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High resolution x-ray spectroscopy of Tungsten and Molybdenum for fusion diagnostic

Y. Yang[1], J. Rzadkiewicz[2], K. Kozioł[2], M. G. O'Mullane[3], A. Patel[4], J. Xiao[1], K. Yao[1], Y. Shen[1], D. Lu[1], R. Hutton[1], Y. Zou[1], and JET Contributors

[1] Shanghai EBIT laboratory, Fudan university(CN) [2] National Centre for Nuclear Research (NCBJ)(PL) [3] Department of Physics, University of Strathclyde(UK) [4] Euratom/CCFE Fusion Association(UK)

yangyang@fudan.edu.cn

Tungsten will be a strong candidate of the material for ITER divertor. All Spectroscopies related to tungsten were then become highlight fields. Meanwhile Molybdenum is an impurity that are not be neglected in many Tokamak plasma, and thus be used for diagnostic widely.

The x-ray transitions from W45+,46+ ions and Mo32+ in the 5.19–5.26Å wavelength range that are relevant as a high-temperature tokamak diagnostic, in particular for JET in the ITER-like wall configuration, have been studied in this work with an electron beam ion trap.

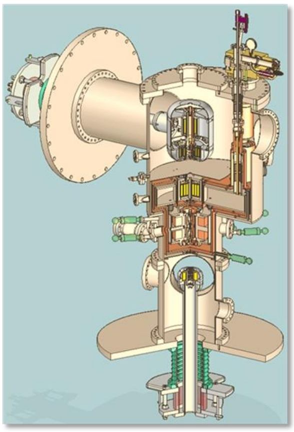

Figure 1: The profile of Shanghai Electron Beam Ion Trap, where the measurements were performed.

Tungsten spectra were measured at the upgraded Shanghai Electron Beam Ion Trap operated with electron-beam energies from 3.16 to 4.55 keV. High-resolution measurements were performed by means of a flat Si 111 crystal spectrometer[1] quipped by a CCD camera. The experimental wavelengths were determined with an accuracy of 0.3–0.4 mÅ[2]. All measured wavelengths were compared with those measured from JET ITER-like wall plasmas and with other experiments[3,4] and various theoretical predictions including COWAN, RELAC, multi-configurational Dirac-Fock (MCDF), and FAC calculations. To obtain a higher accuracy from theoretical predictions, the MCDF calculations were extended by taking into account correlation effects (configuration-interaction approach). It was found that such an extension brings the calculations closer to the experimental values in comparison with other calculations. And Mo32+ spectra in the same region were studied after that. With these very accurate wavelength data, contradiction between theoretical result and measured values was resolved related to impurity transportation speed in the fusion plasma.

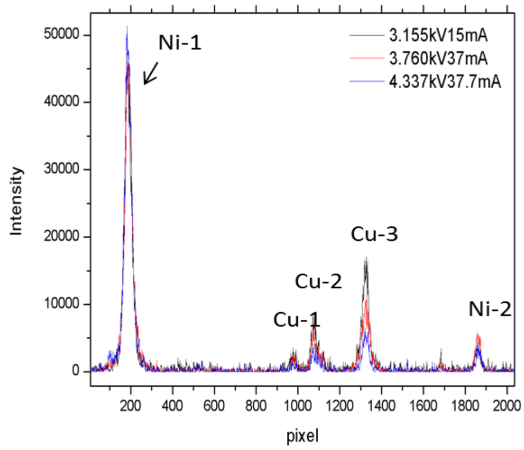

Figure 2: Part results of the measurements. All the spectral peaks are from highly charged tungsten ions, which are Ni-like ions and Cu-like ions as indicated. They are measured at different electron beam energies and beam currents, as marked at the top right respectively.

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