§12. EUV Spectra of Xe Ions Measured from LHD for Study of High Z Ion Emission

Kato, T., Kato, D., Sato, K., Funaba, H., Suzuki, C., Yamamoto, N. (Nagoya Univ.),
Nishimura, H., Nishihara, K. (Osaka Univ.),
O'Sullivan, G. (Dublin City Univ., Ireland)

High Z materials such as Mo and W are expected to be used for fusion reactor. It is required to study the emission mechanism for high Z elements. EUV emission is studied extensively also for light sources for lithography. We measured EUV emission from Xe ions from LHD by Xe gas puffing for study of emission from high Z ions. EUV spectra from Xenon ions in LHD have been measured in the wavelength range 10 – 17 nm. Line identification is more difficult than C and Fe ions. We used the spectra before Xe gas puffing for wavelength calibration. We used mainly the lines from Fe ions for wavelength calibration.

We identify the lines of Xe ions in the spectra during the heating using the measurement by Berlin EBIT [1]. Spectral lines during the heating are identified from ions with outer 4s or 4p electrons (Xe^{23+} ($4s^2 4p$) - Xe^{25+} (4s)) in 12 – 16 nm as shown in Fig.1. In Fig.1, the numbers 1, 3, 5, 7, 8, 11, 13, 14 indicate the lines of Xe^{23+} ($4s^2 4p$), Xe^{24+} ($4s^2$), Xe^{23+}, Xe^{24+}, Xe^{25+} (4s), Xe^{23+}, Xe^{23+} and Xe^{24+}, respectively. These lines are 4p – 4d transitions for the lines of 3, 7 and 8 whereas 4s – 4p transitions for the lines of 11, 13 and 14. Spectral lines during the heating are identified with 4p - 4d and 4s – 4p transitions of Xe^{17+} (4d) - Xe^{25+} (4s) ions in 10 - 12nm as shown in Fig.2. The emission 4p – 4d transitions of Xe $^{17+}$ ions in 10 – 12 nm is much stronger than those in 12 – 16nm. Therefore these emission is not measured in the longer wavelength range, 12 – 16nm during the heating. However emission Xe $^{17+}$ ions is measured during radiation collapse as shown in Fig.3 in 12 – 16 nm. Spectra during radiation collapse are identified with Xe^{8+} ($4d^{10}$) to Xe^{17+} (4d) (open 4d shell). The spectra during radiation collapse are very complicated and difficult to identify. However we could identify most of the lines as shown in Fig. 3. When we compare the charge exchange spectroscopy by Tanuma [2], the spectra during the radiation collapse looks like those from Xe^{17+} and Xe $^{16+}$. However it is difficult to identify these lines because these lines have not been studied yet. We made theoretical calculation using Cowan's code for Xe^{17+} ions. We are making a new identification for measured Xe^{17+} 4p – 4d transition lines with theoretical data by Cowan and Grant codes.

We can make a bench mark test of computer codes using the observed spectral lines. This is important because the theory has not been extensively tested for high- Z low charge ions. We will study plasma conditions which give the best EUV emission and will make a collisional radiative model for high-Z many-electron ions. We calculated the dielectronic recombination rate of Xe^{10+} ions[3] because they are necessary for our model..

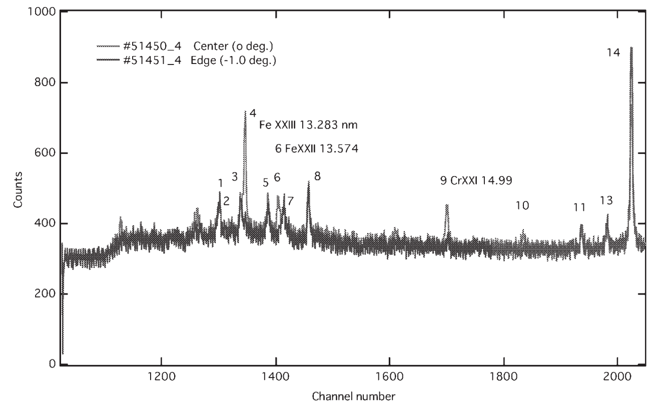

Fig.1 Spectral lines during the heating are identified from ions with outer 4s or 4p electrons (Xe^{23+}($4s^2 4p$) - Xe^{25+}(4s)) in 12 - 16nm.

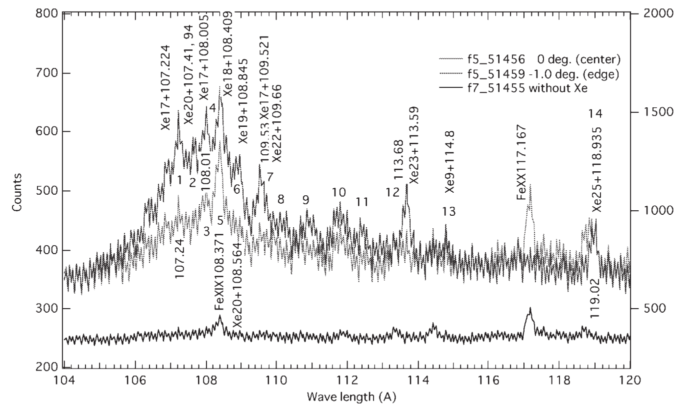

Fig.2 Spectral lines during the heating are identified with 4p - 4d transitions of Xe^{17+} (4d) - Xe^{25+}(4s) ions in 10 - 12nm

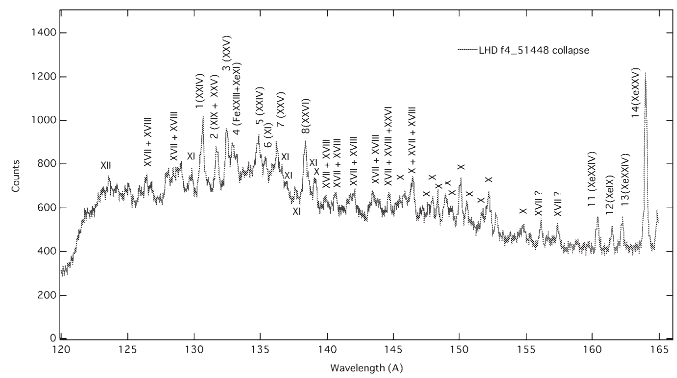

Fig.3 Spectral lines during radiation collapse are identified with Xe^{8+} ($4d^{10}$) to Xe^{17+}(4d) (open 4d shell)

1) R. Radtke,C. Biedemann et al, PEARL conference(2005)
2) H. Tanuma, private communication (2004)
3) M-Y. Song and T. Kato, NIFS-DATA-94 (2005)