

§3. Spectroscopy of Highly Charged Tungsten Ions Using Electron Beam Ion Traps

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Tungsten is a major candidate for the divertor material of ITER, so that its spectroscopic data over wide range of charge state are strongly needed to diagnose and control the high temperature plasma in ITER. An electron beam ion trap (EBIT) is a powerful device for accumulating such atomic data. At The University of Electro-Communications, we have two EBITs; one of them is a high-energy EBIT, called the Tokyo-EBIT,¹⁾ and another is a low-energy EBIT, called CoBIT.²⁾ The complementary use of these two EBITs allows us to study ions over a wide range of charge state. In particular, we are currently interested in the visible and EUV region because a lot of effort has already been paid for the shorter wavelength range such as VUV and X-rays at other EBIT facilities.

In the last fiscal year, a previously unreported line of W^{26+} has been observed in the visible range.³⁾ In this fiscal year, the observation has been extended to wider wavelength range and wider charge state range. Figure 1 shows typical spectra observed for 370 to 470 nm with electron energies of 630 to 825 eV. All the lines indicated by the arrows are previously unreported M1 transitions in highly charged tungsten ions. From the appearance energy, the charge state of tungsten responsible for the line emission is assigned as indicated in the figure. For example, the lines indicated by the arrows in the 825 eV spectrum was identified as W^{26+} because they were not observed with electron energies lower than the ionization energy of W^{25+} (786 eV). Theoretical calculation is under progress to make detailed identification of the observed transitions, including the initial and final states.

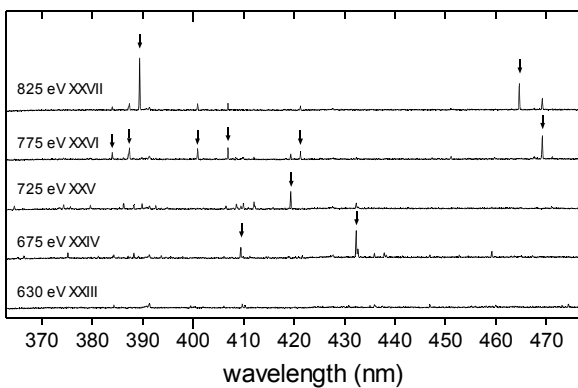


Fig.1. Typical visible spectra obtained with CoBIT.

Figure 2 shows typical EUV spectra of highly charged tungsten ions observed with CoBIT. As shown in the figure, lines from higher charge states were observed as the electron energy increased. We also performed calculation based on the radiative-collisional model. Through the comparison with the calculated spectra, the lines observed in the present spectra were identified as the 5f-3d, 5g-4f, and 6g-4f transitions in W XXIV~XXXI ions. These lines have been previously observed with LHD.⁴⁾ However, the LHD spectra showed much broader band-like structure, reflecting the broader charge state distribution. It was thus impossible to identify the lines from the LHD spectra. In contrast, EBIT spectra are very useful for identifying previously unreported lines as shown in the present measurements.

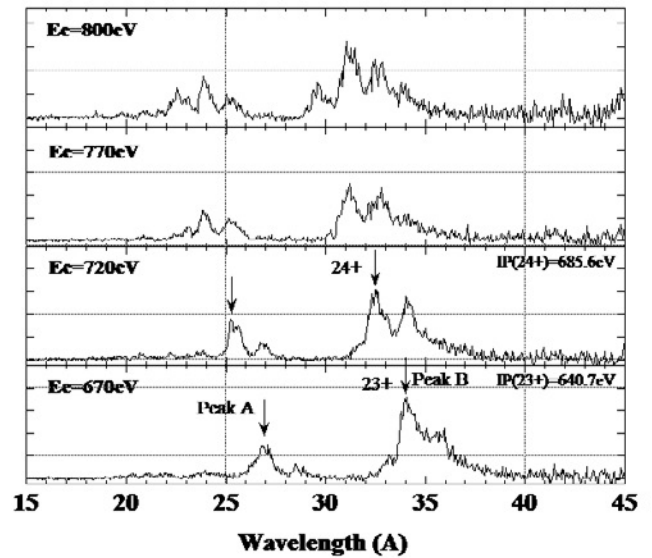


Fig.2. Typical EUV spectra obtained with CoBIT.

- 1) N. Nakamura et al.: Rev. Sci. Instrum. 69 (1998) 694.
- 2) N. Nakamura et al.: Rev. Sci. Instrum. 79 (2008) 063104.
- 3) A. Komatsu et al.: Phys. Scr. T144 (2011) 014012.
- 4) M.B. Chowdhuri et al.: PFR 2 (2007) S1060.

Publication list:

- 1) X. B. Ding et al., Journal of Physics B 44, 145004
- 2) H. Ohashi et al., Rev. Sci. Instrum. 82, 083103
- 3) H. A. Sakaue et al., Proceedings of APiP2011, in press
- 4) X. B. Ding et al., Journal of Physics B 45, 035003
- 5) I. Murakami et al., AIP Conf. Proc. 1344, 96-106
- 6) A. Komatsu et al., Phys. Scr. Volume T144, 014012
- 7) H. Watanabe et al., Canadian J. Phys. 90, 497-501.