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Silver L_1, L_2 and L_3 cross-sections for ionization and x-ray production by electron impact

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Abstract

The experimental determination of ionization cross-sections and total x-ray production cross-sections under electron impact is carried out for the three silver L-subshells. The very complex spectral structure involving several satellite bands was previously investigated by analyzing wavelength-dispersive spectra acquired in an electron microprobe. In this work, careful spectral processing is carried out by means of the POEMA software developed previously, considering the spectral energy intervals which include the main Ag-L emissions. The resulting ionization cross-sections are compared with analytical models based on distorted wave Born approximation calculations, the experimental determinations of the present work being underestimated by these predictions. To the best of the authors' knowledge, this is the first time these magnitudes are reported in the literature in this energy range. The total L-shell x-ray production cross-sections are also compared with the only previous experimental data found, obtained with different experimental settings.

Keywords: inner-shell ionization, x-ray emission, spectral processing

1. Introduction

Ionization cross-sections represent the probability for a specific interaction between a particular projectile and a target atom, after which the latter is left ionized. Atom relaxation after this event can result in Auger transitions or in the emission of characteristic x-rays. The probability for the whole process of ionization and x-ray emission is called x-ray production cross-section (normalized for the number of target atoms per unit area and per incident particle); it may be computed for each of the subshells constituting an atomic shell or as a whole phenomenon. An inherent basic interest surrounds the adequate knowledge of these cross-sections, since it permits us to validate different theoretical models in the frame of atomic physics. On the other hand, the appropriate experimental determination of these parameters is relevant for many applications involving characteristic x-ray emission or electron stopping power in materials [1–3].

Several spectrochemical analytical techniques require a precise understanding of the ionization cross-sections for the elements constituting the target materials, since the uncertainties in these parameters are straightforwardly transferred to the elemental concentrations assessed. This becomes particularly important in the case of absolute (standardless) quantification methods [4].

A number of theoretical models for the ionization cross-sections have been developed, based on the plane wave Born approximation [5, 6], distorted-wave calculations (DWBA) [7–10], binary-encounter Bethe model [11, 12], etc. However, experimental determinations are rather unusual, although they

