§8. Observation of Asymmetric Radial Profile of WVI Located in Edge Plasmas of LHD

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

Tungsten is regarded as a leading candidate material for the plasma facing components in ITER and future fusion reactors. However, Tungsten ions in lower ionization stages have not been measured sufficiently even though it is necessary for accurate evaluation of tungsten influx and comprehensive understanding of the tungsten impurity transport. Therefore, we conducted a vacuum ultraviolet (VUV) spectroscopy diagnostics to measure spectra of emissions released from lowly ionized tungsten ions in Large Helical Device (LHD). Tungsten ions were introduced in the LHD plasmas by injecting a graphite or polyethylene pellet containing a small piece of tungsten metal. A 3 m normal incidence VUV spectrometer with a high dispersion of 0.037 Å/CCD-pixel was utilized to measure detailed spectral shapes and vertical profiles of impurity lines in the wavelength range of 300-3200 Å[1)].

Figure 1 shows VUV spectra in the wavelength range between 635 to 670 Å measured using the 3 m normal incidence VUV spectrometer in the time frame just after the tungsten pellet injection in hydrogen discharge in LHD. A bright WVI line with 5d-6p transitions located at the wavelength of 639.683 Å has been successfully observed. It had large intensity and was isolated from other intrinsic impurity lines. Other two WVI 5d-6p transitions of 605.926 Å and 677.722 Å, and the second and third order emissions of these three lines were also observed[2)].

Figure 2(a) shows a typical temporal evolution of the central electron density, $n_e(0)$, and temperature, $T_e(0)$. The plasma was initiated by the electron cyclotron heating, and three neutral hydrogen beams based on negative ion sources with total port-through power of 8 MW were injected. At the pellet injection, $n_e(0)$ increases and $T_e(0)$ decreases. Figure 2(b) shows a temporal evolution of the second order of WVI 639.683 Å line measured using a 20 cm normal incident VUV spectrometer[3)]. A large emission was observed at the same time of the pellet injection, which is an emission from the pellet ablation cloud. Figure 2(c) shows a vertical profiles of WVI 639.683 Å line measured using a 3 m VUV spectrometer in time frame just after the pellet injection. It is regarded that the profile consists of the WVI emissions from a pellet ablation cloud located at the vertical center of the plasma and that from a plasma confinement region. The profile of the emission from the plasma confinement region has a vertical asymmetry that the signal intensity in the lower half is larger than that in the upper half. This asymmetry having a peak close to the lower edge pf the plasma is more obvious in the time frame 100-200 ms after the pellet injection as shown in Fig. 2(d). Mechanisms forming the asymmetrical profile of WVI line and similarity with asymmetrical W profiles in tokamaks should be investigated in future studies.

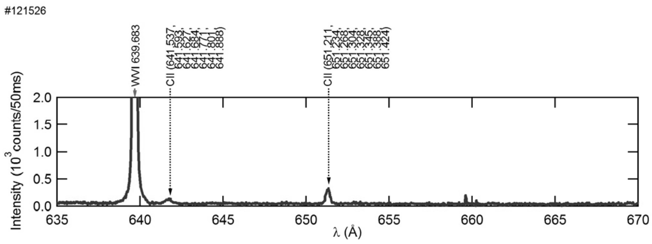

Fig. 1. VUV spectra in the wavelength range between 635 to 670 Å measured using the 3 m normal incidence VUV spectrometer in the time frame just after the tungsten pellet injection.

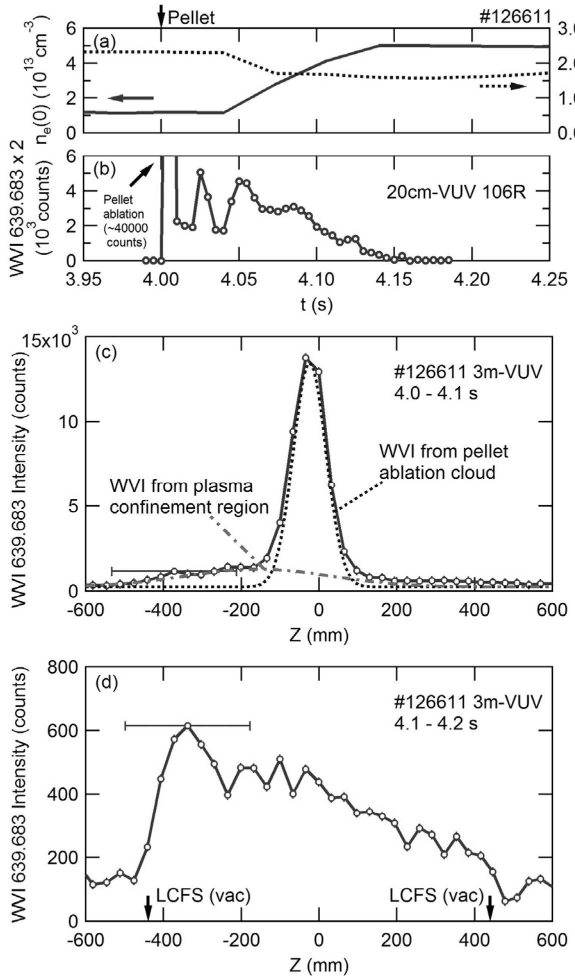

Fig. 2. Temporal evolutions of (a) central electron density and temperature with tungsten pellet injection and (b) intensity of WVI 639.683 × 2 Å line measured using a 20 cm VUV spectrometer. Vertical profiles of WVI 639.683 Å line measured using a 3 m VUV spectrometer in time frames (c) just after the pellet injection and (d) 100-200 ms after the pellet injection.

1) Oishi, T. et al.: Applied Optics **53** (2014) 6900.
2) Oishi, T. et al.: Review of Scientific Instruments **85** (2014) 11E415.
3) Oishi, T. et al.: Plasma and Fusion Research **10** (2015) 3402031.