§29. Wall Conditioning at the Starting Phase of LHD

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The plasma vacuum vessel made of 316 stainless steel with the 78tons of weight has the total volume of 210m^3, and the degreased inner surface of 780m^2 has been cleaned with acid, then with demineralized water and finally with alcohol. After finishing the helium leak test, the pressure of the plasma vacuum vessel has reached 9x10^{-7} Pa at the end of March. On March 28, soon after the coil excitation tests up to 1.5T, ECR discharge cleaning (ECR-DC) with He was carried out using the 2.45 GHz micro-wave in the 875 G standard confining configuration, without baking the vacuum vessel. Figure 1 shows the remarkable gas burst of mainly CO, H_2 and H_2O due to the first discharge with 3kW. By increasing the effective pumping speed from 1 to 10 m^3/s and decreasing the ECR power, the controllable steady discharge has been achieved.

After starting the first campaign, 95°C baking was tried for 61h with confirming device integrity, where the cooling water for the plasma vacuum vessel was changed to the hot water heated at 300kW. The total pressure increased up to 1x10^{-3}Pa under the pumping of 10m^3/s and about 1070Pam^3 of desorbed gas was evacuated, that is, about 16 molecular layers as shown in Fig.2. This result means that this mild baking is effective to degas the area which does not face the ECR plasma.

In order to reduce oxygen impurities as fast as possible at an early stage of the first campaign, titanium gettering was carried out. Toroidally distributed 3 movable Ti-heads were operated twice a day at B=0 for 1h each with the total sublimation rate of about 2g/h, covering the plasma-facing surface over 30% with more than 3 monolayers of Ti.

Since the main program of the second campaign consists of NBI heating experiments and ICR heating tests, wall conditioning of wide areas has been required by covering NBI injection ports and ICRH antennas. For this purpose, glow discharge cleaning (GDC) using He was arranged by installing two sets of 50cm movable electrodes made of graphite.

Figure 2 shows that, under He GDC, surface contaminants C and O are mainly evacuated by forming CO, presumably because the temperature of the vacuum vessel is usually below 30°C or below 95°C even in case of baking. In Fig.2 it is found that the total gas amount evacuated with baking and GDC is comparable to that in ECR-DC in the first campaign. In fact, the plasma stored energy with ECH could exceed 15kJ after evacuation of 100 layers in ECR-DC in the first campaign and 80 layers in GDC from the first day of ECH in the second campaign.

In order to improve and maintain the wall condition, discharge cleaning is effective under combination with main shots.

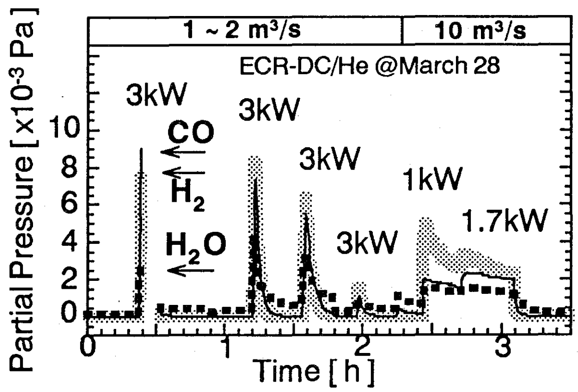

Fig.1 Gas desorption under the first ECR discharge cleaning in LHD.

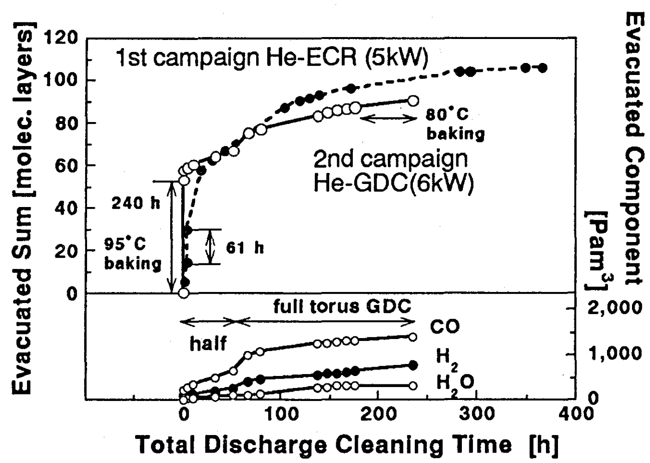

Fig.2 Gas evacuation under GDC in the second campaign in comparison to ECR in the first campaign of LHD.

Reference:

A.Sagara, M.Iima, S.Inagaki, N.Inoue, H.Suzuki, K.Tsuzuki, S.Masuzaki, et al., J. Plasma and Fusion Research, 75 (1999) 263.