Extreme ultraviolet spectra of multiply charged tungsten ions

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Synopsis We present extreme ultraviolet spectra of multiply charged tungsten ions observed with an electron beam ion trap. The observed spectra are compared with theoretical spectra obtained with a collisional radiative model.

Tungsten is the main plasma-facing material in the future experimental fusion reactor ITER, and thus is considered to be the main impurity ions in the ITER plasma. In order to suppress the radiation loss caused by the emission from the impurity tungsten ions, it is important to understand the influx and the charge evolution of tungsten ions in the plasma through spectroscopic diagnostics. There is thus a strong demand for spectroscopic data of tungsten ions. In particular, it has been recently pointed out that the diagnostics and control of the edge plasma are extremely important for the steady state operation of high-temperature plasmas. Thus the atomic data of relatively low charged tungsten ions are of growing significance to the ITER plasma diagnostics [1]. In this study, we present extreme ultraviolet (EUV) spectra of multiply charged tungsten ions observed with an electron beam ion trap, and comparisons with collisional radiative (CR) model calculations.

Multiply charged tungsten ions were produced with a compact electron beam ion trap (EBIT) [2]. Tungsten was introduced into the trap through a gas injector as a vapor of $W(CO)_6$. Emission in the EUV range was observed with a grazing-incidence flat-field spectrometer [3] consisting of a 1200 g/mm concave grating (Hitachi 001-0660) and a Peltier-cooled back-illuminated CCD (Roper PIXIS-XO: 400B).

Figure 1 shows a typical example of the observed spectra. The electron energies shown in the figure are simply determined from the potential difference $V_{\rm dif}$ between the cathode (electron gun) and the middle electrode of the ion trap as $eV_{\rm dif}$. Thus it should be noted that the actual electron energy (interaction energy between the beam electron and the trapped ions) can be different from the $eV_{\rm dif}$ value due to several reasons, such as the space charge of the electron beam and the trapped ions. Based on the electron energy dependence and the comparison with the previous observation with the Livermore EBIT [1], the observed lines have been assigned to W^{6+} to W^{8+} as shown in the figure.

We have made CR model calculations [5] for analyzing the observed spectra. Atomic data used in the model were mainly calculated with the HULLAC atomic code [4]. Comparisons between the experimental and model spectra will be given at the conference.

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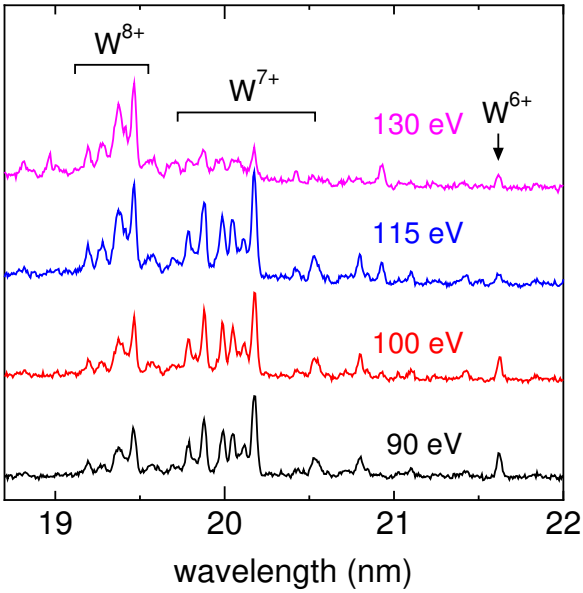

Figure 1. EUV spectra of tungsten ions observed with a compact EBIT at electron energies of 90 to 130 eV.

References

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