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Photon Activation Analysis

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Table of c

Table of contents

Preface

This book is written to give, in a concentrated form, an overview of the application of photonuclear reactions to activation analysis. It is intended to acompany the analyst's work in the photon activation analysis laboratory as a practical usable reference. Emphasis is placed upon analytical qualitative and quantitative data which are based upon experimentally obtained results. Therefore, both a source of general information on photon activation analysis and a laboratory manual are combined in this book. The results of the authors' laboratory work and a large amount of literature data are evaluated and presented as completely as possible by the authors. Special knowledge of photonuclear physics is not required; only a very elementary theoretical introduction is given. More detailed information on the physical and mathematical theory should be sought in the special literature which is cited in the relevant chapters.

The first chapter opens with a short introduction into the subject and a short survey of the history of photon activation analysis. Then the different types of nuclear reactions used for activation analysis are discussed. Finally, the quantitative relation between activating radiation and the radioactivity induced in the irradiated material is evaluated.

The second chapter deals with the different types of photonuclear reactions. It commences with a historical summary of photonuclear research. The different photonuclear reaction mechanisms are then discussed, including the general nuclear properties of the reaction product nuclides.

In the third chapter, again after a short paragraph on the historical development, the principles of the photon sources which are used for activation analysis purpose are explained. Isotope sources, betatron, microtron and linear accelerator are included. Their properties are compared and discussed. Irradiation facilities and apparatus for sample handling are covered.

The fourth chapter is concerned with the radiation measurement systems used for photon activation analysis, especially high resolution photon spectrometers. After a few historical data, the different photon detectors and electronic devices for radiation counting are discussed.

The fifth chapter contains an extended compilation of the photonuclear yield data of analytical importance. All elements of the Periodic Table with few exceptions are

included. Reaction types and activity yields are based exclusively upon experiment. This chapter is intended to be used during practical analytical work, e.g. for identification of radionuclides by their photon emission energies, quantitative evaluation of interference reactions, estimation of analytical sensitivities etc..

Chapter six (section 6.1) deals with photon activation analysis of the light elements (C, N, O, F). This is a special application which entails problems which are different from those occurring during photon activation analysis of the heavier (Z greater than 10) elements. The different chemical separation procedures will be outlined.

In section 6.2 the analysis of the heavier elements is discussed. Cases of single- and multielement determinations are described. Summaries of fundamental photon activation analysis work presented in the literature are given as typical examples for the large variety of different problems. These include analyses of various material classes (organic matter, ores, rocks, water etc.) for different purposes (purity assessment, prospection, environmental analysis etc.).

The cited literature is as complete as possible to the authors and comprises (hopefully!) the most relevant publications on photon activation analysis.

The authors wish to express their appreciation to all who helped to realise this work in any way, be it by advice and critical and helpful discussion, or by practical cooperation during our laboratory work, data collection and evaluation, writing and reviewing. We are especially indebted to Professor R. Neider, who, as the head of our group, encouraged us to complete this work and had significant influence upon its contents by frequent advice and critical discussion.

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