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THE K-SHELL FLUORESCENCE YIELD OF ARSENIC

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Abstract: The K-shell fluorescence yield of arsenic has been determined as $\omega_K = 0.587 \pm 0.003$ by use of spectrometer with wall-less proportional counter filled with methane and admixture of arsenic hydride.

1. Introduction

The value of the *K*-shell fluorescence yield of germanium determined recently by the use of gaseous converter and proportional counter technique[1] is higher than the value expected from the published values of the neighbour elements[2]. Result of a recent determination of the *K*-shell fluorescence yield of gallium using gaseous source and the proportional counter spectrometer[3] showed similar trend with regard to the previously published results obtained by the use of solid sources and double proportional counters[4,5]. As the gaseous source technique seems to be better alternative for measurements in the low energy region, results of further experiments were of interest in order to prove the established trend of higher values. Thus the K-shell fluorescence yield of arsenic, neighbour to germanium was reexamined.

2. Measurements and result

Arsine AsH_3 was found suitable gaseous compound, not affecting appreciably the resolution of the counter when added in an amount of 10 mm of mercury to 1 atm of methane. The multiwire counting system used was the same as in the previous experiment with germanium[1]. The fluorescence was induced by a narrow beam of monochromatic X-rays, coming from an irradiated molybdenum target and passing radially through the counter. Pulse spectrum obtained from the main counter in anticoincidence with the ring counter is shown in Fig. 1. together with the background spectrum obtained when arsine was not present. Under the assumption that the counter detects all the emitted electrons and is transparent for fluorescent X-rays, the peak at the energy of the incident radiation includes the absorption events followed by the emission of Auger electrons while the second peak at the lower energy

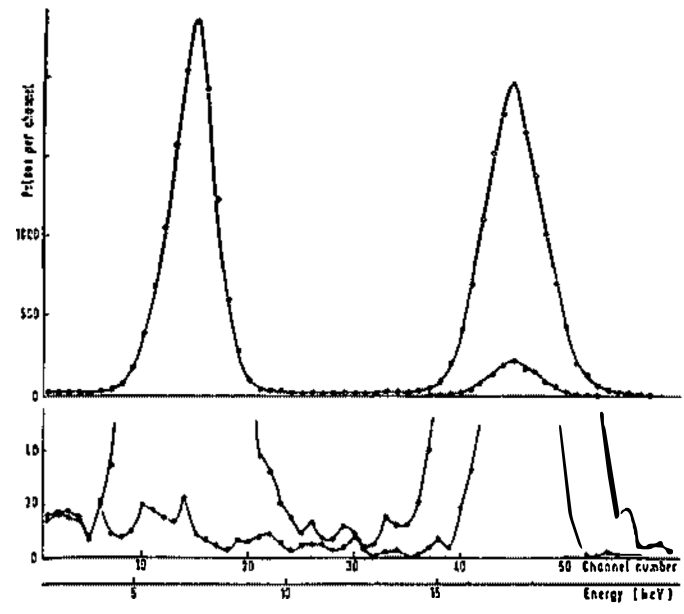

Fig. 1. Pulse height distribution obtained with the counter filled with methane and admixture of arsine (the above part) and the background spectrum obtained without admixture.

contains the absorption events followed by the emission of X-rays escaping from the counter. With these conditions fulfilled the K-shell fluorescence yield ω_K is obtained as

$$\omega_K = \frac{W_K + W_{L,M}}{W_K} \quad \frac{N_e}{N_e + N_0},$$

where W_K and $W_{L,M}$ are probabilities for the photo-effect in the K-shell and in the L- or M-shell resp. while N_0 and N_e are the numbers of counts in the photopeak and in the escape peak, resp. The experimental conditions were close to the required assumptions as the probability for the absorption of the fluorescent radiation was 1.2% and the probability for the electron escape 2%. After applying the resulting correction factor of 0.4% the relative number of counts belonging to the escape peak $N_e/(N_e + N_0)$ amounted to 0.511.

Measurements were repeated at three other energies of incident radiation by the use of rhodium, silver and cadmium targets in order to verify the validity of the applied corrections. The values obtained lie within an interval of $\pm$ 0.002. The probability ratio $(W_K + W_{L, M, N})/W_K$ was obtained as 1.149 $\pm$ $\pm$ 0,003 from a table of K-jump values, given by Blohin[6]. Value for K-jump of arsenic not directly given amongst these data was estimated by interpolation, assuming a smooth Z-dependence of K-jump analogous to the smooth Moseley's law or to the semiempirical $\omega_K(z)$ function. The obtained interpolation curve agrees with the one resulting from the older values by Kirchner[7] in the regions of atomic numbers below 20 and above 40.

In this intermediate region, where both curves do not coincide precisely, Blohin's fit seems preferable as more recent, smoother and better supported by actual experimental points, though, to regret, the origin and the accuracy of these data are not given. Thus the K-shell fluorescence yield of arsenic is determined as

$$\omega_K = 0.587 \pm 0.003^*.$$

The value reported by C. Broyles et al.[8] is 0.53 while the theoretical value by E. J. Callan[9] 0.548. As the present measurement seems to be most reliable the relatively high result obtained strenghtens the validity of higher values for the K-shell fluorescence yield obtained with some neighbour elements by the same measuring technique.

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* The obtained value lies on the smooth curve formed by Fink from the selected most reliable experimental data.

FLUORESCENČNI PRIDELEK ARZENA V LUPINI K

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Vsebina

Fluorescenčni pridelek arzena v lupini K je bil določen z uporabo spektrometra z brezstenskim proporcionalnim števcem polnjenim z metanom in dodatkom arzenovega hidrida. Dobljena je vrednost $\omega_K = 0{,}587 \pm 0{,}003$.