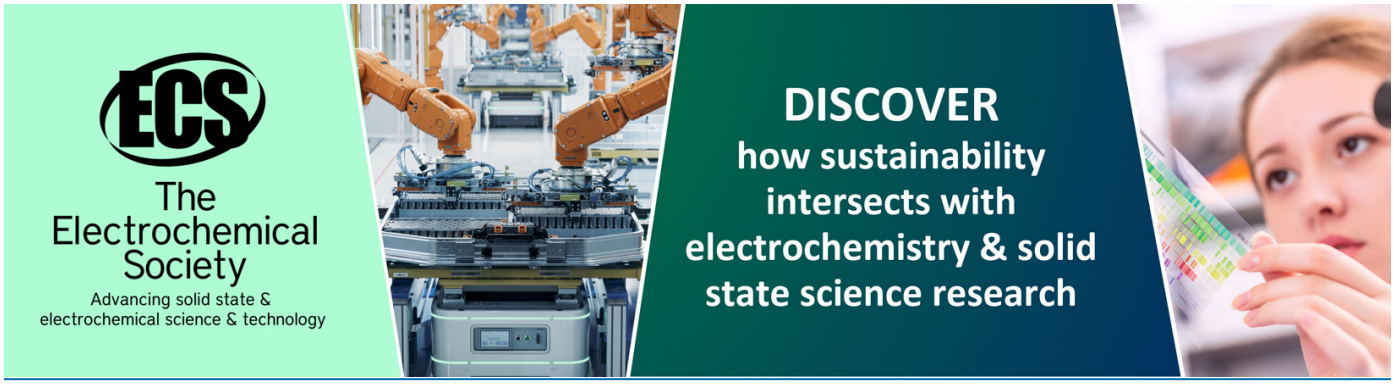
Observation of indirect ionization of W^{7+} in EBIT plasma



Observation of indirect ionization of W^{7+} in EBIT plasma

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Synopsis In this work, visible and EUV spectra of W^{7+} have been measured using the high-temperature superconducting electron-beam ion trap at the Shanghai EBIT laboratory under extremely low-energy conditions. The relevant atomic structure has been calculated by using the flexible atomic code package and the GRASP2K code. A hypothesis for the charge-state evolution of W^{7+} is proposed based on our results. The occurrence of W^{7+} ions results from indirect ionization caused by stepwise excitation between some metastable states of lower-charge-state W ions, at the nominal electron beam energy of 59 eV.

Based on the previous study by Mita *et al.*[1], the spectra of W^{7+} are measured in the visible and EUV range at SH-HtscEBIT[2] under extremely low electron beam energy conditions. The 574.49(3) nm M1 line of W^{7+} is observed at the nominal electron beam energy of 59 eV which is below the ionization energy of W^{5+}. The multi-configuration Dirac-Hartree-Fock calculation further confirms the identification of this line. A hypothesis of charge-state evolution from W^{5+} to W^{7+} is proposed, based on our theoretical studies on the energy levels of these charge states, in order to explain the appearance of W^{7+} spectra. Indirect ionization via cascade excitations from the long-lived metastable states of lower charge W ions play a key role in occurrence of W^{7+}. In addition, the EUV spectra at 75 eV as well as the FAC calculations also prove that W^{7+} can be and is created via indirect ionization out of W^{5+}.

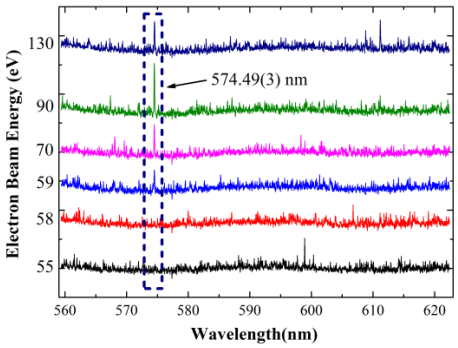

Figure 1. Spectra of tungsten obtained by SH-HtscEBIT at the nominal electron beam energy of 55, 58, 59, 70, 90 and 130 eV in the range of 559-623 nm. The accumulation time of each spectrum is 2 hours. The line at 574.49(3) nm is the M1 transition between the fine structure splitting in the $4f^{13}5s^{2}5p^{6}\ ^{2}F$ ground term of W^{7+}.

References

[1] Mita M *et al* 2017 *Atoms* **5** 13
[2] Xiao J *et al* 2013 *Proceedings of IPAC2013* MOPFI066

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