§12. Spectroscopy of Recombining Plasma in the Decay Phase of LHD

Yamaguchi, N. (Graduate School Medicine and Pharmaceutical Sciences, Univ. Toyama), Morita, S., Goto, M., Oishi, T., Arimoto, H. (Nagoya Univ.)

Because the magnetic field configuration in LHD is maintained after the input power for plasma production and heating is terminated, the after glow plasma could last for a while after the end of plasma sequence. During such decay phase, the electron temperature decreases quickly maintaining enough plasma density, then the after glow plasma would go into the recombining phase and emission spectra would represent purely recombining properties.¹⁾ It has been found that the resonance series lines of hydrogen-like He ions, He II, in the EUV spectral range can be observed for several tens of ms after the termination of heating power.

Figure 1 shows spectra of He II resonance series, 1snp lines, where n is the principal quantum number, observed in the 10 sec steady discharge operation. In Fig. 1(a) or 1(b) it is shown the spectrum at just, t=9.84 s, or 60 ms after, t=9.90 s, the termination of heating power. Corrections have been made for the relative intensity distribution using the calibration factor of the spectrometer²⁾ and for background subtraction in Fig. 1. It is clearly seen that the intensities of 1s-5p, 1s-6p and 1s-7p transitions lines are higher than that of 1s-4p line in Fig. 1 (b).



Fig. 1 Spectra of resonance series lines of He II, 1s-*n*p transitions. (shot#116668)



Fig. 2 Population density distribution of He II excited states.

Populations of the levels n=2 to n=10 divided by statistical weight, the population densities, are plotted in Fig. 2, where each population density has been deduced from the observed line intensity and the averaged transition probability. These results indicate that the population inversion occurs in He II energy levels during the decay phase of LHD discharge.

It is well known that recombination processes can develop population inversion.³⁾ Calculations on the population distribution of He II by the CORLAD $code^{4}$ have reproduced the population inversion in low temperature, Te<3 eV, recombining plasma.

- 1) Goto M., Morita S., et al. : Phys. Plasmas 10 (2003) 1402.
- Dong C., Morita S., Goto M., and Zhou H. : Rev. Sci. Instrum. 82 (2011) 113102.
- Gudzenko L. I. and Shelepin L. A. : Sov. Phys. JETP 18 (1964) 998.
- 4) Ljepojevic N. N., Hutcheon R. J. and Payne J. : Comput. Phys. Commun. 44 (1987) 157.