§16. Measurement of Emission Intensity Profiles with Impurity Gas Puffing Using a 3 m Normal Incidence VUV Spectrometer in LHD

Oishi, T., Morita, S., Huang, X.L., Zhang, H.M., Goto, M.

Quantitative evaluation for the total amount of impurity radiation requires measurements of spatial profile of line emission intensity of the impurity ions. Especially, development of diagnostics for edge impurity emission profiles contributes evaluation of radiation for the discharges in which impurity ions play significant roles in the edge plasmas such as impurity-seeded detachment discharges. Therefore, we conducted a vacuum ultraviolet (VUV) spectroscopy diagnostics for plasmas with impurity gas puffing to measure spectra of emissions released from edge plasmas in Large Helical Device (LHD)

Figure 1 shows an observation range of the VUV spectroscopy on a poloidal cross section of the magnetic field with a magnetic axis R_{ax} = 3.6 m and the toroidal magnetic field B_t = 2.75 T. A space-resolved 3 m normal incidence spectrometer was installed on a horizontal diagnostic port (#10-O) to measure VUV emissions in wavelength range of 300-3200 Å.[1] The optical axis was arranged perpendicular to the toroidal magnetic field at holizontally-elongated plasma cross section. The observation range is expanded vertically to cover the full vertical profile of the emission from plasmas.

Figure 2 shows the vertical profiles of emission intensity for (a) NeVII (465.22 Å) and NeVIII (770.41 Å) line spectra for discharges with Ne gas puffing and (b) ArVII (585.73 Å) and ArVIII (700.245 Å) line spectra for discharges with Ar gas puffing. The electron density was maintained to 4 × 10^{13} cm^{-3} in a flat-top phase for 4 s. The horizontal axis, Z (mm), is the vertical position of observation chords at R = 3600 mm as indicated in Fig.1. The emission intensity profile has a peak structure outside the last closed flux surface (Z < -460mm, Z > 460 mm) because these ion species indicated in Fig. 2 locates in the ergodic layer. On the other hand, large intensity peaks were observed at Z = 180 mm for NeVIII, and Z = -80 mm and -360 mm for Ar VII. The main emission source for them is the edge plasma close to divertor X-point. However, the reason of a large vertical asymmetry has not been clarified. Now we are comparing the data to 2-dimentional EUV spectroscopy to clarify spatial structures and absolute intensities of the impurity emissions.[2]

Figure 3 shows relationship between positions of intensity peaks in the ergodic layer and ionization potentials, E_i, for ArVII, ArVIII, NeVII, and NeVIII line spectra. The positions of intensity peaks located both upper half (left axis) and lower half (right axis) are plotted. It is a reasonable observation that the ions are located at different vertical positions depending on E_i, i.e., ArVII: E_i = 124.4 eV, ArVIII: E_i = 143.5 eV, NeVII: E_i = 207.3 eV, and NeVIII: E_i = 239.1 eV.

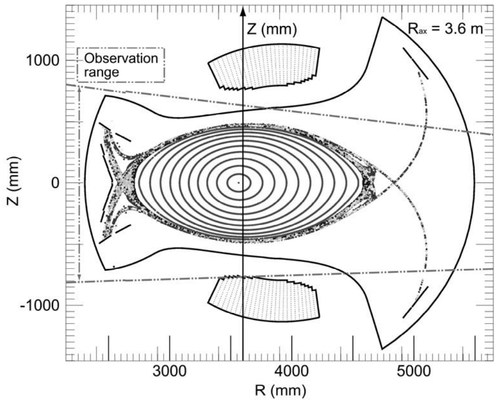

Fig. 1. Observation range of the VUV spectroscopy for the full profile measurement.

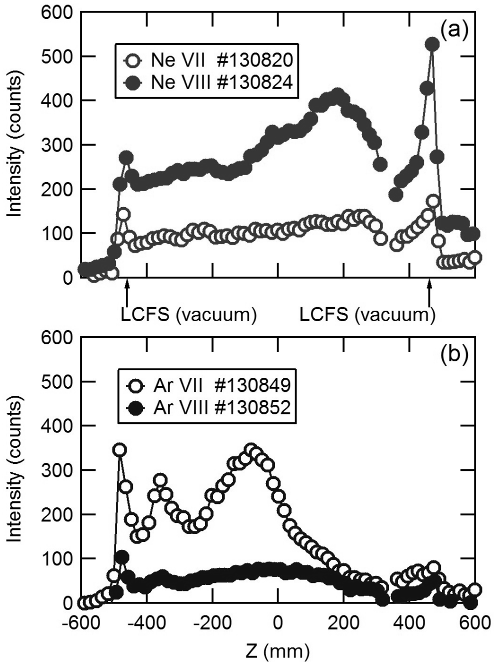

Fig. 2. Vertical intensity profiles of (a) NeVII, NeVIII, (b) ArVII, and ArVIII line spectra.

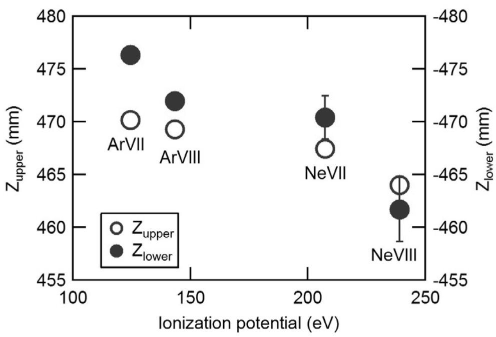

Fig. 3. Relationship between positions of intensity peaks in the ergodic layer and ionization potentials for ArVII, ArVIII, NeVII, and NeVIII line spectra.

1) Oishi, T. et al.: Applied Optics **53** (2014) 6900.
2) Zhang, H.M. et al.: Japanese Journal of Applied physics **54** (2015) *in press*.