3 - 23 K-shell X-ray Production Cross Sections of Silicon Induced by Ne^{7+} Ions Near Bohr Velocity

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The inner-shell ionization induced by the ion-solid collisions has been extensively studied in the last decades. In these studies, tabulations and more recent reviews of the status for light ions impacting show that the direct ionization is the main mechanism responsible for K-shell vacancy production of projectile ions and target atom[1,2], and most of the available experimental data, spanning a large range of relative velocities and target atomic numbers, are accurately described in a consistent way by ECPSSR theory. However, it is paid less attention to K production by heavy ion near Bohr velocity.

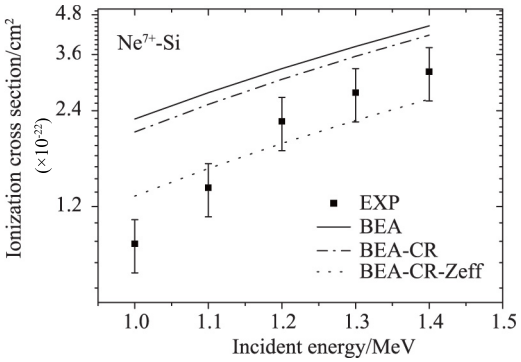

Fig. 1 (color online) K-shell X-ray production cross sections of silicon induced by Ne^{7+} ions.

In the present work, K-shell X-ray production mechanism of silicon induced by Ne^{7+} ions was investigated. Fig. 1 presents K-shell X-ray production cross sections of silicon induced by Ne^{7+} ions, and the theoretical predications were also shown for comparison. It can be seen that, BEA theoretical results overestimates the experimental data by a factor of 1.3 in average, while the calculations of BEA theory taking into account the effect of Coulomb Repulsion and effective-charge modification are consistent with the experimental data.

At low velocities, the highly charged heavy ions carrying their residual orbital electrons interact with the target atom, the screening effect of the residual orbital electrons to the atomic nucleus can't be neglected since they acts as ions or atoms rather than point charge. Hence, the projectile nuclear charge must be replaced by the effective nuclear charge in the calculation of classical BEA model. In the present work, the effective nuclear charge is estimated based on the Slater's rule[3] ($z_{\rm eff} = z - \sigma$, σ is screening constant due to the shielding of the electrons between the nucleus and the electrons which is considered). The screening constant was calculated by taking into account the shielding of the residual electrons of the projectile with initial charge state. For Ne^{7+} ions, the initial electrons configuration is $1s^2 2s^1$, the screening constant is about 2.05, so the effective nuclear charge is about 7.95. In addition, the effect of the coulomb repulsion has two parts in the energy region. One is slowing-down of the projectile in the nuclear Coulomb field, which refers to the effective collision energy of the projectile, another part arises from the change of the projectile trajectory because of the Coulomb deflection.

References

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