A NEW INTERNAL REFERENCE METHOD FOR ACTIVATION ANALYSIS AND ITS APPLICATION.

DETERMINATION OF Ti, Cr, Ni AND Zr IN ALUMINIUM ALLOYS BY MEANS OF PHOTON ACTIVATION

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A new internal reference method for activation analysis has been developed. The method can be used effectively for special samples in which suitable elements as internal standards are absent and the self-shielding effect can be neglected. In this method, W b g of element B as an internal reference is added to the sample which contains W a g of element A to be determined, whereas the comparative standard is prepared by mixing only the element A and B in a known concentration ratio of W a/W b. When the sample and comparative standard are irradiated by particles with the same energy distribution, even though both are irradiated separately by particles with different flux, W a can be determined easily by the following equation,

\[ W_a = \left( \frac{A_R}{A_R^*} \right) W_b^* \]

where \(A_a\) and \(A_R\) are count ratios between gamma-rays emitted by two radioactive nuclides produced from elements A and B in the sample and comparative standard, respectively. The usefulness of the present method was examined through the determination of Ti, Cr, Ni and Zr in several commercial aluminium alloys by means of photon activation, and the accuracy and precision of the method were verified.

Introduction

In activation analysis, three internal standard methods have so far been proposed by many investigators,\(^1\) - \(^7\) and have been used extensively for the determination of trace elements in a wide variety of materials.\(^2\) - \(^6\)

An important characteristic of the first method is that a suitable element present initially in the sample is used as an internal standard. In other words, the sample itself is used as a material of the comparative standard. In this method, correction of the inhomogeneities of flux between the sample and comparative standard are achieved by applying the standard addition method in preparation of the comparative standard. Although this method was first proposed by LELIAERT et al,\(^1\) there were
important recent modifications by the present authors. As a result, it was demonstrated that the self-shielding effects between the sample and comparative standard may cancel out completely, and that the amount of trace element to be analyzed in the sample can also be evaluated easily by using a very simple equation, even though the sample and comparative standard are irradiated separately by particles of different flux.

In the second method an element to be analyzed in the sample consists of at least two stable isotopes, which are converted easily to radioactive nuclides through particular nuclear reactions, and one of the stable isotopes is used as an internal standard. When this method is carried out by adding an accurately known amount of an enriched isotope to the duplicated sample, corrections of the self-shielding effects and the inhomogeneities of flux between the sample and mixture spiked with the enriched isotope are attained similarly to the first method. This method was recently developed by the present authors and named stable-isotope dilution activation analysis.

The third method can be used effectively to special samples in which suitable elements as internal standards are entirely absent and the self-shielding effect can be neglected. In this method, correction of the inhomogeneities of flux between the sample and comparative standard is accomplished by adding an exactly known amount of a suitable element as an internal reference to the sample and comparative standard, respectively.

The last method has been extensively studied by many workers. OKA et al. have first proposed a semi-empirical equation, according to which, the weight ratio between the element to be analyzed and the internal reference in the sample is directly proportional to the radioactivity ratio between the radioactive nuclide produced from the element to be analyzed and that from the internal reference. The authors have applied it to the determination of a trace element as an impurity in a single-matrix element by using the matrix itself as an internal reference. On the other hand, CHEN et al., JOGLEKAR et al. and SEGEBADE et al. have also presented recently an identical equation for thermal neutron, 14 MeV neutron and photon activation analyses, and they have tried to determine a trace or minute amount of an element in a wide variety of samples by adding a known amount of a suitable element as an internal reference to the sample and comparative standard. In all cases described above it was necessary to determine the proportionality constant k. Unfortunately, however, the definition of the proportionality constant k is not yet complete enough to include all the factors.

In the present study, development of a new internal reference method for activation analysis was tried by studying the basic principle of the third method from a different point of view, and the applicability of the method was also examined by