§12. Studies on Behaviors of Low Z Impurities Using Line Intensity Ratios in EUV Region

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In this study, we have observed extreme ultraviolet (EUV) emission spectra from relatively low Z impurities with atomic number less than 10 to investigate their behaviors in LHD plasmas. The observed impurities are boron, carbon, nitrogen, oxygen, and neon originated from wall conditioning, vacuum break, and gas seeding experiments. Spectral lines of 1s–2p transition of He-like ions are specifically observed by a 2 m Schwob-Fraenkel grazing incidence spectrometer[1] because of the advantages described below.

The lines of this transition are composed of pairs of resonance and intercombination lines which appear very closely with slight wavelength separation. Therefore, the line intensity ratios between the resonance and intercombination lines could be accurately derived from the measurement without any calibration of spectral sensitivity of the spectrometer. In general, these line intensity ratios are available for the determination of electron temperature because they have large temperature dependence. Also, reliable collisional-radiative models can be constructed because electronic configurations of low Z ions are relatively simple. The temporal evolutions of the line intensity ratios are measured with a frame rate of about 100 ms. Comparing with electron temperature profiles measured by a Thomson scattering diagnostic, we can infer the position of the emission and contribution of the recombining plasma component, which can result in understanding of the emission mechanism in radiation collapse or plasma detachment.

In the beginning of an experimental campaign, boron and oxygen lines are expected to appear because of boronization and vacuum break. Therefore, we have attempted the observations of Li-like spectral lines of these impurities in discharges just after the start of the 17th experimental campaign. An example of an EUV spectrum in 4–7 nm region observed on the first day of the campaign is shown in Fig. 1. Resonance and intercombination lines of 1s–2p transitions of He-like B IV were clearly observed at 6.031 and 6.106 nm, respectively. The lines of He-like C V are also found simultaneously at 4.027 and 4.073 nm, and it is clearly found in Fig. 1 that the line intensity ratio tends to be different between boron and carbon. The detailed analyses of experimental data are planned in the future comparing with theoretical calculations using collisional-radiative models. On the other hand, the similar lines of He-like O VII at 2.160 and 2.180 nm were not clearly observed probably due to good wall conditioning before the experimental campaign.

1) Schwob, J. L., Wouters, A. W. and Suckewer, S.: Rev. Sci. Instrum. **58** (1987) 1601.

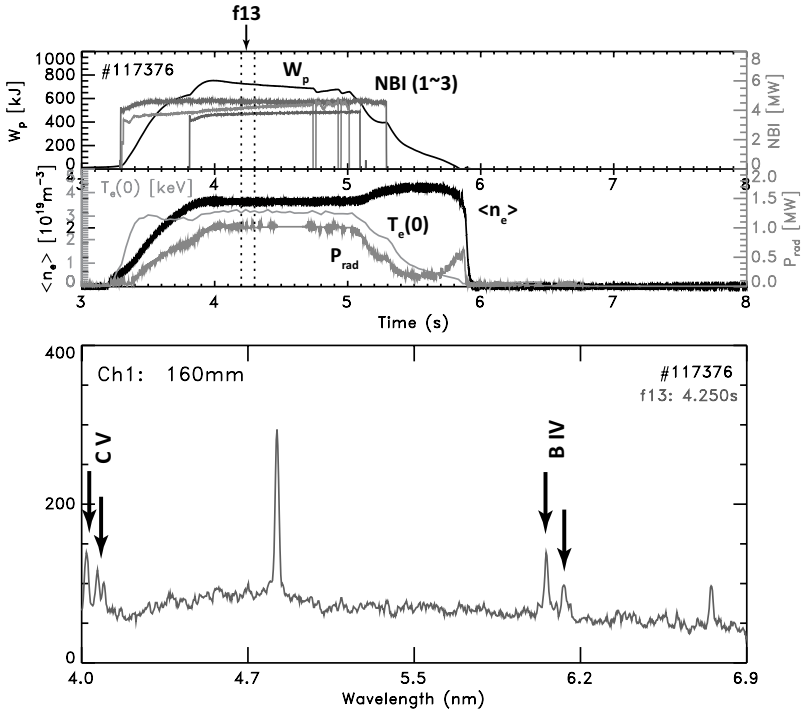

Fig. 1: Waveforms of parameters and EUV spectrum from He-like boron and carbon ions observed in a discharge on the date when the 17th experimental campaign started.