## §14. Spectroscopy of Recombining Plasma in the Decay Phase of LHD

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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, then the after glow plasma would go into the recombining phase and emission spectra would represent purely recombining properties.<sup>1)</sup> We have surveyed a large amount of spectroscopic data in LHD experimental shots obtained by using the grazing incident SX-EUV spectrograph with a flat-field output surface.<sup>2)</sup> It has been found that the EUV spectra from hydrogen-like He ions (He II) can be observed for a few tens of ms after the termination of heating power. Figure 1 shows a spectrophotographic image detected by a CCD, which displays temporal variation of emission spectra around the time of power shutdown, where the steady-state discharge has been operated for 10 s. A clear change in spectral emission characteristics can be seen after the power shutdown, where resonance series lines of He II and the recombination continuum are observed for about 60 ms in the decay plasma.

The intensity distribution of He II at the time 20 ms after the power shutdown is shown in Fig. 2. The intensities of 1s-5p and 1s-6p transitions lines are higher than that of 1s-4p line. This indicates that the population inversion takes place in the higher energy levels of He II ion during decay phase of LHD plasma.

- 1) Goto M., Morita S., et al.: Phys. Plasmaa 10 (2003) 1402.
- Dong C., Morita S., Goto M., and Zhou H.,: Rev. Sci. Instrum. 81 (2010) 033107.



Fig. 1. Time evolution of EUV spectral image in the wavelength range from 22 to 26 nm just before and after shutdown the heating power in an LHD shot (#116668). The time axis goes upward from bottom.



Fig. 2. Spectra of recombining He II ions at 20 ms after the input power shutdown. Spectral intensity distribution of the resonance series lines for the upper state shows that population inversion takes place in the after glow plasma.