§31. Excited States of Hydrogen Atoms Reflected on a Tungsten Target

Sakamoto, M., Terakado, A., Nojiri, N., Ezumi, K., Nakashima, Y., Ichimura, M., Imai, T. (Univ. Tsukuba),
Kato, D., Sakaue, H.

Hydrogen recycling is one of the most important issues for stable steady state operation such as particle control. The condition of hydrogen atoms reflected on the plasma facing material is important information for hydrogen recycling study. So far, it has been indicated 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. 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 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. The plasma is produced with ion cyclotron range of frequency (ICRF) waves and confined by the magnetic mirror. Plasma particles flowing out to the end region hit the target plate as well as the end plates and neutralized gas is pumped out with a large-scale cryo-pump system. The ion temperature of the end-loss plasma is a few hundreds eV.

Figure 1 shows a typical CCD camera image of the Hα emission profile in front of the target plate. The position of z = 0 indicates the target surface. The Hα line intensity near the target becomes higher due to interaction between end-loss plasma and the target plate. Figure 2 shows the profile of the Hα line intensity along the central axis of the target. The solid line in Fig. 2 is drawn by fitting with two exponentials. The fitting curve agrees very well with the data. Decay lengths are ~7 mm and ~100 mm. Figure 3 shows short and long decay lengths as a function of the electron density. The short decay length is almost constant within 1 x 10^{16} m^{-3} to 2.5 x 10^{16} m^{-3}. On the other hand, the long decay length increases slightly with the density. This density dependence suggests that the Hα emission near the target is not attributed to electron impact excitation, since the decay length must be decreased with increase in the density if the population density is decided by the electron impact excitation. Besides, these two decay lengths are orders of magnitude shorter than the mean free path of the electron impact excitation. One of the most possible mechanism of the Hα emission near the target is that the hydrogen atoms reflected on the target surface are electrically excited due to interaction with the target.

Cascade spontaneous emission was calculated using a collisional-radiative model. Figure 4 shows time evolution of the population density of n=3, indicating that the population density of n=3 decreases with two time constant. It is consistent with the experimental results. It is considered that two exponential decay is attributed to a cascade spontaneous process.

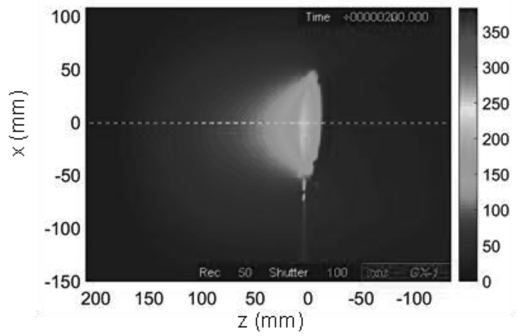

Fig.1 CCD camera image of the Hα emission profile in front of the target plate.

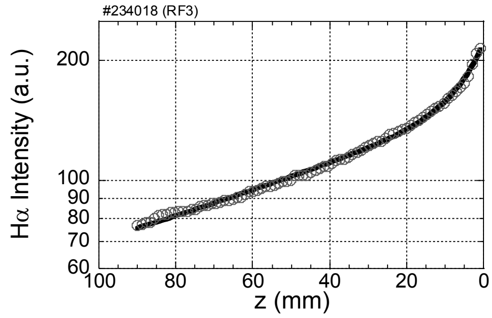

Fig. 2 Hα line intensity as a function of the distance from the target plate.

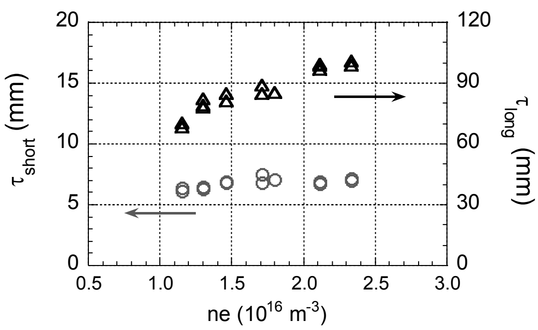

Fig. 3 Short and long decay lengths as a function of the electron density.

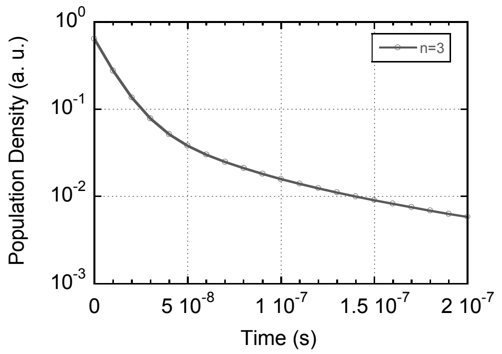

Fig. 4 Time evolution of the population density of n=3, which is calculated with collisional-radiative model.