Fully Stripped Beryllium-Ion Collisions with Atomic Hydrogen Initially in an Excited State

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The ITER and JET projects use beryllium-containing materials in plasma facing wall components. Due to the high temperature environments, the erosion of the wall followed by ionisation of Be is inevitable. Therefore, collisions between resulting Be ions with atomic hydrogen can take place when a neutral beam of hydrogen atoms is injected into the plasma for heating and diagnostic purposes. However, due to the toxicity of Be, there are no experimental measurements of cross sections for such collisions. This makes theoretical calculations of beryllium ion collisions with hydrogen [1, 2] the only source of data for plasma modelling. We studied collisions between bare beryllium ions and ground state atomic hydrogen in our previous work [3]. This was done using the wave-packet convergent close-coupling (WP-CCC) approach which solves the three-body Schrödinger equation by employing a two-centre expansion for the total scattering wave function. This work is now extended to Be^{4+} ion scattering on hydrogen in its lowest excited states within the projectile-energy domain between 1 keV/u and 500 keV/u [4]. Specifically, this includes collisions with the hydrogen target initially in the 2s, $2p_0$ and $2p_1$ states. Integrated total and state-selective electron-capture cross sections are calculated. The results suggest that at low energies, collisions with hydrogen in each considered excited state produce a total electron-capture cross section approximately an order of magnitude larger than for scattering on the ground state. However, as projectile energy increases, the cross section for capture from the excited states falls well below the H(1s) electron capture cross section. A possible reason for this observation could be related with the way the target electron radial densities are distributed in different initial states. The results obtained in this work are compared to previous calculations where available. In terms of the n-resolved charge-exchange cross sections, where n is the principal quantum number of the formed Be^{3+} ion in the final state, significant disagreement is found between our results and some previous calculations available in the literature.

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