the tritium retention, the deuterium discharge was employed.

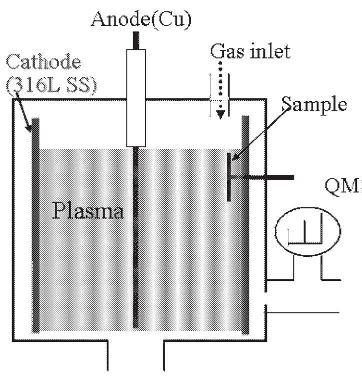

Fig.1 Glow discharge apparatus.

The stainless steel (SS) was chosen as the liner material. The deuterium discharge was conducted with gas pressure of 8 Pa and voltage of 320 V for 2 h. During the discharge, the reduction of D_2 partial pressure was measured to obtain the amount of retained deuterium. Namely, the retention was determined by residual gas analysis, RGA. The amount of retained deuterium was 4.8 x 10^{16} D/ cm^2, which was roughly the same as that of hydrogen, H. Since the chemical property of tritium is similar with that of deuterium, the tritium produced in the LHD plasma is trapped similarly with the deuterium. The amount of retained deuterium in the present experiment is regarded as the highest value of (D+T) retention in the wall.

The inert gas discharges using He, Ne and Ar may be employed to reduce the fuel hydrogen retention. After the implantation of deuterium, Ne discharge was conducted for 2 h to reduce the deuterium retention. Fig. 2 shows the partial pressures of Ne, HD and D_2. The ratio of removed (H +D) to the amount of implanted D was 24%. This value was close to the ratio of removed H after H_2 discharge followed by Ne discharge, 28 %. Fig. 3 shows the changes of partial pressures of Ar, HD and D_2. The ratio of removed (H + D) to the amount of implanted D was 12 %, which was the same as the ratio of removed H after the H_2 discharge followed by Ar discharge.

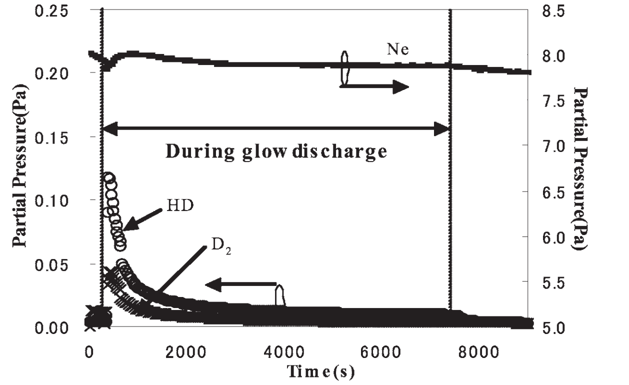

Fig.2 Change of partial pressures during Ne glow discharge.

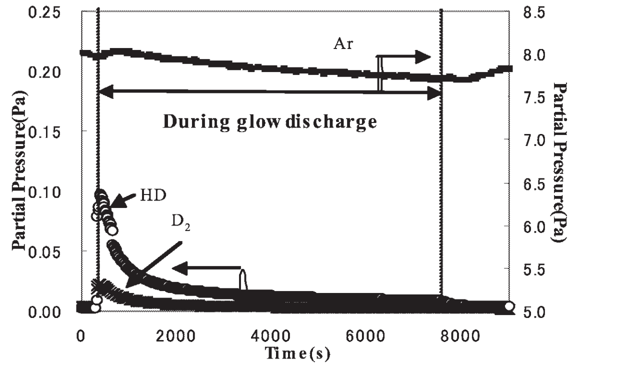

Fig.3 Change of partial pressures during Ar glow discharge.

In order to measure the desorbed D during He glow discharge, the usual quadruple mass spectrometer, QMS, can not be used because the m/e ratio of D_2 is the same as He. Thus, very high resolution QMS was used for the He discharge after D_2 discharge. The ratio of removed (H+D) to the amount of implanted D was 45 %, which was higher compared with the case of Ne or Ar discharge.

The amount of retained deuterium in SS was obtained in the present experimental conditions, i.e. the highest energy of D is 320 eV, and the deuterium pressure 8 Pa. The ratio of removed deuterium by the inert gas discharge became larger as increase of the implantation depth of inert gas ion and decrease of the sputtering yield. The helium discharge was most effective to reduce the deuterium retention. The amounts of retained He, Ne and Ar were one order, two orders and three orders of magnitude smaller than that of the deuterium retention, respectively.

In the present study, the essential parameters of deuterium or tritium retention in SS wall and the influences of inert gas discharge for reduction of fuel hydrogen retention were successfully obtained.

1) Kimura, Y. et al, To be presented in 14^{th} International Conference of Fusion Reactor Material, Sapporo, Sept., 2009.