§45. Hydrogen Glow Discharge Cleaning in LHD

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1. INTRODUCTION

During the second campaign, He glow discharge cleaning (G-DC) was conducted every night after plasma experiments; accordingly line averaged Z_{eff} of about 2 (for hydrogen discharges) and of about 2.5 (for helium discharges) were achieved.

Before the third campaign, actively cooled graphite divertor tiles were installed, and the total area of graphite surface became about 30 m^2. After about 6 months opening of the vessel, one month of mild baking and several hours He G-DC were applied, and NBI heating worked well at the very early stage in the third campaign. However, in the hydrogen-gas-puffing discharges, they were significantly contaminated by helium gas. This indicated that helium gas desorbed probably from divertor plates during the discharge, and due to its large recycling rate, helium gas became dominant after the termination of hydrogen-gas-puffing. To avoid hydrogen discharges contaminated by desorbed helium gas, Hydrogen(H_2) G-DC was conducted before hydrogen-puffing discharges.

2. HELIUM DESORPTION

Figure 1 shows the line averaged electron density, gas-puffing signal and the ratio of HeI (587.6 nm) /Hα in the line of sight seeing the peripheral region during a hydrogen discharge after the He G-DC. During gas-puffing, the ratio of HeI/Hα is 0.1-0.2, though after the termination of gas puffing, it increased rapidly up to 0.8. In the range of T_e in edge plasma region was less than 200 eV usually, and the line intensity of the HeI (587.6nm) is nearly one order smaller than that of Hα. That means helium atomic density was comparable to hydrogen atomic density even during gas-puffing, and was superior to hydrogen atomic density after the termination of gas-puffing.

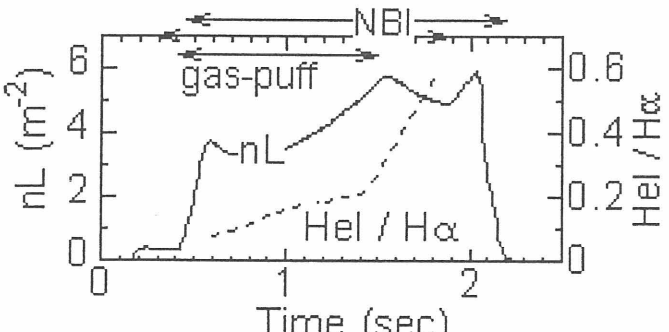

Fig. 1: Time evolutions of line integrated density and the ratio of the line intensities of HeI and Hα. (Shot# 8588)

3. HYDROGEN GLOW DISCHARGE CLEANING

In the H_2 G-DC, typical discharge voltage was about 400V (about 200V for the He G-DC), and the averaged current density at the wall was 26 mA/m^2 (36 mA/m^2 for He G-DC) with the assumption of total surface area (780 m^2). Accumulated helium were removed with the time constant of about 1 hour (fig. 2). The sputtering rates of iron for 400 eV H^+ is about one order lower than 200 eV He^+. Therefore, the iron sputtering is considered to be reduced during the H_2 G-DC comparing with the He G-DC. The partial pressures of impurities, such as the mass numbers, M = 15, 18, 28, 44, were measured by quadruple mass-spectrometer. The partial pressures of M = 15 and 28 after the H_2 G-DC were larger than that after the He G-DC, and the difference in the former was about one order of magnitude and a factor of about 5 for the later. Such differences of the partial pressures were not observed in M = 18 and 44. The partial pressure of M = 15 is considered to be the crack part of CH_4, and M = 28 is considered to represent the behavior of C_2H_4 rather than CO in this case (air leak can be neglected). The increase processes of these partial pressures are under consideration.

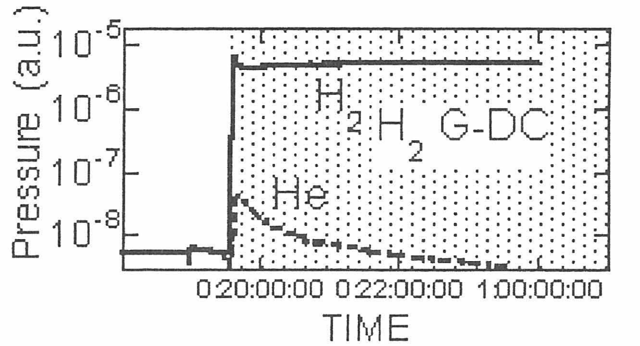

Fig.2: Time evolution of the partial pressure of helium during the H_2 G-DC.

4. EFFECTS OF THE H_2 G-DC ON MAIN DISCHARGES

Figure 3 shows the time evolutions during a hydrogen discharge after the H_2 G-DC. The HeI/Hα ratio was reduced dramatically compared with fig. 1 even after the termination of gas-puffing as expected.

Though the He contamination was reduced, carbon impurity was rather increased by the H_2 G-DC compared with those obtained by the He G-DC. The partial pressure of M = 15 (CH_4) between the main discharges after the H_2 G-DC kept the same level as the start up phase of the third campaign near the end of the third campaign. On the other hand, carbon oxides were reduced by the wall conditioning procedure. These results can be interpreted that oxygen were reduced well by the wall conditioning procedure, but for the graphite divertor plates and the implanted hydrogen during the H_2 G-DC desorbed with forming CH_4. This is a possibility. The line averaged Z_{eff} during the hydrogen-puffing discharges became larger than that in the second campaign, and it was typically 3. On the other hand, Z_{eff} during the helium-puffed discharge did not changed largely comparing with the second campaign. The relationship between the wall conditioning procedure and the impurity behavior is so important for the new wall conditioning program in the next campaign. The quantitative analysis is in progress.

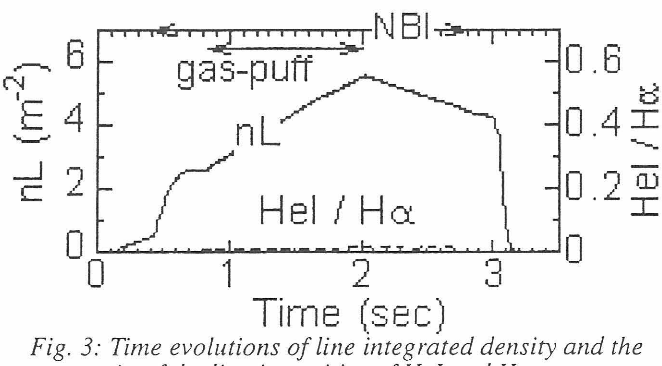

Fig. 3: Time evolutions of line integrated density and the ratio of the line intensities of HeI and Hα. (Shot# 9714, after H_2 G-DC)