§59. Estimation of the Discharge Cleaning Effects after Boronization Using Spectroscopic Approach

Kado, S. (High Temperature Plasma Center, Univ. of Tokyo), Ida, K.

Conditioning of plasma facing walls is of a key issue in controlling neutral sources in the plasma periphery as well as in minimizing impurity contamination into the core region. Baking procedure of the vacuum vessel and glow discharge cleaning(GDC) using hydrogen or helium working gas are the most commonly employed techniques. In addition to these, Boronization using di-borane(B_2H_6) gas mixed with helium working gas was started to be applied, in this fiscal year, to reduce low-Z impurity contents.

After boronization, inner wall of the vacuum vessel is covered by the B-H compound, which could result in the increase of the hydrogen release during the main discharges. Thus, He-GDC is necessary to "dry up" the hydrogen in the wall. On the other hand, too long period GDC could cause a side effect of increasing the high-Z impurities on the surface of the boron layers due to the physical sputtering by the He ions accelerated by the cathode sheath potential.

Therefore, the period of the He-GDC after the boronization needs to be minimized.

In this study, the relative hydrogen atom removal rate from the B-H compound were monitored by measuring the Balmer- α line(656.2nm) emission during the He-GDC. 50cm-Czerny-Turner spectrometer with Cooled CCD detector for Charge Exchange Spectroscopy system for LHD routine experiments was temporally used for the Balmer- α spectrum, which was much weaker than the bulk helium lines. The observation ports were at 10.5U,10.5L, 7.5U and 7.5L ports, where the numbers denoted the toroidal angle.

In the 5th cycle LHD experimental campaign period, held in this fiscal year, boronizations were carried out twice, on 12/Jan/2002 and 27/Jan/2002. After the former, the He-GDC was done about 60 hours. We have 2 GDC system in LHD. The discharge voltage and current for one were 171V and 9.7A, respectively, and for the other, 180V and 11 A, respectively. These conditions were stable during the He-GDC so that the emission intensity can be considered as being correlated to the hydrogen atom density.

The temporal evolution of the Balmer- α intensity during the He-GDC is shown in Fig. 1. Decrease in the intensity is rather rapid in the first few hours, and then slows down. Figure 1(a) is at the 10.5L and U ports where the GD anode electrode is inserted, while (b) is at the 7.5L and U ports where there is no electrode. This is the reason of the fact that the emission intensity in (a) is about one order of magnitude higher than that in (b).

In estimating the optimal He-GDC period, it is useful to compare to the case in routinely performed He-GDC after the main discharge experiments. Figure 2 shows the temporal evolution of the Balmer- α emission for the He-GDC in the end of the experiment. The 2nd boronization and the post-boronization He-GDC are performed in the previous day. The relative intensity shown as the pixel count of the CCD detector was about 350 count/s in the beginning of the GDC and started to decrease in 10 minutes. The reduction of the emission intensity is rather slow. Comparing Fig. 1 and 2, one can see that the hydrogen adsorbates on the wall reaches to the usual condition, 250-300 count/s emission at 10.5 ports, in about 3 hours of post-boronization He-GDC. Longer He-GDC acts as the usual He-GDC. It may take at lease a few days to "dry up" the hydrogen in the wall by He-GDC, as seen in Fig. 1, so that the sufficient effect cannot be expected even by the over-night He-GDC as done in the usual conditioning. On the contrary, it may only increase the sputtered impurities.

Thus, we suggest the post-boronization GDC should be ceased in about 3 hours and the He-GDC after the usual experiments is enough in about 30 minutes.

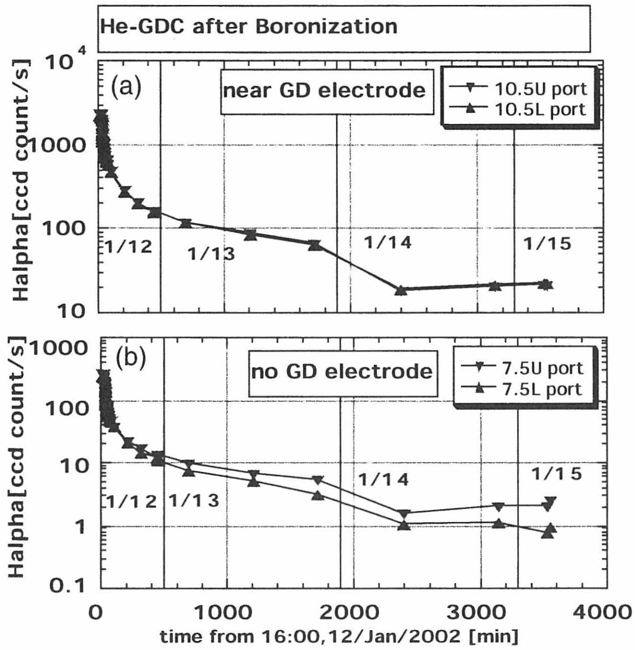

Fig. 1 Temporal evolution of the Balmer- α line intensity during the post-colonization He-GDC. (a) is for the ports near the GDC electrode while (b) for the port where there is no electrode.

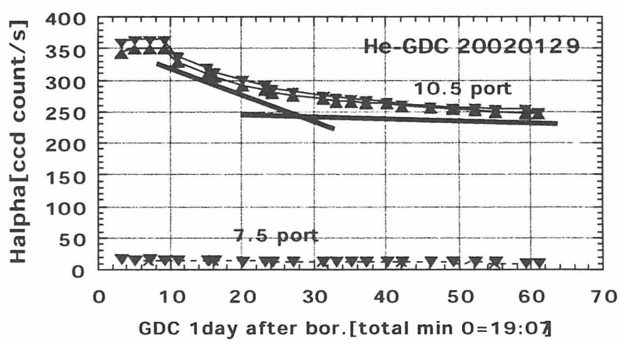

Fig. 2 Temporal evolution of the Balmer- α line intensity during the He-GDC after the usual experiment. Solid lines are drawn only for the rough estimate to determine the period.