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K X-ray satellite relative intensities of Ca excited by photons

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Abstract The intensity ratios of $K_\alpha L^1/K_\alpha L^0$ and $K_\beta L^1 / K_\beta L^0$ of Ca in $CaCO_3$ and $CaHPO_4 \cdot 2H_2O$ compounds are measured by photon (Cr tube) excitation employing a plane crystal (LiF 200) wavelength dispersive spectrometer Comparison of these ratios with the published data shows a slight evidence of the dependence of the ratio on the incident photon excitation energy and chemical composition of the Ca compounds and a definite dependence of the ratios on multiple ionization

Keywords : K X-ray satellites, calcium compounds, photon excitation

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Introduction

Single K-shell ionization produces the normal K_α and K_β characteristic X-rays from atoms. Single K plus L shell ionization produces K X-ray satellites. These are designated as KL^n where n is the number of L holes. This multiple ionization can be produced by photons, electrons, ions and heavier ions [1-6]. However, as the mode of excitation changes from photons to ions to heavier ions the probability of producing more number of L holes (multiple ionization) increases. With photon excitation, the first satellite can well be studied because of the following advantages : (1) non-deterioration of the target and (2) negligible secondary excitations. A few attempts [3, 7, 8] have been made by photon excitation particularly below $Z = 17$. Recently Murthy *et al* [9] carried out studies on the relative intensity ratios of the first satellites of K_α and K_β, respectively to those of K_α and K_β characteristic X-rays emitted with single K hole of Ca in $CaCO_3$. They carried out measurements using a plane crystal (LiF 200) wavelength dispersive spectrometer with X-rays produced from Rh anode. In the present communication, we have studied the relative intensity ratios of the first satellites of K_α and K_β X-rays to those of their respective K X-rays emitted with single K hole (diagram lines) of Ca in $CaCO_3$ and

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$CaHPO_4 2H_2O$ compounds using Cr tube X-rays for excitation with a view to see (1) the dependence of these ratios on the excitation energy and (2) the possible evidence of chemical effects.

The measurements are carried out with a Philips 1410 wavelength dispersive crystal (LiF 200 ; 2d = 4.027 Å) spectrometer with Cr tube X-rays at 30 kV voltage and 30mA current. Murthy *et al* [9] used settings of 40 kV and 30 mA for the Rh tube. In our case the tube voltage is lesser and also the energy of the characteristic X-rays emitted by Cr is lower than the energy of X-rays emitted by Rh. Pellets of 5-mm thick and 50 mm diameter of pure powders of $CaCO_3$ and $CaHPO_4.2H_2O$ are used. The data are collected in 2 theta steps of 0.05^0 intervals. The measured spectra with the various X-ray lines are shown in the Figure 1. The intensity ratios of

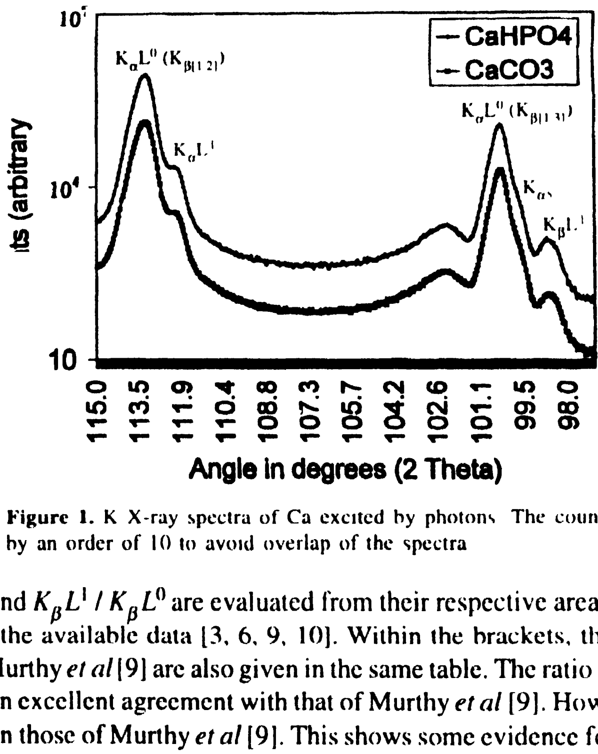

Figure 1. K X-ray spectra of Ca excited by photons The counts of $CaHPO_4$ are increased by an order of 10 to avoid overlap of the spectra

$K_\alpha L^1 / K_\alpha L^0$ and $K_\beta L^1 / K_\beta L^0$ are evaluated from their respective areas and are given in Table 1 along with the available data [3, 6, 9, 10]. Within the brackets, the corresponding values reported by Murthy *et al* [9] are also given in the same table. The ratio by electron excitation of Parratt [6] is in excellent agreement with that of Murthy *et al* [9]. However, the present values are higher than those of Murthy *et al* [9]. This shows some evidence for the dependence of the ratio on the excitation energy. As the excitation energy decreases the ratio is found to be increasing. Secondly, the relative intensities of the two compounds studied show slight evidence of possible chemical effects. The ion excitation values are higher than the present values,

Table 1. K X ray satellite relative intensities (%)

Ratio	Present work (Cr tube) photon excitation $CaCO_3$	$CaHPO_4 2H_2O$	Parrott [6] electron excitation CaO	McWherter *et al* [3] proton excitation Ca	Aberg [10] Theory
$K_\alpha L^1/K_\alpha L^0$ [$K_{\alpha(1,2)}$]	2.8±0.2 (2.2±0.2)*	2.6±0.2	2.2	10.0	3.1
$K_\beta L^1/K_\beta L^0$ [$K_{\beta(1,3)}$]	1.1±0.2 (0.8±0.2)*	1.4±0.2		4.8	

Values in the brackets are of Murthy *et al* [9]
***Used Rh tube anode**

which shows that the ratios also depend definitely on the probability of multiple ionization, which increases for ion– and heavier ion-excitations. However, Aberg's [10] theoretical values based on Ne like structure, with no screening, are in better agreement with present measurements than with the previous values [6, 9].

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