§65. Estimation of the Discharge Cleaning Effects Using Spectroscopic Approach

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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.

Another usage of GDC for regular experiments in LHD is to replace recycling gasses in the main plasma discharges which have been adsorbed in the inner wall of the chamber. After experiments using the hydrogen gas, for example, if the main discharge in the next day is planned to use the helium gas, then the GDC using the helium is performed during the night. This kind of conditioning is essential especially in the ion cyclotron resonance heating (ICRH) experiments, because the minority gas fraction has a direct effect on the heating efficiency in the minority ion heating scenario.

For the moment, the GDC is monitored by the Residual Gas Analysis(RGA) using the quadrapole mass analyzer located in the pumping system. It would be made possible to measure temporal evolution of the emissions from atoms, molecules and radicals in the vacuum vessel when the spectroscopic approach is applied.

This fiscal year was the first year for this collaboration work, so that we have set up a simple spectroscopic system and have made some trials to measure GDC plasmas.

We used temporarily the 10 channels of fiber optics which were already located from the 10.5L and 7.5L ports of LHD to the diagnostic room for the charge exchange recombination spectroscopy(CXS) for the ion temperature and the radial electric field diagnostics. A 10 cm-monochrometer with photomultiplier tube(PMT) system was brought from our university. We obtained the spectra from 350nm to 750nm in about 2 minutes by scanning the wavelength at 200 nm/min.

Figure 1 shows the spectra for the He-GDC just before the end of the 4th experimental campaign period. The data were smoothed from about 120k points because the row spectrum was too noisy to detect spectral lines due to the discharge current ripples to avoid the transition to the arc discharge and due to the dark and photo- current noises in the PMT. Bright lines are of the He I emissions. No impurity line was detected in the present system even at the 10.5L port which is close to a GDC electrode.

Both hydrogen and helium were used in the main discharges of the day. Therefore the main objective of the GDC was to replace the adsorbed hydrogen with the helium. Only the Balmer-α line(656.2nm) was detected as a hydrogen line spectrum. This may originate from the hydrogen molecule adsorbate. As shown in Fig. 2, the decrease of the brightness of the Balmer-α line at the 10.5L viewing port, measured using a cooled CCD detector for CXS with 60 seconds exposure time, was only about 20-30% over 6 hours of the He-GDC. The conditions of the GDC, such as gas pressure, current and voltage, were stable so that it seemed that the replacement of the adsorbates from hydrogen to helium was not enough in the present condition for the overnight GDC. The Balmer-α line at the 7.5L port, far from the GDC electrode, was too weak to detect. This fact indicates that the effect of GDC has localized around the electrode.

Therefore, the quantitative estimates of this exchange effects are of the subject in the next fiscal year. The enhancement of the sensitivity to the photon flux by using, say, the photon-counting technique might be required for the study of the spatial dependence of the GDC or the GDC effects on the impurities.

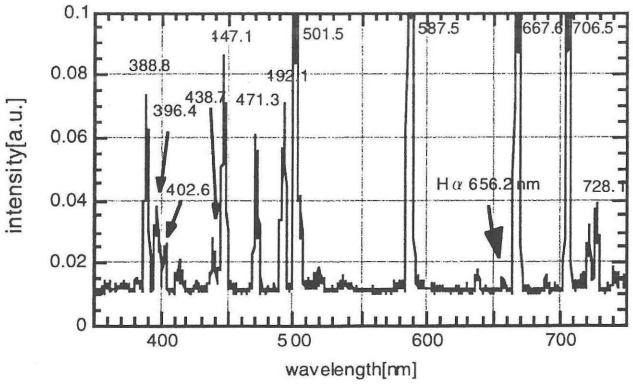

Fig. 1 Spectra for the He-GDC on 31/Jan/2001(10.5L port). The numbers are wavelengths of identified He I lines.

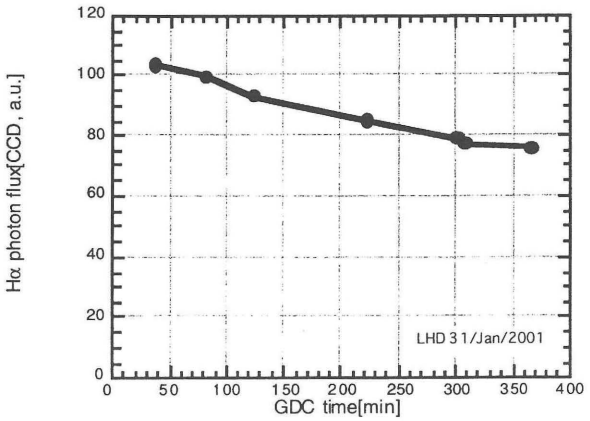

Fig. 2 Temporal evolution of the Hα intensity measured using a cooled CCD detector(10.5L port). Exposure time was set to be 60 seconds.