
 BOOK REVIEWS

Mass Spectrometry and its Applications to Organic Chemistry. By J. H. Beynon, Head of the Physics Section, I.C.I. Dyestuffs Division, Manchester (England). D. Van Nostrand Company, Inc., 120 Alexander Street, Princeton, New Jersey. 1960. xiii + 640 pp. 17.5 × 25 cm. Price, \$24.00.

The bases of the analytical chemistry of complex mixtures have been and continue to be separation and characterization. For obvious reasons the most used analytical methods have always been those in which the necessary characterization is more or less automatically coupled to the separation method. The ideal analytical method is one that completely separates the components of a mixture, and simultaneously provides a unique characterization of the separated components. The reader of the volume under review cannot help but finish his reading with the impression that mass spectrometry as practiced in the laboratory of the author, J. H. Beynon, is a very close approximation to the ideal analytical method. The appearance at this time of a volume that can lead its readers to such a conclusion is most opportune, since it has recently become possible for any laboratory with a sufficiently large annual capital budget to acquire equipment that is equal in potential performance to that employed by Beynon.

Two classes of reader will find this book of particular value. These are, (1) organic chemists who would like to learn whether or not high resolution mass spectrometry will help them in the solution of their analytical and/or structure problems, and (2) analytical spectroscopists who have or are about to have the responsibility for interpreting high resolution mass spectra of complex organic compounds and their mixtures. Beynon's forté, as indicated in the preface to the volume and by the important papers he has contributed to the analytical chemical literature, is qualitative organic analysis by means of high resolution mass spectrometry, *i.e.*, the determination of the exact empirical formulas of substances through precise determination of molecular weights. At least 90% of this volume may be viewed as an introductory manual to the art which Beynon has fathered, and/or material that Beynon believes to be pertinent to the practice of this art. The other 10% of the book is a deliberately brief review of some of the other aspects, largely of an analytical chemical nature, of mass spectrometry.

The reviewer intends the implication of the preceding paragraph, to wit, that Beynon's book will be of little interest or use to the chemist (physicist or biologist) who is interested in the state of development of mass spectrometry in the large. Beynon and the publishers are to be congratulated for choosing a relatively unambiguous title for their volume, although greater precision in naming the book would have been achieved by preceding "chemistry" with "analytical" in the title.

With respect to the actual structure and content of the book, the first six chapters (240 pages) describe mass spectrometers and their auxiliary laboratory appurtenances and the measurement of the intensive and extensive aspects of mass spectra. The seventh chapter (48 pages) is a general description of the nature of the mass spectra of molecules that are generated by single electron impact. The eighth and ninth chapters (130 pages), that constitute the heart of the book, are devoted to qualitative analysis by mass spectrometry and the nature of the mass spectra of various classes of substances. As indicated above, there is a tenth chapter (60 pages) that summarizes other applications of mass spectrometry. Finally, there are 100 pages of tables in seven appendices that will be invaluable to the mass spectroscopist engaged in interpreting high resolution mass spectra of organic compounds. The bibliography includes 2,485 separate citations.

Although this book is on the whole an excellent one, it has some definite weaknesses. For example, although a description is given of the Eyring, *et al.*, quasi-equilibrium rate theory of the origin of mass spectra, no use of this theory is made in the discussion of the various aspects of mass spectra such as the origin of ions of non-integral mass-

to-charge ratio, isotope effects on fragmentation patterns, or the general nature of fragmentation patterns. A lack of understanding by the author of some important aspects of mass spectrometry is indicated by the erroneous explanation given on page 277 for the experimental data shown in Figure 124 on page 278.

A lack that will detract from the utility of this book to many analytical chemists is the very little space devoted to the important problem of the use of mass spectrometers in type or group analysis and the inadequate discussion of the use of low energy ionizing electrons in simplifying the interpretation of mass spectra and particularly in the distinction between doubly charged ions and singly charged ions of half the mass (see pages 56 and 57).

On the basis of the reviewer's personal experience, typographical errors are to be expected in a volume of the size of the present one, and they do occur. One that might be confusing to the reader inexperienced in the field occurs on page 254, where the equation describing the reaction that results in the broad peak at $m/q = 30.5$ in the butane mass spectra, the products are given as $(C_3H_8^+) + CH_2$ instead of the correct $C_3H_8^+ + CH_4$.

As a final critical remark it should be noted that like all experts in a particular analytical technique, Beynon occasionally falls prey to the disease of over-enthusiasm. Thus he devotes two-thirds of page 344 to a description of an indirect mass spectral technique for distinguishing between a saturated hydrocarbon with four fused rings and an alkyl benzene of the same empirical formula ($C_{16}H_{26}$ not $C_{16}H_{16}$ as given in the text). As Beynon points out elsewhere in his book, any laboratory that can afford a \$100,000 mass spectrometer will have optical spectrophotometers and with an ultraviolet instrument available the solution of this problem is trivial.

The typography and the subject index are excellent, and the binding and paper appear to be of a quality that will permit the frequent use that will be given this book by practicing analytical mass spectroscopists.

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Solid State Physics. Advances in Research and Applications. Volume 11. Editors, FREDERICK SEITZ, Department of Physics, University of Illinois, Urbana, Illinois, and DAVID TURNBULL, General Electric Research Laboratory, Schenectady, New York. Academic Press Inc., 111 Fifth Avenue, New York 3, N. Y. 1960. xvi + 438 pp. 16 × 23.5 cm. Price, \$12.50.

The scientist who wishes to keep abreast of developments in the rapidly expanding field of solid state physics has been well served by the series of volumes bearing the above title. In the eleventh volume, as in the past, each article is written by an authoritative worker in the field, thereby maintaining the high standards set by the previous editions. A welcome additional feature of this volume is the inclusion of a cumulative index to the first ten volumes in the series.

The theme of a large portion of this volume is the determination of the detailed electronic energy band structures of solids, by galvanomagnetic, piezoresistive, photoelectric and cyclotron resonance techniques, all of which may be classified as advances in research. This reviewer would like to see more articles dedicated to advances in applications, in keeping with the original concepts of the series.

In the section entitled "Semiconducting Properties of Gray Tin," G. A. Busch and R. Kern review not only the solid state electronic properties of gray (or α) tin, but also the kinetics of the transition between the α - and β -modifications. The results of a large number of measurements of conductivity, Hall coefficient, magnetoresistance, thermoelectric power, magnetic susceptibility and photoconductivity are discussed, and from them the authors have chosen values of the semiconductor parameters which are thought to be most reliable. The wide variations in the data may be attributed to the difficulty of preparing pure samples.

Single crystals of α -tin were first successfully grown only in 1958.

High pressure research has expanded considerably since the appearance of P. W. Bridgman's "The Physics of High Pressures" in 1949, and the chapter entitled "Physics at High Pressures" by C. A. Swenson, with references covering the period from 1946 to date, is a timely review of developments in this area of research on the solid state. The article describes the application of new materials and techniques to such measurements as PVT data, phase transitions, resistivities of metals and semiconductors, superconductivity, nuclear magnetic resonance, dielectric constant, optical spectra and diffusion. Particular emphasis is given to studies of high pressure in the cryogenic region, a specialty of the author.

Continuing the theme of the dependence of the properties of a solid upon applied stress, the succeeding article by Robert W. Keyes reviews "The Effects of Elastic Deformation on the Electrical Conductivity of Semiconductors." The quite large piezoresistance effects observed in many semiconductors are a result of the disturbance of the electronic energy levels by an applied stress, and the author describes in detail the ways in which measurements of such phenomena can be interpreted to yield various features of the electronic structure.

In his chapter "Imperfection Ionization Energies in CdS-Type Materials by Photoelectronic Techniques," Richard H. Bube reviews some recent investigations of photoelectronic behavior in Group II-Group VI insulators. The location of the complex ionization levels introduced into such insulators by both impurities and defects is not always possible by standard techniques, and the author shows how such levels may be deduced from photoelectronic data and gives a generalized picture of their relative positions for different anions and cations.

The longest and most comprehensive chapter, "Cyclotron Resonance" by Benjamin Lax and John G. Mavroides, is a complete survey of the development of cyclotron resonance techniques, particularly as applied to solids, and draws upon the experience of a decade of pioneering in this field. The authors trace the maturing of this powerful technique to its present position as a sophisticated and valuable tool in the exploration of the basic electronic properties of charged carriers in solids, concluding with a summary of the achievements to date and some future prospects.

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Perchlorates. Their Properties, Manufacture and Uses.

ACS Monograph No. 146. Edited by JOSEPH C. SCHUMACHER, Vice President, Research, American Potash and Chemical Corporation. Reinhold Publishing Corporation, 430 Park Avenue, New York 22, N. Y. 1960. xii + 257 pp. 16 X 23.5 cm. Price, \$8.75.

This volume comes into the world of chemical literature well fortified by forewords. There is the general introduction for the ACS Monograph Series in which the observation is made that the line of demarcation between pure and applied science has virtually disappeared. A foreword by F. C. Mathers points up the delayed acceptance in this

country of perchlorates as interesting and useful compounds and expresses the hope that some stimulus toward the discovery of a cheap process will be brought about by this book. The same wish is found in the Editor's preface where acknowledgment is given to his associates in the American Potash and Chemical Corporation who have contributed most of the text. Chapter 1 is in a sense also an introduction. It gives a chronological account of the development of the production of perchlorates from their discovery in 1816 by Count Frederich von Standon to the new expansion brought about by the use of perchlorates in solid propellants.

The monograph was promoted by a desire to share the substantial bibliography on perchlorates which the Editor had collected over many years. This has been done generously. There are over a thousand references to the scientific and patent literature.

Four chapters by R. D. Stewart deal with the general chemistry of perchlorates. W. A. Gale also contributes to four chapters. The use of perchlorates mainly as desiccants and some solubility data on aqueous systems of several perchlorates are by this writer alone. He is co-author with the editor and T. W. Clapper in an important chapter on the manufacturing processes and with M. Weber in an interesting chapter on the uses of perchlorates in explosives and in solid propellants. The analysis of perchlorates and the use of perchlorates in analytical chemistry are discussed at length by H. A. Kerry. The biological activity of perchlorates and the precautions to be observed in handling perchlorates are described in separate chapters by E. Levins.

An organization of this kind leads inevitably to some duplication of references which are given at the end of each chapter and also to much repetition. Many common factors are encountered in discussing the biological action, the use in explosives and propellants, the hazards in manufacturing, and the precautions in handling. There are sections of the book where one has the impression that statements have been collected directly from reference cards and that there is lacking some critical comment by the authors and by the Editor. This restrained attitude toward the printed word is not helpful to the reader in evaluating some of the statements. On pages 133 and 176 we are confronted with apparently conflicting statements about the reaction of ammonium perchlorate with carbon taken from Carlson's British and Swedish patents, respectively. Some other observations could bear elaboration but none is given. "The first known complex perchlorate anions were formed from lead perchlorate," "Water was oxidized to hydrogen at the anode." "The solid phases were identified as basic salts by X-ray analysis" are some examples. There are some lapses in the index. The compound $P(OH)_4ClO_4$ is not to be found in the index although $Se(OH)_6ClO_4$ is listed. It is called selenium perchlorate and referred to in the text as a basic salt. A formula index would have been a useful addition.

This monograph belongs on the bookshelf to anyone who deals with perchlorates. The general reader would find much to interest him in its pages, but one is left with the impression that in some areas there is still a pronounced difference between applied and pure chemistry.

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