# Activation Analysis of Aluminium

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# ACTIVATION ANALYSIS OF ALUMINIUM

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Summary:

An analysis of pure aluminium alloyed with magnesium was performed by means of gamma spectrometry *). Chemical separations were not employed. The isotopes to be determined were obtained in conditions of optimum activity by suitably choosing the time of irradiation and decay. The following elements were detected and measured quantitatively: Iron, zinc, copper, gallium, manganese, chromium, scandium and hafnium.

*) Cf. Activation analysis of aluminium earlier performed by P. Iredale [1]

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## Introduction

It may often be difficult to evaluate a complex gamma spectrum due to the fact that the activity of one isotope may be so dominant that the other isotopes are almost completely masked in the compton continuum.

The energies of several isotopes can, in addition, lie so close to each other that the resolution available is not sufficient to separate them. However, if the isotopes by means of which the analysis is performed possess rather different half-lives, it is possible to separate them using short, medium or long irradiation times with correspondingly suitable decay times. The analysis of aluminium may serve as an illustration.

## Experimental

### Irradiation and decay times

Aluminium sample I

Irradiation: 2 h  Decay: 1 h  Determination of Mn

Al, Mg decays

Aluminium sample II

Irradiation: 1 day  Decay: 1 day  Determination of Cu, Ga

Al, Mg, Mn decays

Aluminium sample III

Irradiation: 4 days  Decay: 20 days  Determination of Fe, Cr, Sc, Zn and Hf

Al, Mg, Mn Cu, Ga decays

In the diagrams 1-4 gamma spectra obtained at the above given intervals are shown. The measurements were performed by means of a hundred channel pulse height analyzer with a Na I (Tl) crystal 2" x 2".

The aluminium samples, in small pieces grounded with carborundum, were washed in acetone both before and after activation.

Amounts of samples:

Sample I : 6,5 mg
Sample II : 20 mg
Sample III : 18 mg

Thermal neutron flux: $\sim 6 \cdot 10^{11}$ n/cm$^2$ s.

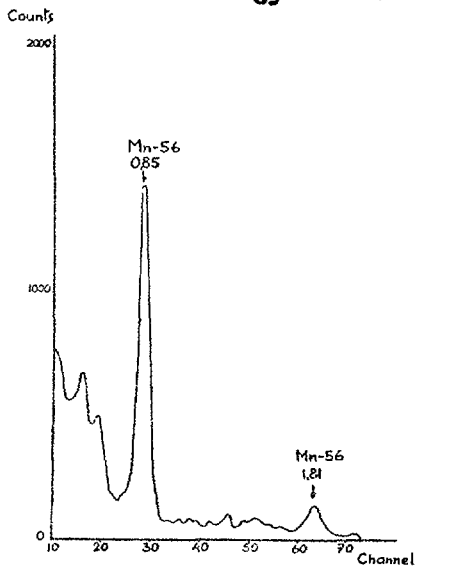
The identifications of the isotopes were based on an accurate determination of their gamma energies and a coarse determination of their half-lives.

The quantitative determinations were made by comparison with samples containing known amounts of the isotopes sought.

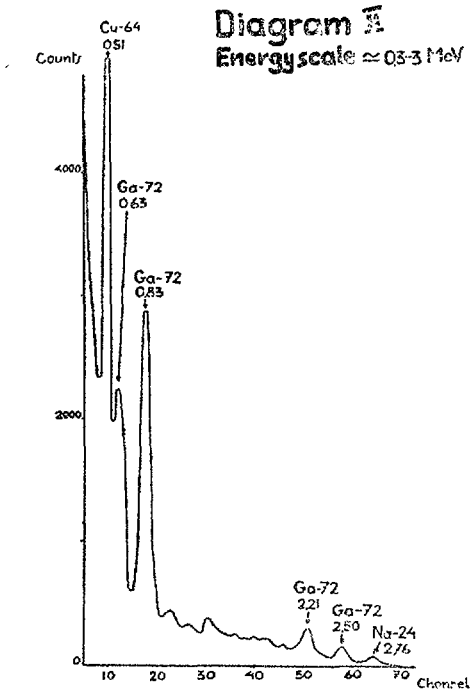
The identifications and the quantitative measurements were made by determination of the following isotopes:

| Isotopes | $T_{1/2}$ | $\gamma$-energies (MeV) [2, 3] |
|---|---|---|
| $Mn^{56}_{25}$ | 2.6 h | 0,85 (100 %) 1,81 (30 %) 2,13 (20 %) |
| $Cu^{64}_{29}$ | 12.8 h | 0.51 ( $\beta^+$ 19 %) |
| $Ga^{72}_{31}$ | 14.2 h | 0.63 (24 %) 2.21 (33 %)<br>0.84 (100 %) 2.51 (26 %) |
| $Cr^{51}_{24}$ | 28 d | 0.32 (10 %) |
| $Sc^{46}_{21}$ | 85 d | 0.89 (100 %)<br>1.12 (100 %) |
| $Zn^{65}_{30}$ | 245 d | 1.11 (46 %)<br>0.51 ($\beta^+$ 2 %) |
| $Fe^{59}_{26}$ | 45 d | 1.10 (57 %) 0.19 (2.8 %)<br>1.29 (43 %) |
| $Hf^{181}_{72}$ | 46 d | 0.13 0.48 0.057 |

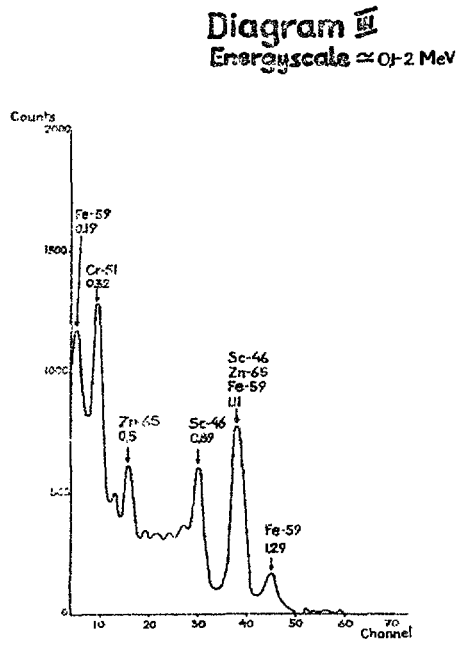
## Diagrams



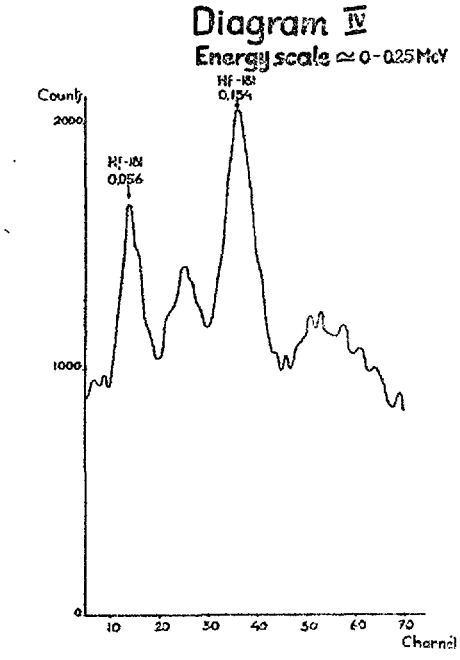

Spectrum of $Mn^{56}_{25}$




Spectrum of $Cu^{64}_{29}$ and $Ga^{72}_{31}$




Spectrum of $Fe^{59}_{26}$, $Sc^{46}_{21}$, $Zn^{65}_{30}$ and $Cr^{51}_{24}$




Spectrum of $Hf^{181}_{72}$

Results

| | | |
|---|---|---|
| Iron | 2500 | ppm |
| Zinc | 200 | " |
| Copper | 150 | " |
| Gallium | 100 | " |
| Manganese | 70 | " |
| Chromium | 10 | " |
| Scandium | < 1 | " |
| Hafnium | < 1 | " |

According to communications from the manufacturer*/, the amounts of impurities should be as follows:

| | | |
|---|---|---|
| Iron | 2000 - 3000 | ppm |
| Zinc | 100 - 200 | " |
| Copper | 100 - 200 | " |
| Manganese | 100 - 200 | " |
| Chromium | < 100 | " |
| Nickel | < 100 | " |
| Titanum | < 300 | " |
| Silicon | < 1500 | " |
| Magnesium(added) | 1.9 - 2.1 | % |

*/ Svenska Metallverken AB, Finspong, Sweden

## Discussion

Nickel, titanum and silicon were not detected in this analysis because of the relatively low sensitivities for those elements to gamma spectrometry. However, the elements gallium, scandium and hafnium, which were not detected in the chemical analysis, were easily detected by this activation analytical method.

It would be difficult to determine magnesium because of the disturbing activities of aluminium and manganese. An additional magnesium activity will also be obtained because of the reaction, $Al^{27}_{13}$ (n, p) $Mg^{27}_{12}$. However, this activity can be corrected for by means of epithermal activation.

A small activity for $Na^{24}_{11}$ is stated for sample II. This activity is probably due to impurities resulting from the handling and from the reaction: $Al^{27}_{13}$ (n, α) $Na^{24}_{11}$.

With a distance of about 10 cm between source and crystal, the aluminium pieces may be assumed, to a good approximation, to be point sources. (Aluminium pieces: 1 mm height, width and length < 3 mm).

The correction for self-absorption for gamma rays above 0.8 MeV is in this case less than 1 %.

## Acknowledgement

I am greatly indebted to Mr. W. Sas-Korczynski for carrying out the spectrometric measurements.

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