

Throughout the book, one feels a lack of emphasis on problems arising from the scarcity of biochemicals, and often methods are cited for their rapidity and with little regard as to whether or not biochemicals are available in sufficient amounts. But the book is well worth having for the researcher and the student, and surely meets the author's plan "that the reader will be able to form an impression of the possibilities, limitations and achievements of each technique." The book will be useful to many, and one hopes that it will inspire some to take up the fascinating field of rapid reactions.

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Noble Gases and Their Compounds. By G. J. MOODY and J. D. R. THOMAS, Welsh College of Advanced Technology, Cardiff. The Macmillan Co., 60 Fifth Ave., New York 11, N. Y. 1964. 62 pp. + vii. 13.5 × 20.5 cm. Price, \$2.00.

After a ten-page introduction including historical background and factual data about the noble gases, pages 11 through 52 discuss the recent developments in noble gas chemistry. More than half of the 134 references end with (1962) or (1963).

The authors' stated purpose of bringing together into a convenient volume information from many different journals has certainly been accomplished. The book can easily be read in one evening and gives a quick survey of the early part of the recent interesting developments in a field of chemistry quite nonexistent before 1962. The writing was too early to include much on the now extensive aqueous chemistry of xenon, and theoretical discussions of binding have been largely ignored.

The careful reader will be bothered by numerous mistakes such as crediting a theoretical chemist with a warning about the hazards of XeO₃ in a publication dated earlier than the actual discovery (by someone else) of XeO₃, quoting a m.p. of 100° when the quoted authors said "was observed not to melt up to 100°," etc.

More serious than these mistakes and typographical errors is the lack of critical evaluations and even of careful reading of the papers referred to. As an example of this lack, on page 19 there are quoted values of 10 and of 15.3 kcal./mole for the enthalpy of sublimation of XeF₄ as if they were equally reliable. In fact, the former was just a guess made for the purpose of a rough calculation, and the latter was a measured value.

Many of the references quoted were preliminary announcements published quickly as notes because of the great interest in the new field. A number of these notes include mistakes that were later corrected in "Noble Gas Compounds," University of Chicago Press, a report of a conference held in April, 1963. Although the present authors include this book among their references, they evidently did not have time to read it. If they had, they could have corrected a number of these errors in the literature instead of serving to perpetuate them.

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Inorganic Ultramicroanalysis. By I. P. ALIMARIN and M. N. PETRIKOVA, U.S.S.R. Academy of Sciences. The Macmillan Co., 60 Fifth Ave., New York 11, N. Y. 1964. xv + 151 pp. 14.5 × 22.5 cm. Price, \$6.00.

According to the authors, this small book represents an attempt to present a systematic summary of the techniques of ultramicroanalysis, which they define as the analysis of masses of 10⁻⁸–10⁻¹² g., using volumes of 10⁻³ to 10⁻⁶ ml. Soviet work in the field—particularly that of the authors—is strongly represented, of course.

About two-thirds of the book is devoted to methods of qualitative analysis. The manipulative techniques described are essentially those developed by Benedetti-Pichler many years ago. The tests suggested for the qualitative detection of various elements use conventional reagents: thiocyanate for iron, cobaltinitrate for potassium, chloride for silver, and so on.

Some minor alterations of the nonsulfide scheme of qualitative microanalysis published some 10 years ago by C. L. Wilson and his colleagues are suggested.

The chapter dealing with methods of separation is more interesting. Electrolytic separations using either platinum or mercury cathodes are described in some detail, and directions are given for electrolyzing vanadium-copper-iron and vanadium-chromium solutions, with subsequent detection of the separated elements at levels of 10 to 100 nanograms (millimicrograms).

A miniature ion-exchange column is referred to. A photograph of the column and fraction collector is shown, but details of column dimensions and flow rates are not given (many other techniques mentioned in the book are described with similar vagueness).

The section on quantitative analysis covers both gravimetric and volumetric methods. Ultramicrobalances and methods for their calibration are treated briefly in what amounts essentially to a summary of published American experience in the field.

However, in volumetric ultramicroanalysis—especially in the employment of potentiometric and amperometric methods—there is evidence of very good work, and some elegant techniques are described. Supporting data are presented in the form of titration curves.

In addition to a not-unreasonable number of typographical errors, the book contains other errors which indicate either carelessness or a lack of understanding of the material treated.

Thus in discussing the theoretical limits of application of ultramicroanalysis, the authors use as a sole criterion statistical adherence to the laws of chemical equilibrium. Hence 10⁶ molecules are sufficient for a quantitative analysis accurate to 0.1% ($\sqrt{10^6}/10^6 = 0.1\%$). Little thought is required to discover the general inapplicability of this criterion.

On page 3, equation 3 is incorrectly stated to represent the fractional change in vapor pressure of a liquid as a function of the curvature of its surface. The authors have confused differences in pressure with differences in vapor pressure.

On page 97, the cantilever ultramicrobalance ("fishpole balance") is erroneously called a torsion balance, and a drawing of a cantilever balance (Figure 35) is mislabeled accordingly. (Perhaps the reviewer is unduly perturbed by this error, since the drawing is reproduced without credit from one of his papers.)

On the same page, the quantity *J* appearing in equation 13 is defined as the moment of inertia of the fiber, whereas actually it is the moment of inertia of its cross section about the line of intersection of the neutral plane with the cross section.

The general impression created is that the work done by the authors in volumetric ultramicroanalysis is quite good, but that in attempting their more general survey of the field of ultramicroanalysis, they have been hasty and uncritical.

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The Chemistry of Imperfect Crystals. By F. A. KROGER, Philips' Research Laboratories, Eindhoven, The Netherlands. John Wiley and Sons, Inc., 605 Third Ave., New York 16, N. Y. 1964. 1039 pp. + xiv. 6.5 × 9 cm. Price, \$33.00.

Traditionally, chemistry has dealt more with reactions between atoms and molecules in gaseous or liquid media than in solids. Although chemists as long ago as 1914 were aware that non-stoichiometric solids (Bethollides) existed, it was not until attempts to explain their electrical properties were made that the great importance of crystal imperfections (impurities and lattice defects) became evident. Gudden and Pohl (1920–1930) were among the first to recognize this. However, it was Schottky and Wagner who showed how statistical thermodynamics and the law of mass action could be usefully applied to reactions in crystals involving vacancies and electrons, as well as atomic species.

Parallel to this development of the chemistry of crystal imperfections, there has been a corresponding, and even greater, in terms of numbers of publications, development of the physics of crystal imperfections beginning with A. H. Wilson's energy band model in 1931. The gap between the chemistry and physics of crystal imperfections has steadily closed with time, and today the common meeting ground is the microscopic attack on the nature of the imperfections themselves as disclosed chiefly by optical and electron spin resonance investigations backed up by crystal field theory.

Kroger's book, as the title states, is concerned primarily with the chemistry of imperfections. In this pursuit, it is by far the most comprehensive and complete work of its kind published to

date. Although thermodynamics and the law of mass action are adopted as the basis for most of the discussions, some knowledge of band theory and crystal optics is assumed in the treatments relating to semiconductors and alkali halides. However, these topics, as well as the more strictly chemical, are introduced with sufficient explanatory matter that most readers will encounter little difficulty in understanding.

The book is divided into three parts. Part I deals with crystal preparation and the thermodynamics of phases. Part II deals more specifically with imperfections and their equilibria in such reactions as ionization, association, and precipitation. The various kinds of crystal order are discussed. This part also includes a most complete treatment of particular crystals, primarily the alkali halides and semiconducting compounds. Part III concerns itself with applications. These involve corrosion, solid-state cells, the photographic process, catalysis, and phase transitions.

It is a large book (1039 pp.) but somewhat smaller in size than would be two volumes of the same total number of pages. An attempt has been made to conserve space in the volume, but unfortunately this has required reducing some of the figures to a point where they are readable only with difficulty. This perhaps could have been helped by combining Chapters 4 and 5 and omitting some of the solution chemistry. The multiple listing of references on separate pages has also added to the space problem. This is a feature, however, that the reference-minded reader will greatly appreciate since it allows him to immediately identify the source material without need to refer to the elusive ends of the chapters. A complete author index is included and is useful. The subject index is less extensive but appears to be adequate.

F. A. Kroger, the author, is widely known and eminently qualified for the huge task he has completed in writing this book. The exposition and organization are excellent and a relief from the spotty treatment characteristic of some multiauthored surveys. Although Kroger has co-authored in recent years a number of review articles (many with H. J. Vink), which cover some of the same ground as in this book, there is considerable to be said for having the material included in book form with other related subject matter.

Two aspects of book derived from the European continent which may not be familiar to American readers might be commented on. One concerns the nomenclature adopted to symbolize the different crystal imperfections. The author (with H. J. Vink) introduced the "atomic notation" for such imperfections and these have, to a large extent, been adopted in this country. At the same time, he has adopted the designation of charges by means of the accent ($'$), dot (\cdot), and cross (\times) for minus, plus, and neutral, respectively, rarely seen in American usage. Many readers will also find the writing of chemical reactions in solids confusing and might wish the author had discussed and summarized the problem early in the volume.

The second point concerns the prevalent use of graphs showing the logarithm of the concentrations of imperfections *vs.* the logarithm of the concentration of one of the constituents in a reaction (G. Brouwer, *Philips Res. Rept.*, **9**, 366 (1954)). These are alternatives to analytical expressions obtained from the mass action relations and the neutrality condition. The plots have the advantage of quick, semiquantitative visualization of different approximate solutions for the analytical expressions. Those adept at making mathematical approximations may prefer the analytical method. As for the plots, one needs to be experienced with the making and interpreting of them in order to derive useful conclusions from them. They then can prove very valuable. Another advantage of the plots is the wealth of information which can be put into them.

As with most books of this size, some errors have crept in. Many of the latter have been corrected in an addendum. Those that remain are few and in no way reduce the usefulness of the volume.

As mentioned before, one of the valuable features is the completeness of the literature survey relating to the subjects of this volume. Not only have all the pertinent references been included, but many of them have appeared only in the last year. Because of Kroger's intimate familiarity with the literature, he has been able to indicate to readers interested in extending their knowledge where additional information can be found. This makes his book of particular value as a reference work. It will, therefore, prove useful to those doing solid-state research, as well as to instructors and to students. The book might be used as a text, but it is indispensable as a reference book.

In the preface, Kroger states that he hopes this book will earn

a place next to others already published on solid-state chemistry. There can be no doubt that his wish will be fulfilled. Nowhere can one find the comprehensive documentation of the literature interwoven with an appropriate discussion of the topics as exists in this book. The author is to be congratulated for a lasting contribution.

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Organic Functional Group Analysis by Micro and Semimicro Methods. By NICHOLAS D. CHERONIS, Late Professor of Chemistry, Brooklyn College, City University of New York, and T. S. MA, Professor of Chemistry, Brooklyn College, City University of New York. John Wiley and Sons, Inc., 605 Third Ave., New York 16, N. Y. 1964. 696 pp. + xxv. 16 × 24 cm. Price, \$25.00.

This excellent book, which was written by two pioneers in the field of organic analysis on a micro or semimicro scale, contains a wealth of information. It is divided into three parts—"Principles and Techniques," "A Critical Survey of the Analytical Methods for Functional Group Determinations," "Experimental Procedures"—and includes the following information.

Part One. Principles and Techniques.—Chapter 1 (20 pp.), "Introduction," briefly discusses the subjects of organic analysis in general, and it then goes on to define functional groups and the problems involved in their analyses, as well as the application of these analyses to the compounds of unknown structure. Table 1 lists the functional groups with their structures and classifications (oxygen, nitrogen, unsaturated, sulfur, and miscellaneous). In all, there are 115 listings, and only a few of them overlap, such as alcohol and hydroxyl, acetal and ketal, etc. Table 2 includes a summary of the more important methods used for the estimation of the listed functional groups, such as alkimetry for carboxyl, cleavage with hydriodic acid for alkoxy, catalytic hydrogenation for unsaturation, etc.

Chapter 2 (10 pp.), "Classification and Limitations of Analytical Methods," includes a discussion on the basis of classification from the standpoints of both the weight and the equivalency of the sample. Definitions of the terms macro, semimicro, and micro methods follow, together with a discussion of the advantages and the problems of micro procedures.

Chapter 3 (33 pp.), "Chemical Basis of Functional Group Determinations," includes aqueous and nonaqueous titrations, oxidation-reduction reactions, measurement of water formed (or consumed) in the various reactions, measurement of gases formed, and formation of precipitates. Six tables summarize the discussion, and three additional tables present pH, K_a , and K_b data. The summary tables give a great deal of information at a glance.

Chapter 4 (9 pp.), "Influence of Molecular Structure on the Reactions Employed for the Analysis of Organic Compounds," discusses such things as the selection of the reagents to be used and the reactivity of the functional group in the presence of other constituents.

Chapter 5 (29 pp.), "General Analytical Techniques," gives information regarding the balances, weighing, weighing accessories, titration, and filtration. The authors have ignored the work on the standardization^{1,2} of the various pieces used for weighing and drying and show pieces of their own. The reviewer cannot help but be prejudiced on this point, owing to his association with the problem. However, others who are farther removed from it might not notice this. The reviewer also feels that the term "microchemical balance" should have been used in place of "microbalance," since the latter term is used to better describe such balances as the quartz fibre type.

Part Two. A Critical Survey of the Analytical Methods for Functional Group Determinations.—Chapters 6 and 7 (116 pp.), "The Oxygen Functions, Part I" and "The Oxygen Functions, Part II," contain eight headings each, which discuss a total of fifteen functions. Each heading is subdivided; for example, the heading "The Acetal Function" includes the general aspects, determination of the alkoxy groups present, and the determination of the function by hydrolysis. There are a number of

(1) American Society for Testing Materials, ASTM Designations, E 124-57T, 1957; E 124-61, 1961.

(2) A. Steyermark, H. K. Alber, V. A. Aluise, E. W. D. Huffman, E. L. Jolley, J. A. Kuck, J. J. Moran, C. L. Ogg, and C. O. Willits, *Anal. Chem.*, **26**, 1186 (1954).