§6. Spectroscopic Analysis of Highly Charged Tungsten Ions in LHD with Help of CoBIT

Sakaue, H.A., Morita, S., Kato, D., Murakami, I.,
Yamamoto, N. (Chubu Univ.),
Nakamura, N. (Univ. of Electro-Commu.)

Tungsten is planned to use as material for the divertor plates in ITER because of the high sputtering threshold energy for light ion bombardment, the highest melting point among all the elements, and less tritium retention compared with carbon-based materials. Since in ITER extremely high particle- and heat-fluxes are predicted based on the intermittent edge plasma transport, *e.g.,* edge-localized-mode, it causes a serious damage to such components. Tungsten is therefore considered to be one of the most abundant impurities in the ITER plasma. Emission lines of highly charged tungsten ions thus play an important role in the spectroscopic diagnostics of the ITER plasma, and consequently the spectroscopic data of tungsten ions have been studied at several facilities [1-3]. An electron beam ion trap is a useful device for the systematic spectroscopic studies of highly charged tungsten ions. We have constructed a compact electron beam ion trap, called CoBIT [4-6], and observed extreme ultraviolet (EUV) spectra of highly charged tungsten ions (W XX ~ W XXXIV) in the wavelength range of 15~45 Å. The observed lines have been identified as the 6g-4f, 5f-4d, 5p-4d and 5g-4f transitions of W^{20-35+}.

Spectra from tungsten injected with an impurity pellet have been observed in LHD. Emission lines from the various highly charged tungsten ions are included in the observed spectra and it is necessary to identify the charge state of tungsten ion. We have already succeeded in the identification of the emission line from highly charged tungsten ions of W^{20+} to W^{35+} through the experiment using CoBIT. From the comparison of those experimental data, observed lines from LHD have been identified. Figure 1 shows the electron energy dependence of EUV spectra after impurity tungsten pellet injection. The electron temperature of the plasma increases sequentially from the bottom spectrum. The emission lines from highly charged tungsten ions, of which the charge states are of W^{21+} to W^{40+}, were identified. As the temperature increases, the emission lines shifts to higher charge state of tungsten. In the low temperature plasma, the 6g-4f and 5g-4f transitions are dominant, while in the high temperature plasma the 5f-4d and 5p-4d transitions become dominant. In plasmas with higher temperature, it is then possible to observe the transition lines of the 5d-4p.

We now plan to measure the electron energy dependence of the tungsten EUV spectra systematically.

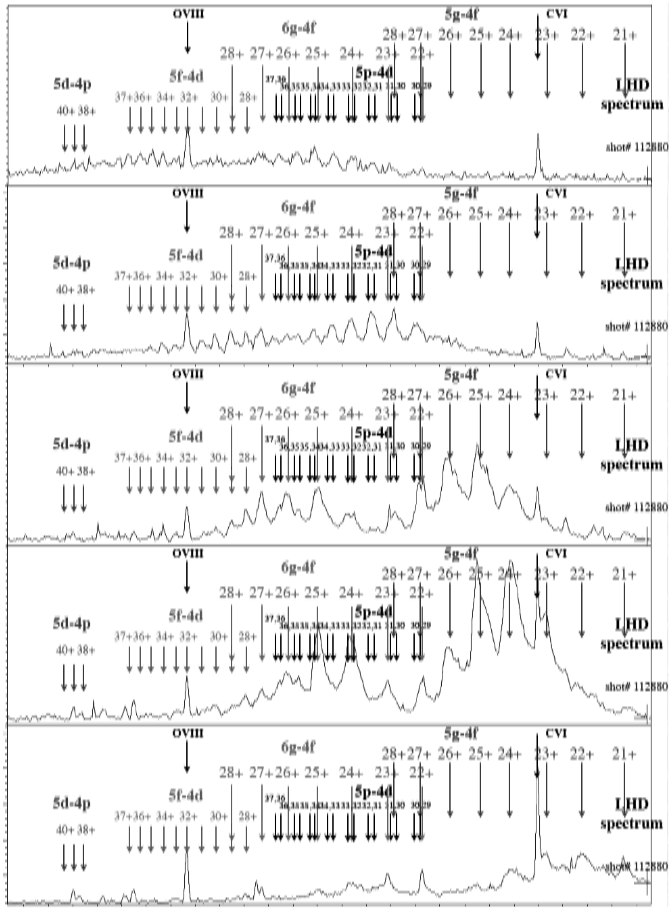

Figure 1 Electron energy dependence of EUV spectra after impurity tungsten pellet injection in LHD. The electron temperature increases sequentially from the bottom spectrum.

1) Pütterich, T. *et al.* : *J. Phys.* B **38** (2005) 3071
2) Chowdhuri, M. B. *et al.*: *PFR* **2** (2007) S1060
3) Clementson, J. *et al.*: *J. Phys.* B **43** (2010) 144009
4) Nakamura, N. *et al.*: *Rev. Sci. Instrum.* **79** (2008) 063104
5) Sakaue, H. A. *et al.*: J. Phys.:Conf. Ser. **163** (2009) 012020
6) Sakaue, H. A. *et al.*: *AIP Conf. Proc.* (2012) 143891