Total Bremsstrahlung Cross-Section for Pb at Incident Electron Energy of 50 keV

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Introduction

The process of emission of photon, when the incident electron decelerates in the field of the nucleus of the target atom is called ordinary bremsstrahlung (OB). The photon emitted by target due to the polarization by incident electron is called polarization bremsstrahlung (PB). In Polarization bremsstrahlung dynamic response of the target atom is taken into account. Total bremsstrahlung (TB) cross-section is the sum of OB and PB cross-section. Various researchers [1-3] give theoretical models to study the ordinary bremsstrahlung in thin and thick targets. These models describe the ordinary bremsstrahlung without considering the contribution of polarization bremsstrahlung, which has vital role in the process of bremsstrahlung.

Various authors [4-6] have been presented contribution of polarization bremsstrahlung. Amusia [7] has shown PB is included in OB in a stripped atom approximation (SAA) for high but non relativistic electron energies, in born approximation. Avdonina and Pratt [8] and Korol [9] give methods for calculation of bremsstrahlung spectra in SAA.

Theoretical calculations

The sum of the ordinary bremsstrahlung (OB) and the polarization bremsstrahlung (PB) cross-section forms the total bremsstrahlung, for the Pb at incident electron energy of 50 keV has been studied. In these calculations, the theories of Avdonina and Pratt [8], Amusia [7] and Tseng and Pratt [10] were compared. Avdonina and Pratt had given the theoretical composite expression for bremsstrahlung cross-section which includes the contribution of polarization bremsstrahlung with ordinary bremsstrahlung, given as,

$$\sigma(W_e,k,Z)=\sigma_B(k)-\frac{\sqrt{3}}{\pi}\ln(\frac{q_+}{q_-})+\sigma_{cor}(W_e,k,Z)$$

Where $\sigma_B(k)$ is the bremsstrahlung cross-section given by Avdonina and Pratt [8], which includes a screening parameter, Z is the atomic number of target atom, $q_\pm$ is the momentum transfer and $\sigma_{cor}(W_e,k,Z)$ is given by

$$\sigma_{cor}(W_e,k,Z)=C(T_i,Z)F_{\mathrm{mod}}\sigma_{amusia}(W_e,k,Z)$$

Where $\sigma_{amusia}(W_e,k,Z)$ is cross- section given by Amusia [7], $C(T_i,Z)$ is higher order Born correction factor, F_{mod} is modified Elwert factor. The Tseng and Pratt [10] theory has been modified by introducing the modified Elwert factor and higher order Born correction factor and is given by

$$k\sigma_{\mathrm{mod}}(k)=C(T_i,Z)F_{\mathrm{mod}}(OB\ cross-section\ [10])$$

The plot of comparison of various theories for Pb at incident electron energy of 50keV is shown in Fig. 1.

Result and Discussion

From the comparisons of these theories it was found that for Incident electron energy of 50 keV, the modified theory of Tseng and Pratt is more accurate than theory of

Avdonina and Pratt [8], in the photon energy region from 10 keV to 50 keV. But, in the lower photon energy region from 1keV to 10 keV the Avdonina and Pratt theory [8] is more accurate as compared to modified Tseng and Pratt and Amusia theory.

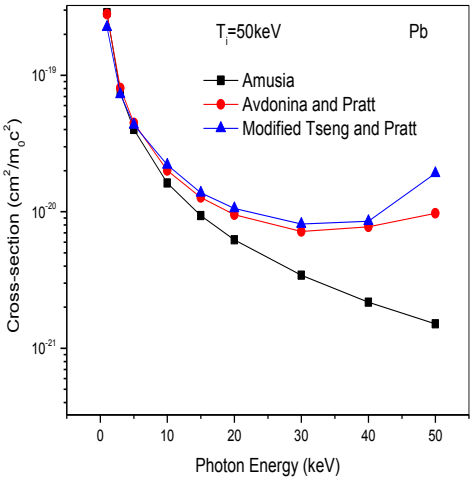

Fig.1 Plots of total bremsstrahlung cross-section versus photon energy at incident electron energy of 50keV for Pb.

The total bremsstrahlung cross-section calculated from Modified Tseng and Pratt and Avdonina and Pratt theories, which include both OB and PB, were higher by 30% to 80% than the Amusia theory which only includes contribution of OB. These deviations among the various theories indicate the importance and the contribution of the polarization bremsstrahlung, in the study of bremsstrahlung process. Thus we cannot be neglected the contribution of PB while studying the bremsstrahlung process in low and medium photon energy.

Further studies are required to improve the modified Tseng and Pratt theory in the lower photon energy range so that it becomes more accurate. More studies are required both theoretically and experimentally to check the contribution of the polarization bremsstrahlung in the total bremsstrahlung cross-section.

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