Progress of tungsten spectral modeling for ITER edge plasma diagnostics based on tungsten spectroscopy in LHD

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Strong radiative cooling by tungsten ions in the core plasma is one of issues in fusion reactors. Quantitative analysis of tungsten density in divertor plasma, scrape-off layer, and main plasma relies on accuracy of spectroscopic model of tungsten ions. We have developed a collisional-radiative (CR) model for tungsten ions to calculate line intensities of tungsten ions [1]. We also have measured tungsten spectra in wide wavelength region from extreme ultraviolet (EUV) to visible wavelengths simultaneously in the Large Helical Device (LHD) with tungsten pellet injection [1-5] and in the compact electron beam ion trap (CoBIT) [6] to validate the CR model for tungsten ions. We measured spectra from W^{3+} to W^{44+} ions in LHD plasmas. EUV spectral lines of W^{6+} measured in HL-2A were used to estimate influx from divertor to main plasma by applying the CR model calculation [7]. Radial intensity profiles of W^{44+} [2], W^{24+}, W^{25+} and W^{26+} ions [4] measured by spatial resolved EUV spectrometer gave the ion density profiles also by applying the CR model. Radial profiles of visible M1 line intensities of W^{26+} and W^{27+} ions were measured [5] and tungsten transport in LHD plasmas is examined from the time variation of the profiles. So-called unresolved transition array (UTA) measured in EUV spectra at 4.5-7nm are commonly seen in fusion plasmas with electron temperature of around 1 keV, which corresponds to edge temperature in ITER. The UTA is strong and largely contributes to the radiation power at this temperature. This feature is produced with numerous lines from W^{25+} - W^{34+} ions [1], but two-wide-peak spectral profile has not been reproduced yet, especially for 6nm-peak, by the CR model. We have developed the CR model to include recombination processes which were not considered before for tungsten ions. We find spectra of W^{25+} - W^{34+} ions due to recombination processes from the ground state are not strong enough to reproduce the 6nm-peak of the UTA. One of possibilities to explain the shortfall is radiation due to recombination of excited tungsten ions with free electron. We will discuss such effects by implementing the processes in our CR model in order to compare the measured and synthesized spectra.

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