§21. Study on Hydrogen Recycling in LHD

Sakamoto, M. (Univ. Tsukuba),
Kobayashi, M., Ozaki, T., Sakamoto, R., Masuzaki, S., Tokitani, M.

The hydrogen recycling is one of most important issues for the steady state operation in a future fusion device. In order to study hydrogen recycling properties in LHD, experiments of the hydrogen ice pellet injection into the plasmas, which were produced only by helium gas puff without hydrogen gas puff. The density range was ~0.6 x 10^{19} m^{-3} to ~6 x 10^{19} m^{-3}.

Figure 1(a) shows the time evolution of the line-averaged electron density. The injection time was ~4.25 s. It is found that the decay time of the density after the pellet injection (i.e. effective particle confinement time) became longer as the density became higher, indicating that the recycling coefficient became higher with the density. It should be noted that we cannot distinguish between hydrogen recycling and helium recycling from the change in the density decay. The ratio of hydrogen ion density to total ion density of hydrogen and helium is shown in Fig. 1(b), indicating that the hydrogen population was higher at the lower density. This means that the hydrogen desorption rate, which is a ratio of a hydrogen desorption flux from the wall to influx to the wall, is higher at the lower density. It depends on the discharge history. After the pellet injection, the hydrogen population recovered the original level at the high density discharge but it became lower than the original level at the low density discharge. The detailed analysis is the future work.

Figure 2 shows energy spectra of hydrogen neutral flux to the wall, which was measured at 0.08s after the pellet injection by a neutral particle analyzer (NPA). It should be noted that NPA does not have sensitivity for He.

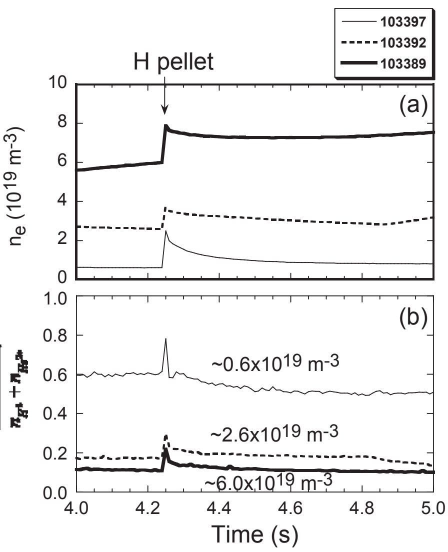

Fig.1 Time evolution of (a) line-averaged electron density and (b) ratio of hydrogen ion density to total ion density of hydrogen and helium in the pellet injection.

It is found that the neutral flux from the high density plasma is one order of magnitude lower than that from the low density plasma, suggesting that the charge-exchange (CX) neutrals that are produced in the core region by the pellet injection are shielded by the boundary plasma. Figure 3 shows the time evolution of hydrogen neutral flux with the energy of 0.8 keV in the pellet injection. In the case of the low density plasma (Fig. 3(a)), the CX flux increased rapidly just after the pellet injection. The rapid increase seems to be caused by the charge exchange between the residual hydrogen ions in He plasma and the ablated hydrogen neutrals. The CX flux decreased after the pellet injection due to increase in the boundary plasma density (i.e. shielding). The CX flux recovered after several tens ms due to redistribution of electron density (i.e. the decrease of the local density) and then it decreased again. In the case of high density plasma, on the other hand, there was no change in the CX flux by the pellet injection as shown in Fig. 3(b) and (c). From these results, high energy CX neutrals seem not to contribute to the hydrogen recycling.

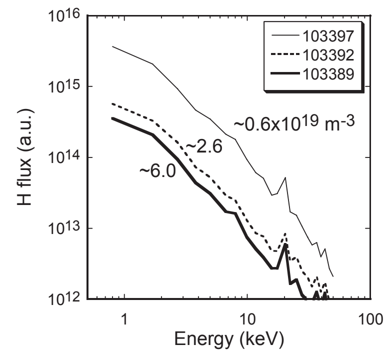

Fig. 2 Energy spectra of hydrogen neutral flux just after the pellet injection.

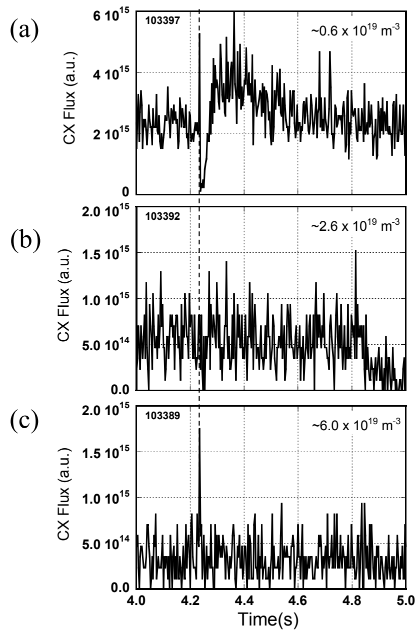

Fig. 3 Time evolution of hydrogen neutral flux with the energy of 0.8 keV in the pellet injection.