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Measurement of K shell fluorescence cross-section of Ca and K compounds

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Abstract

The cross-section for Ca and K compounds were determined by measuring the KX-ray yields from targets excited 5.96 keV photons and using theoretical K shell photoionization cross-section. By comparing the experimental results with relativistic Hartree–Fock calculation, a good agreement has been obtained considering the experimental errors.

Keywords: K shell; Chemical effect; Cross-section; X-ray fluorescence

1. Introduction

X-ray fluorescence (XRF) analysis has become an important technique for the multi-elemental analysis of unknown samples. The availability of X-ray detectors with high resolution has made this technique a very efficient and nondestructive method of elemental analysis. Such experiments have also been used to evaluate the relative intensity of different types of characteristic X-rays of an element present in different oxidation states. Besides, the measurement of KX-ray production cross-section is important in the study of some basic phenomena in atomic, molecular and radiation physics and in the nondestructive elemental analysis of materials of using energy dispersive fluorescence (EDXRF). Also, comparison of measured cross-sections with theoretical estimates provides a check on the validity of various physical parameters such as photoionization cross-section, fluorescence yield, KX-ray emission rates and jump ratios involved in the evaluation of theoretical estimation. Experimental and theoretical emission lines and X-ray production cross-section rates have been reported by different authors [1–10]. Büyükkasap [11] measured alloying effect on KX-ray production cross-section in Cr_xNi_{1-x} and Cr_xAl_{1-x} alloys. Söğüt et al. [12] measured chemical effect on K shell X-ray production cross-section of Mn, Fe, Co, Ni and Cu molecules. K shell ionization cross-section of Si atoms using relativistic electrons have been determined by Shchagin et al. [13] and Söğüt et al. [14] have measured K shell cross-sections for Br and I compounds using radioisotopes as excitation sources. Garg et al. [15] have measured KX-ray production cross-sections for some elements with $40 \leqslant Z \leqslant 70$ at 122 keV. KX-ray

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fluorescence cross-sections for various elemental ranges been have determined by Chander et al. [16]. Durak et al. [17] experimentally determined the KX-ray production cross-section for medium Z elements at induced photon energies of 122 keV. The X-ray production cross-sections of bromide and iodine compounds have been measured by Küçükönder [18]. Söğüt et al. [19] measured chemical effect on enhancement of Coster–Kronig transitions of L_3 X-rays. In this work, the KX-ray production cross-section of compounds containing Ca and K elements were measured.

2. Experimental method

In this work, the compounds studied were KBr, $K_2Cr_2O_7$, K_2CrO_4, KOH, KCl, K_2SO_4, K_2MnO_4, K_2CO_3, KSCN, KHC_2O_4, KNO_3, $KMnO_4$, $KClO_3$, $K_4Fe(CN)_6 \cdot 3H_2O$, $KHSO_4$, $K_4(FeCN)_6$, $KHCO_3$, KIO_3, KI, $CaSO_4 \cdot 2H_2O$, $Ca(CO_3)$, $Ca(CH_3COO)_2$, $Ca(NO_3)_2 \cdot 4H_2O$, $Ca_3(PO_4)$, CaO, $CaCl_2 \cdot 6H_2O$ for K and Ca compounds. Powdered samples were sieved to 400 mesh size and prepared thickness ranging from 15 to 37 mg/cm^2. The samples were irradiated by 5.96 keV photons emitted by an annular 1.85 GBq ^{55}Fe radioactive source. The incident beam and fluorescence X-rays emitted from the target were detected and analyzed with a

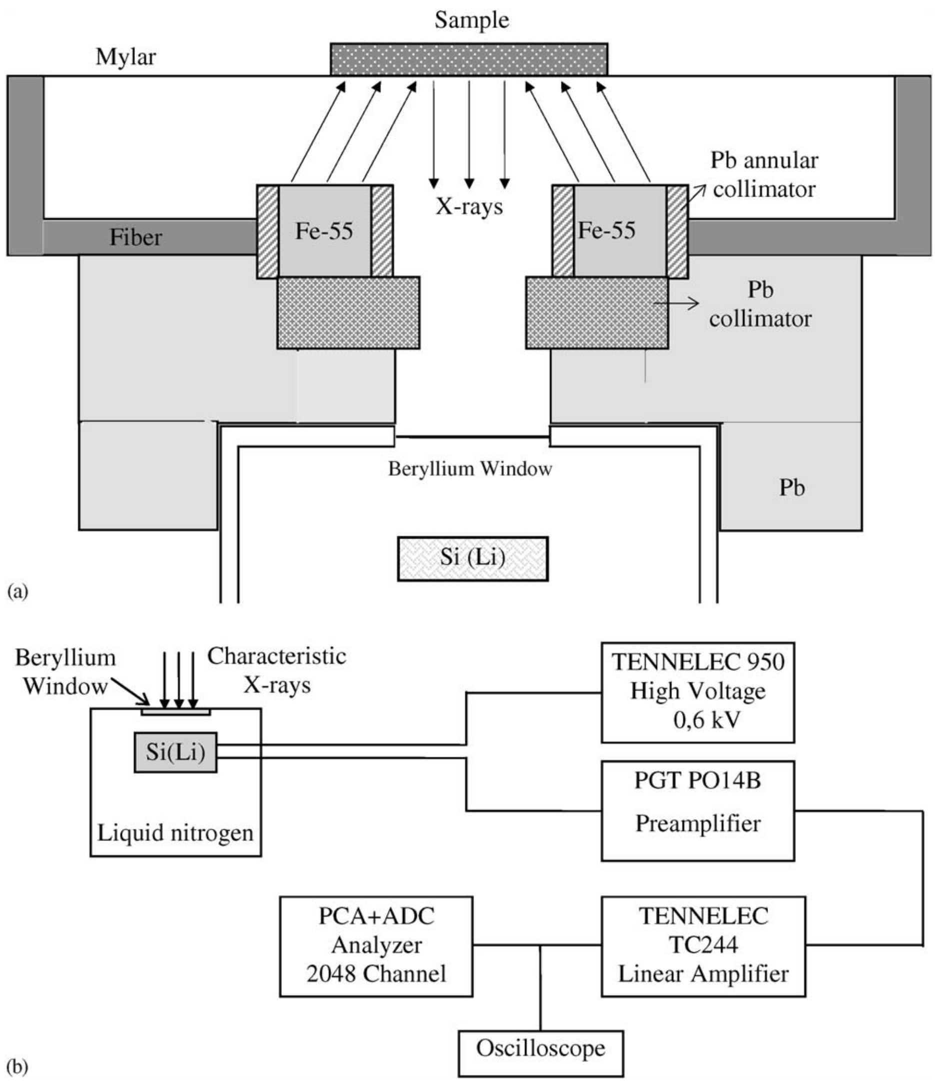

Fig. 1. Experimental setup (a) and schematic diagram of the experimental setup (b).