§27. Impact of Excited States of Reflected Hydrogen Atoms on Hydrogen Recycling

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The condition of hydrogen atoms reflected on the plasma facing material is one of important information for hydrogen recycling study. So far, it has been suggested that some of hydrogen atoms reflected on the material are electrically exited depending on the collision conditions such as energy of hydrogen atoms and a kind of material. However, there is less experimental data and analysis and electrically exited state of a reflected atom is not took into account in the boundary plasma modeling. It is important to investigate the mechanism of such phenomena to understand the hydrogen recycling. In this study, electrically excited state of reflected atoms has been discussed through results in GAMMA 10.

In GAMMA10, the plasma is produced with ion cyclotron range of frequency (ICRF) waves and confined by the magnetic mirror and the electrostatic potential produced by electron cyclotron heating (ECH), and the plasma is also heated by additional ICRF (RF3). Plasma particles flowing out to the end region hit the end plates and neutralized gas is pumped out with a large-scale cryo-pump system. In this experiment, a target plate with the diameter of 0.1 m was installed at 0.7 m downstream from the end-mirror coil. The target material was tungsten. The Hα emission profile near the target plate was measured using a high-sensitive CCD camera with an interference filter.

Figure 1 shows time evolution of electron line density at the west barrier cell. In this discharge, ECH was applied at the plug cells from t = 140 ms to 170 ms and the additional ICRF heating was applied at the anchor cell from t = 180 ms to 240 ms. The line density increased about twice due to RF3 and the density of the end loss plasma is expected to increase similar to the line density at the barrier cell. We compare profiles of the Hα intensity at the times indicated by ① and ② in Fig.1. The Hα intensity profile during ECH could not be measured due to that the Hα intensity was too weak, since end loss flux decreased by electrostatic potential produced by ECH. Figure 2 shows a CCD camera image of the Hα emission profile in front of the target plate at the time indicated by ② in Fig.1.

Figures 3(a) and 3(b) show the Hα intensity as a function of z (i.e. distance from the target) at the times indicated by ① and ② in Fig.1, respectively. It is found that there are two exponential components of the decay of the intensity. In the case of the normal ICRF heating (time of ①), a short decay length is ~9 mm and a long decay length ~75 mm. In the case of the additional ICRF (time of ①), a short decay length is ~11 mm and a long decay length ~82 mm. As seen in our previous experiments, both decay lengths are too short to be attributed to emission from reflected hydrogen neutrals and neutrals produced by dissociation via the molecular ion, if they are at electronic ground state. In addition, the decay lengths did not change so much even though the density of end loss plasma increased due to RF3. These results indicate the hydrogen atoms reflected on the target surface should be electrically excited.

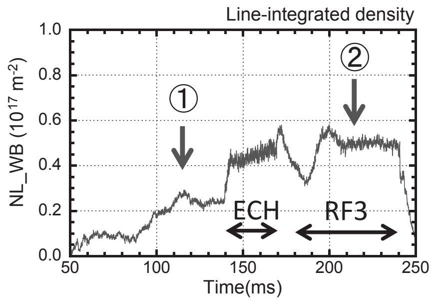

Fig.1 Time evolution of electron line density at the west barrier cell.

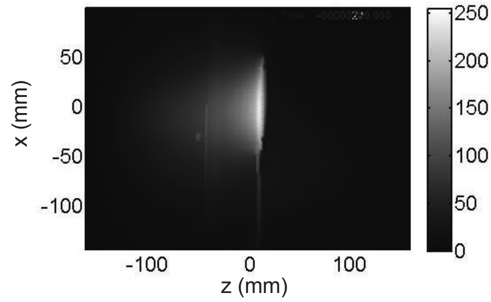

Fig.2 CCD camera image of the Hα emission profile in front of the target plate at the time indicated by ② in Fig.1.

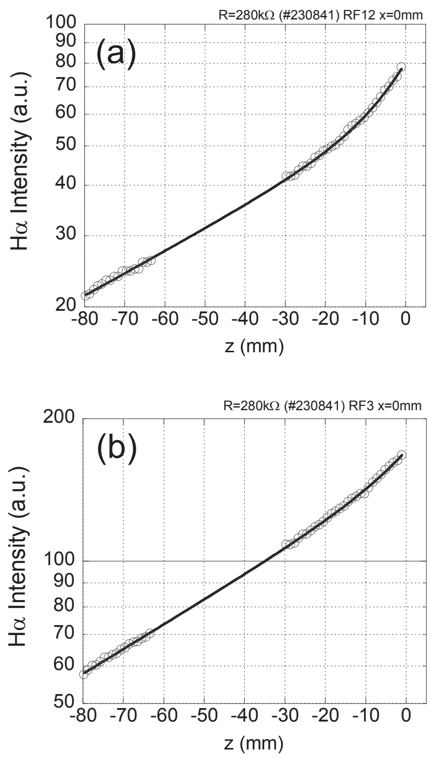

Fig.3 Profiles of the Hα intensity at the time indicated by (a) ① and (b) ② in Fig.1.