Identification of EUV spectral lines of highly charged tungsten from Zr-like W^{34+} to Se-like W^{40+} ions observed with an EBIT at NIST*

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In recent years, tungsten has drawn much attention in plasma physics because of its high melting point and low erosion characteristic. It is being planned for use as a plasma facing material in the divertor region of the fusion reactor ITER. Because of its large number of orbital electrons, there are many different possible tungsten ions present in the plasma as an impurity. So, spectra observed from the plasma will contain many strong lines coming from these different tungsten ions. The identification of such spectral lines and their intensity ratios can be used to diagnose the different plasma parameters. The intermediate charge states of tungsten i.e. Zr-like W^{34+}- Se-like W^{40+} are among the most prominent ions in the plasma and they radiate spectra in the EUV range. Thus, they play an important role in the radiative losses of the plasma. Utter et al. [1] used the Livermore EBIT to record spectra of Rb-like W^{37+} to Cu-like W^{45+} at beam energies of 1.79 keV to 3.02 keV and in the wavelength region 4.0 nm-8.5 nm. Wavelength and line intensity ratios were calculated using simulated spectra based on the wavelength predictions of Fournier [2].

In the present work, we observed emission spectra from 2.7 nm to the longer wavelength side i.e. upto 17.3 nm for these Zr-like W^{34+} - Se-like W^{40+} ions produced in the EBIT at NIST [3]. Beam energies varied between 1.65 keV and 2.00 keV. The spectral line intensities were determined by performing simulations with the non-Maxwellian CR code NOMAD [4]. The identified strong lines represent electric dipole n = 4-4 transitions in these ions. The radiative and collisional data used in NOMAD were calculated with the FAC [5] code in which the relativistic Dirac equation with a model potential and relativistic distorted-wave approximation for collisional processes are implemented. Good quantitative agreement was found for the wavelengths as well as intensities between the modelled and experimental spectra. 18 new lines were identified among the total 40 lines observed. Our measurements not only added new spectral lines in the region 4 nm-8.5 nm to those reported by Utter et al. [1] but also predicted new lines in the longer wavelength region.

References

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