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RESEARCH ARTICLE

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Measurements of elastic scattering cross sections for 25.2, 28.5, 37.4, 36.8, and 42.2 keV X-ray photons in elements with $22 \leq Z \leq 83$

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The differential elastic scattering cross sections were measured for 25.2 (Sn-Kα), 28.5 (Sn-K$\beta_{1,3}$), 37.4 (Nd-Kα_1), 36.8 (Nd-Kα_2), and 42.2 (Nd-K$\alpha_{1,3}$) keV X-ray photons at 139° scattering angle in elements with $22 \leq Z \leq 83$. The measurement was done in reflection mode experimental setup involving $_{50}$Sn/$_{60}$Nd secondary targets excited with ^{241}Am radioisotope. The scattered X-ray photons were detected using a high-resolution low energy germanium detector (horizontal configuration, FWHM = 300 eV at 59.5 keV) coupled with computerized multichannel analyzer. The intensity of X-ray photons along with geometrical factors were calculated from the theoretical knowledge of *K* X-ray fluorescence cross sections and measured *K* X-ray yields from excited targets. The measured values of differential cross sections were compared with the theoretical available values based on form factor and second-order S-matrix (SM) approaches. The experimental values of cross sections exhibit a large deviation from modified form (MF) values for the elements with $B_K/E_{in} \approx 1$, where B_K is the *K*-shell binding energy of electrons and E_{in} is the energy of incident photon. These deviations in experiment results were smooth out by the inclusion of anomalous scattering factors (ASFs) to the MF values. The measured elastic cross sections were found to be ~7% lower than MFASF values and agree with SM values for all elements under investigation.

1 | INTRODUCTION

Rayleigh scattering is a process in which photons are scattered by bound atomic electrons and leaving behind the target atom in unchanged state. The Rayleigh scattering from different parts of the atomic charge distribution is coherent and results in either constructive or destructive interference, depending on the relative phases of the scattered photons. A comprehensive understanding of Rayleigh scattering cross sections of atoms, molecules, and solids is very useful to obtain the structural information of the materials,[1,2] narrow-beam photon absorption coefficients,[1] and dosimetric computations for reactor and medical physics.[3,4] The theoretical calculations of Rayleigh scattering of unpolarized photons by a free electron were done by Thomson[5] using classical electrodynamics. The basic form of the Thomson formula, $d\sigma_T/d\Omega = (1/2)\, r_o^2(1 + \cos^2\theta)$, was modified for scattering from an extended charge distribution by incorporating the classically derived atomic form factor, $F\ (q,Z)$, where r_o is the classical radius of the free electron. Franz[6] suggested an electron binding correction

