B-I28 AAPPS-DPP2019

3rd Asia-Pacific Conference on Plasma Physics, 4-8,11.2019, Hefei, China

Estimation of tungsten influx rate and study of edge tungsten behavior based on the observation of EUV line emissions from W^{6+} ions in HL-2A

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Tungsten is designated as a desirable material for the ITER divertor plate since the tungsten has several favorable properties of high melting point, low chemical erosion and physical sputtering rates and low tritium retention. Study of the tungsten is highly motivated in several fields of fusion research, e.g. physical properties, plasma wall interaction and impurity transport. In ITER, the edge tungsten transport is extremely important to control the tungsten influx. It is of course important to evaluate the tungsten influx. Since the electron temperature in the ITER divertor region ranges in 25-100eV, ionization stages of W^{2+} to W^{9+} ions are dominant in such a low-temperature region. However, the tungsten influx has never been evaluated before in fusion research because of the absence of tungsten spectra from such low-ionized tungsten ions. Then, tungsten spectra from low-ionized tungsten ions are intensively investigated in HL-2A using an extreme ultraviolet (EUV) spectrometer in wavelength range of 25-500Å. Tungsten is introduced into HL-2A plasmas using a laser blow-off (LBO) system with a newly developed tungsten target. A quasi-continuum called unresolved transition array (UTA) is clearly observed as a typical tungsten spectrum in three different wavelength ranges of 25-42Å, 47-70Å and 140-280Å. In addition, two isolated line emissions from W^{6+} ions, i.e. WVII (5p-5d: 216.219Å) and WVII (5p-5d: 261.387Å), are observed with strong intensity for the first time in tokamak plasmas, while several weak WVIII transitions are also observed around 200Å, as shown in Fig. 1. The intensity ratio and the wavelengths of the two lines determined in the present experiment show good agreement with the intensity ratio calculated with a collisional-radiative model developed for the W6+ ion and a previous result by Sugar and Kaufman (1975 *Phys. Rev.* A **12** 994), respectively. On the other hand, the WVII line emission occasionally reappears in the discharge after the LBO injection, suggesting a re-entry of the tungsten deposited onto divertor plates. Analysis of the discharge suggests an enhanced sputtering at the divertor plate where the tungsten from LBO is deposited. Based on the W VII emission observed during the re-entry event of tungsten ions, an influx of the W^{6+} ion Γ_{W6+}, to the edge plasma is evaluated using the inverse photon efficiency calculated with the ADAS code using an average-configuration option. As a result, it is found that Γ_{W6+} is typically within the range $(0.1\text{-}2.0)\times10^{13}$ $cm^{-2}s^{-1}$.

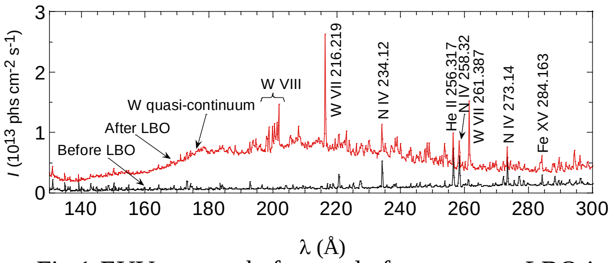

Fig.1 EUV spectra before and after tungsten LBO in wavelength range of 120-300Å.

References

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