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To cite this article: S Pakalka *et al* 2020 *J. Phys.: Conf. Ser.* **1412** 152039

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Inner-shell ionization of W^{25+}

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Synopsis Inner-shell ionization by electron impact is investigated for the W^{25+} ion. Decay of inner-shell vacancy through Auger transitions is analyzed. Contribution of direct ionization process to double and triple ionization is presented.

Inner-shell ionization by electron impact can lead to cascade of radiative and Auger transitions. Direct ionization of the valence shells is stronger compared to the ionization from the inner shells. On the other hand, the inner-shell ionization can be important for ionization balance in plasma. What is more, excitation with multiple autoionization can also contribute to higher ionization stages.

The aim of the current work is to analyze electron-impact ionization from the inner shells of tungsten ions with the open $4f$ shell in the ground configuration and to estimate contribution of inner-shell ionization to multiple ionization.

Energy levels and ionization cross sections are studied using Flexible Atomic Code (FAC) [1] which implements the Dirac-Fock-Slater approach. Electron-impact ionization cross sections are obtained in the distorted wave approximation.

Theoretical single ionization threshold for the W^{25+} ion is 782 eV and the double ionization threshold is equal to 1612 eV. Direct ionization from the $4s$, $4p$, $4d$, and $4f$ shells of the ground $4s^2 4p^6 4d^{10} 4f^3$ configuration leads to single ionization since the energies of the corresponding configurations are below the double ionization threshold. On the other hand, ionization from the deeper shells is the source of multiple ionization.

Electron-impact direct ionization cross sections from shells of the W^{25+} ion are presented

in Fig. 1. It can be seen that contribution from the deeper shells that can contribute to multiple ionization reaches $\sim 10\%$. Energy levels of the $W^{26+} 3d^9 4f^3$ configuration are above the triple ionization threshold. Current data show that decay of this configuration ends in W^{27+} . The configuration with the largest probabilities decays to $4d^8 4f^3$ (46%), $4p^5 4d^9 4f^3$ (26%), and $4d^9 4f^2$ (12%). On the other hand, influence of correlation effects for these configurations can lead to triple ionization of W^{25+} . It was demonstrated that correlation effects are important in triple ionization of Se^{3+} [2]. What is more, decay of the $W^{25+} 3p^5 4f^8$ configuration leads to double and triple ionization.

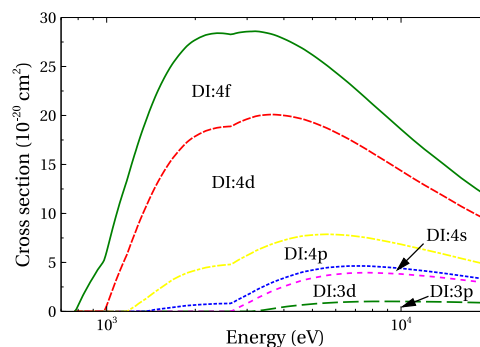


Figure 1. Direct ionization cross sections for the shells of W^{25+} .

References

- [1] Gu M F 2008 *Can J Phys* **86** 675
- [2] Koncevičiūtė J *et al* 2018 *Phys. Rev. A* **97** 012705

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