

Chapter 6

Energy-Dispersive X-Ray Spectrometry

6.1. ENERGY-DISPERSIVE X-RAY SPECTROMETRY

6.1.1. Introduction

The distinction drawn in this book between energy-dispersive and nondispersive methods is given in the last paragraph of Section 3.2. Excitation for energy dispersion by high- and low-power x-ray tubes, radioisotopes, and ion beams is discussed in Sections 4.1.4, 4.1.3, and 4.1.2, respectively. The advantages and limitations of energy and wavelength dispersion are compared in Section 3.5.4. This section (6.1) is concerned with only the analytical techniques of energy dispersion.

Energy-dispersive x-ray spectrochemical analysis can be applied on standard commercial x-ray fluorescence spectrometers and diffractometers using proportional and scintillation counters. However, because of the poor resolution of these detectors, such application is feasible only for specimens having only one heavier element in a light matrix—or at most three or four such elements having widely separated pulse-height distributions.

For fluorescence spectrometers, the goniometer is fixed at $0^\circ 2\theta$ and the crystal is removed; coarse collimators may be used in the source and detector positions. The specimen is placed in the same position as for wavelength dispersion. In earlier instruments having tabletop goniometers, like that shown in Figure 3.2, the distance from specimen to detector may be reduced by mounting the detector after the source collimator. For diffractometers, the goniometer is fixed at $90^\circ 2\theta$, and coarse collimators or wide slits may be used. The specimen is placed in the same position as for diffractometry so that lines joining the specimen with the x-ray tube and

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Vlado Valkovic



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Introduction to X-Ray Spectrometric Analysis Eugene P. Bertin, 2013-06-29 X ray fluorescence spectrometry has been an established widely practiced method of instrumental chemical analysis for about 30 years However although many colleges and universities offer full semester courses in optical spectrometric methods of instrumental analysis and in x ray dif fraction very few offer full courses in x ray spectrometric analysis Those courses that are given are at the graduate level

Consequently proficiency in this method must still be acquired by self instruction on the job training and experience workshops held by the x ray instrument manu facturers the one or two week summer courses offered by a few uni versities and certain university courses in analytical and clinical chemistry metallurgy mineralogy geology ceramics etc that devote a small portion of their time to applications of x ray spectrometry to those respective disciplines Moreover with all due respect to the books on x ray spectrometric analysis now in print in my opinion none is really suitable as a text or manual for beginners in the discipline In 1968 when I undertook the writing of the first edition of my previous book Principles and Practice of X Ray Spectrometric Analysis my objective was to provide a student text However when all the material was compiled I decided to provide a more comprehensive book which was also lacking at that time Although that book explains principles instrumentation and methods at the begin ner s level this material is distributed throughout a mass of detail and more advanced material

Principles and Practice of X-Ray Spectrometric Analysis E.P. Bertin, 2012-12-06 Since the first edition of this book was published early in 1970 three major developments have occurred in the field of x ray spectrochemical analysis First wavelength dispersive spectrometry in 1970 already securely established among instrumental analytical methods has matured Highly sophisticated miniaturized modular solid state circuitry has replaced elec tron tube circuitry in the readout system Computers are now widely used to program and control fully automated spectrometers and to store process and compute analytical concentrations directly and immediately from ac cumulated count data Matrix effects have largely yielded to mathematical treatment The problems associated with the ultralong wavelength region have been largely surmounted Indirect association methods have extended the applicability of x ray spectrometry to the entire periodic table and even to certain classes of compounds Modern commercial computerized auto matic simultaneous x ray spectrometers can index up to 60 specimens in turn into the measurement position and for each collect count data for up to 30 elements and read out the analytical results in 1 4 min all corrected for absorption enhancement and particle size or surface texture effects and wholly unattended Sample preparation has long been the time limiting step in x ray spectrochemical analysis Second energy dispersive spectrometry in 1970 only beginning to assume its place among instrumental analytical methods has undergone phenomenal development and application and some believe may supplant wavelength spectrometry for most applications in the foreseeable future

Analysis of Paints and Related Materials William C. Golton, 1992 Analytical Sedimentology Douglas W. Lewis, David McConchie, 2012-12-06 The first edition of

Practical Sedimentology contained discussions of principles and techniques that could be applied to the analysis of sediments in the field and in laboratories. Colleagues at the University of Canterbury and the University of New England Lismore have helped with practical. When considering a revised edition we felt that it was inappropriate to restrict consideration to the simple and common discussed in this volume. At the University of Canterbury we techniques because so many modern analyses of sediments are particularly grateful to K Swanson for advice on preparing use sophisticated and often expensive equipment to examine materials for scanning electron microscopy and paleontology sediments and sedimentary rocks. A review of the wide range of logical specimens to G Coates working at the university at of available techniques and equipment was not feasible in the time of the first edition of Practical Sedimentology for same volume as a review of principles. The original intent to compilation of and additions to the procedures for textural analysis and some tables and sketches to Ted Montague for produce a concise summary of practical sediment studies in an inexpensive format was maintained but now in the form the bulk of the chapter on borehole sedimentology to Dr J. Physical Methods in Modern Chemical Analysis V3 Theodore Kuwana, 2012-12-02 Physical Methods in Modern Chemical Analysis Volume 3 presents the fundamental principles the instrumentation or necessary equipment and applications of selected physical methodologies in chemical analysis. This volume contains chapters that discuss various topics on chemical analysis methods such as transform methods in chemistry X ray spectrometry the principles of electrochemical measurements and global optimization strategy for gas chromatographic separations. The book will prove to be an excellent reference material for chemists researchers and students of chemistry. **Undergraduate Instrumental Analysis** Thomas J. Bruno, James W. Robinson, George M. Frame II, Eileen M. Skelly Frame, 2023-07-31 Analytical instrumentation is crucial to research in molecular biology medicine geology food science materials science forensics and many other fields. Undergraduate Instrumental Analysis 8th Edition provides the reader with an understanding of all major instrumental analyses and is unique in that it starts with the fundamental principles and then develops the level of sophistication that is needed to make each method a workable tool for the student. Each chapter includes a discussion of the fundamental principles underlying each technique detailed descriptions of the instrumentation and a large number of applications. Each chapter includes an updated bibliography and problems and most chapters have suggested experiments appropriate to the technique. This edition has been completely updated revised and expanded. The order of presentation has been changed from the 7th edition in that after the introduction to spectroscopy UV Vis is discussed. This order is more in keeping with the preference of most instructors. Naturally once the fundamentals are introduced instructors are free to change the order of presentation. Mathematics beyond algebra is kept to a minimum but for the interested student in this edition we provide an expanded discussion of measurement uncertainty that uses elementary calculus although a formula approach can be used with no loss of context.

Unique among all instrumental analysis texts we explicitly discuss safety up front in Chapter 2 The presentation intentionally avoids a finger wagging thou shalt not approach in favor of a how to discussion of good laboratory and industrial practice It is focused on hazards and remedies that might be encountered in the use of instrumentation Among the new topics introduced in this edition are Photoacoustic spectroscopy Cryogenic NMR probes and actively shielded magnets The nature of mixtures in the context of separations Troubleshooting and leaks in high vacuum systems such as mass spectrometers Instrumentation laboratory safety Standard reference materials and standard reference data In addition the authors have included many instrument manufacturer s websites which contain extensive resources We have also included many government websites and a discussion of resources available from National Measurement Laboratories in all industrialized countries Students are introduced to standard methods and protocols developed by regulatory agencies and consensus standards organizations in this context as well

Instrumental Analysis of Pollutants C.N. Hewitt,2012-12-06 Recent years have seen advances in instrumentation and chemical analytical methods Environmental scientists and analytical chemists working in this field must now be familiar with a wide range of techniques and applications This text aims to introduce the major instrumental methods being used

Nuclear Methods in Mineralogy and Geology Attila Vértés,Sándor Nagy,Károly Süvegh,2012-12-06 This book appears a century after the discovery of radioactivity It was in 1896 when Henri Becquerel reported his first results about the penetrating radiation which could darken the packed photographic plates The initial fascination of radioactivity e g the discovery of new radioactive elements the first real description of the structure of atoms and their nuclei the applications of radiotracers the high sensitivity of activation analysis etc was followed by the use of atomic bomb in 1945 The mushroom cloud became a symbol of destructive nuclear power And even nuclear energy production which provides about 20% of the world s electricity is overshadowed by radioactive waste However the latest results suggest that the Accelerator Driven Transmutation Technology ADTT will solve this problem since this technique can decrease the lifetime of the fission products comparatively to the human lifespan Practical control of fusion may also be possible in the first decades of the next millennium

Microscopy Methods in Nanomaterials Characterization Sabu Thomas,Raju Thomas,Ajesh K Zachariah,Raghvendra Kumar Mishra,2017-05-17 Microscopy Methods in Nanomaterials Characterization fills an important gap in the literature with a detailed look at microscopic and X ray based characterization of nanomaterials These microscopic techniques are used for the determination of surface morphology and the dispersion characteristics of nanomaterials This book deals with the detailed discussion of these aspects and will provide the reader with a fundamental understanding of morphological tools such as instrumentation sample preparation and different kinds of analyses etc In addition it covers the latest developments and trends morphological characterization using a variety of microscopes Materials scientists materials engineers and scientists in related disciplines including chemistry and physics will find this to be a detailed method orientated guide to microscopy methods of

nanocharacterization Takes a method orientated approach that includes case studies that illustrate how to carry out each characterization technique Discusses the advantages and disadvantages of each microscopy characterization technique giving the reader greater understanding of conditions for different techniques Presents an in depth discussion of each technique allowing the reader to gain a detailed understanding of each

Soil and Environmental Analysis Keith A. Smith, Malcolm S. Cresser, 2003-10-15 Evaluating traditional and recent analytical methods according to speed sensitivity and cost efficiency this reference supports specialists in the selection of effective analytical techniques and equipment for the study of soils soil contaminants and environmental samples Updated and revised this Third Edition illustrates the advantages limitations range and challenges of the major analytical approaches utilized in modern research laboratories It includes new chapters and expanded discussions of the measurement of organic pollutants in the environment and gas fluxes between the land surface and atmosphere and an extensive range of environmental materials

X-Ray Spectroscopy in Environmental Sciences Vlado Valkovic, 2024-12-06 Applications of X ray spectroscopy to air water and soil pollution studies are covered in detail in this essential publication Air pollution can hardly be studied by any other method to such an extent Much of our present knowledge in this field was obtained by laboratories using many of the same methods described in this work A number of examples illustrate the contribution of X ray emission spectroscopy and its capabilities in the area of water pollution Examples of soil pollution studies by the use of biological monitors is also presented A comprehensive reference list with the help of author and subject indices provides direction for further investigation

Quantitative Microbeam Analysis A.G Fitzgerald, 2017-07-12 Quantitative Microbeam Analysis provides a comprehensive introduction to the field of quantitative microbeam analysis MQA MQA is a technique used to analyze subatomic quantities of materials blasted from a surface by a laser or particle beam providing information on the structure and composition of the material Contributed to by international experts the book is unique in the breadth of microbeam analytical techniques covered For each technique it develops the theoretical background discusses practical details relating to choice of equipment and describes the current advances The book highlights developments relating to Auger electron spectroscopy in scanning electron microscopes and transmission electron microscopes and advances in surface analytical imaging and accelerated ion beam surface interactions

Heavy Metals in the Environment: Origin, Interaction and Remediation Heike Bradl, 2005-03-03 Excessive levels of heavy metals can be introduced into the environment for example by industrial waste or fertilizers Soil represents a major sink for heavy metals ions which can then enter the food chain via plants or leaching into groundwater In Heavy Metal Ions in the Environment the author looks at where heavy metals ions come from how they interact with the environment and how they can be removed from the environment by a process known as remediation This book serves as a valuable addition to an increasingly important field of study which is at present served by a limited number of archival texts Includes comprehensive coverage of heavy metal ions in the environment Is practical and easy to read Is suitable for students and researchers in

environmental science and environmental or chemical engineering *Analysis of Airborne Particles by Physical Methods*
 Malissa Hanns, 2018-01-18 An accurate and complete characterization of the solid pollutants in air taking into account the physio chemical and technological data available concerning the origin transformation and the effects of dust is a synoptic approach known as SISintegrated dust analysis and is the underlying concept of this book **The Chemical Analysis of Water**
 D. T. E. Hunt, Anthony Leslie Wilson, 1986 Information requirements of measurement programmes Sampling Basic problems and aims of sampling Time and frequency of sampling Overall design of sampling programmes Procedures for obtaining samples of waters Preparation transport storage and stability of samples The nature and importance of errors in analytical results Random error Systematic error Accuracy Effects of errors on decision making Need to estimate analytical errors Estimation and control of the Bias of analytical results Detailed consideration and assessment of individual sources of Bias Assessment of the overall Bias of analytical results Estimation and control of the precision of analytical results Model of Random errors Achievement of specified accuracy by a group of laboratories Types of inter laboratory studies Reporting analytical results Reporting results close to the lower concentration limit of an analytical system The selection of analytical methods General precautions in water analysis laboratories Analytical techniques Automatic and on line analysis Computers in water analysis The scope for computing in water analysis and related activities **Modern Instrumental Analysis**
 Satinder Ahuja, Neil Jespersen, 2006-10-17 Modern Instrumental Analysis covers the fundamentals of instrumentation and provides a thorough review of the applications of this technique in the laboratory It will serve as an educational tool as well as a first reference book for the practicing instrumental analyst The text covers five major sections 1 Overview Sampling Evaluation of Physical Properties and Thermal Analysis 2 Spectroscopic Methods 3 Chromatographic Methods 4 Electrophoretic and Electrochemical Methods 5 Combination Methods Unique Detectors and Problem Solving Each section has a group of chapters covering important aspects of the titled subject and each chapter includes applications that illustrate the use of the methods The chapters also include an appropriate set of review questions Covers the fundamentals of instrumentation as well as key applications Each chapter includes review questions that reinforce concepts Serves as a quick reference and comprehensive guidebook for practitioners and students alike *Accuracy of Solution X-ray Spectrometric Analysis of Copper-base Alloys*
 Robert Alvarez, Richard Flitsch, 1965 Sample Preparation for Trace Element Analysis
 Zoltan Mester, Ralph E. Sturgeon, 2003-12-16 Following the collection of a sample every analytical chemist will agree that its subsequent preservation and processing are of paramount importance The availability of high performance analytical instrumentation has not diminished this need for careful selection of appropriate pretreatment methodologies intelligently designed to synergistically elicit optimum function from these powerful measurement tools Sample Preparation for Trace Element Analysis is a modern comprehensive treatise providing an account of the state of the art on the subject matter The book has been conceived and designed to satisfy the varied needs of the practicing analytical chemist It is a multi author

work reflecting the diverse expertise arising from its highly qualified contributors The first five chapters deal with general issues related to the determination of trace metals in varied matrices such as sampling contamination control reference materials calibration and detection techniques The second part of the book deals with extraction and sampling technologies totaling 15 chapters providing theoretical and practical hints for the users on how to perform specific extractions Subsequent chapters overview seven major representative matrices and the sample preparation involved in their characterization This portion of the book is heavily based on the preceding chapters dealing with extraction technologies The last ten chapters are dedicated to sample preparation for trace element speciation First title to provide comprehensive sample preparation information dealing specifically with the analysis of samples for trace elements The 39 chapters are authored by international leaders of their fields

Encyclopedia of Spectroscopy and Spectrometry, 2016-09-22 This third edition of the Encyclopedia of Spectroscopy and Spectrometry Three Volume Set provides authoritative and comprehensive coverage of all aspects of spectroscopy and closely related subjects that use the same fundamental principles including mass spectrometry imaging techniques and applications It includes the history theoretical background details of instrumentation and technology and current applications of the key areas of spectroscopy The new edition will include over 80 new articles across the field These will complement those from the previous edition which have been brought up to date to reflect the latest trends in the field Coverage in the third edition includes Atomic spectroscopy Electronic spectroscopy Fundamentals in spectroscopy High Energy spectroscopy Magnetic resonance Mass spectrometry Spatially resolved spectroscopic analysis Vibrational rotational and Raman spectroscopies The new edition is aimed at professional scientists seeking to familiarize themselves with particular topics quickly and easily This major reference work continues to be clear and accessible and focus on the fundamental principles techniques and applications of spectroscopy and spectrometry Incorporates more than 150 color figures 5 000 references and 300 articles for a thorough examination of the field Highlights new research and promotes innovation in applied areas ranging from food science and forensics to biomedicine and health Presents a one stop resource for quick access to answers and an in depth examination of topics in the spectroscopy and spectrometry arenas

Encyclopedia of Materials Characterization Charles A. Evans, 1992 This is a comprehensive volume on analytical techniques used in materials science for the characterization of surfaces interfaces and thin films This flagship volume is a unique stand alone reference for materials science practitioners process engineers students and anyone with a need to know about the capabilities available in materials analysis An encyclopedia of 50 concise articles this book will also be a practical companion to the forthcoming books in the series Knovel

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