Dielectronic Recombination of Tungsten Ions

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Synopsis *Ab-initio* calculations of dielectronic recombination rate coefficients of Ne-, Pd-, Rh- and Ag-like tungsten have been performed. The present calculated rate coefficients are compared with other calculations where available. A large discrepancy was found for Pd-like W, which implies that more *ab initio* calculations and experimental measurements are badly needed. The data obtained are expected to be useful for modelling plasmas for fusion applications, especially for the ITER community.

The DR process plays an important role in high-temperature plasmas, where it affects both the ionization balance and radiative energy losses. Tungsten is being considered as a plasma-facing component (PFC) in magnetically confined fusion devices, such as ITER, because of its low sputtering rate, high temperature characteristics and low tritium absorption, so atomic data for tungsten has become of major importance [1, 2]. A significant number of publications on computational DR rate coefficients of have appeared for tungsten during the past decade. DR rate coefficients from the atomic data and analysis structure (ADAS) databases are currently the most widely used to model various fusion plasmas in the nuclear fusion community. The computations of such DR rate coefficients are based on the semiempirical Burgess-Merts formulas and the generalized collisional-radiative framework. The accurancy of such rates is another problem.

We carried out a detailed calculation on dielectronic recombination rate coefficients of Rh- [3], Ne-, Pd- and Ag-like W [4]. As an example, only status of Pd-like W (W^{28+}) is summarized in Fig. 1. For W^{28+}, which has a ground level $[Kr]4d^{10}$, The doubly excited configurations $4d^9 4fnl$ $(4d-4f)$, $4d^9 5l'nl$ $(4d-5l')$ and $4d^9 6l'nl$ $(4d-6l')$ as well as $4p^5 4d^{10} 4fnl$ $(4p-4f)$ and $4p^5 4d^{10} 5l'nl$ $(4p-5l')$ were included in the calculations. Energy levels, radiative transition probabilities and autoionization rates were calculated up to $n \leq 18$ and $l \leq 6$, and the contributions from higher-n levels were extrapolated up to $n = 1000$. Calculated radiative recombination (RR) rate coefficients obtained by Trzhaskovskaya *et al.* [5] are also presented for comparison. There is thus no doubt that the DR process can have a greater influence than RR on plasma balance. An *ab-initio* calculation by Safronova *et al.* [6] using the Cowan code is also available, but the total rate coefficient predicted from this calculation is about ten times smaller than that of by Foster [7], Pütterich *et al.* [8] and the FLYCHK [9] code, as well as present FAC calculation at energies over 500 eV. This is most likely due to omission of significant resonances [4]. Considering the current status of these discrepancies, further studies, especially experimental measurements of DR cross-sections are urgently needed.

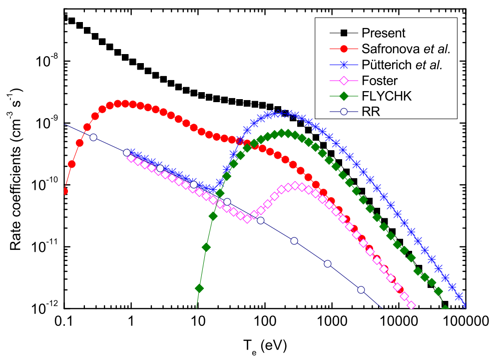

Figure 1. Total DR rate coefficients as a function of Te in Pd-like W.

References

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