Application of atomic data to quantitative analysis of tungsten spectra on EAST tokamak

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ITER has adopted tungsten as the divertor material for the D-T operation. In order to improve the divertor heat load capability, the tungsten mono-block has been equipped on upper divertor of EAST tokamak at 2014 [1]. The tungsten accumulation has been often observed in NBI-heated H-mode discharges suggesting a sufficient improvement of tungsten confinement [2], which is one of the critical issues to achieve long pulse H-mode discharges. Then, a quantitative analysis on tungsten behaviors is urgently desired for maintaining the high-performance plasma of EAST.

In order to study the tungsten behavior in long pulse discharges, tungsten spectra have been measured at 20-140Å with a newly installed extreme ultraviolet (EUV) spectrometer fulfilled a fast time response charge-coupled detector (CCD) of 5ms/frame [3]. It is found that emission lines from highly ionized W ions of W^{40+} to W^{45+} can be easily observed with strong intensities in longer wavelength range of 120-140 Å when the central electron temperature exceeds 2.5keV. Unresolved transition array (UTA) is always observed at 45-70 Å.

In this work, several isolated lines from W^{40+} – W^{45+} in the longer wavelength range are used for the quantitative evaluation based on the absolute intensity measurement, i.e., W^{40+} ($3d^{10}4s^24p^4\ ^3P_2$ – $3d^{10}4s^24p^4\ ^3P_1$) at 134.87Å, W^{42+} ($3d^{10}4s^24p^2\ ^3P_0$ – $3d^{10}4s^24p^2\ ^1D_2$) at 129.41Å), W^{43+} ($3d^{10}4s^24p\ ^2P_{1/2}$ – $3d^{10}4s^24p\ ^2P_{3/2}$) at 126.29 Å and W^{45+} ($3d^{10}4s\ ^2S_{1/2}$ – $3\ d^{10}4p\ ^2P_{1/2}$) at 126.998Å. In the analysis the photon emissivity coefficient (PEC) of tungsten lines and fractional abundance (FA) of tungsten ions under ionization equilibrium are utilized as the atomic data. In practice, the effective ionization and recombination coefficients from Atomic Data and Analysis Structure (ADAS) database are used in a set of rate equations to calculate the FA in EAST plasmas with measured electron temperature and electron density profiles. An effect of the impurity transport is also considered. Meanwhile, the PEC is directly obtained from ADAS database (arf40_ic series). The tungsten concentration is evaluated from tungsten radiation power coefficient calculated with ADAS database based on the total radiation loss measurement. The results obtained with these approaches are compared with each other.

Acknowledgments
This work was supported by the National Magnetic Confinement Fusion Science Program of China (Grant Nos.2014GB124006, 2013GB105003,2015GB101000), National Natural Science Foundation of China (Grant Nos. 11575244, 11275231, 11305207), and was partly supported by the JSPS-NRF-NSFC A3 Foresight Program in the field of Plasma Physics (NSFC: No. 11261140328, NRF : No. 2012K2A2A6000443)

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