

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 ( $\grave{\cdot}$ ), 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<sup>1,2</sup> 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).

figures which acquaint the reader with some of the pieces of apparatus used. In the reviewer's opinion, these are of questionable value to a beginner, since very few details are given regarding the parts or the dimensions to show the size of the equipment. On the other hand, the experienced microanalysts will find them to be of considerable value as a guide when investigating new methods or making a choice between existing ones. The same condition applies to other chapters.

Chapter 8 (98 pp.), "The Nitrogen Functions," discusses eleven types of functions; some of these cover several related functions, such as azido, cyano, and isocyano. The material is presented in a manner similar to that of the oxygen functions—a general discussion of each function, which includes several methods, and the apparatus used. The authors discuss the gasometric method, but fail to include the manometric one. The apparatus for the latter is the more versatile and more frequently used today.

Chapter 9 (38 pp.), "The Sulfur Functions," has seven sections which describe fifteen functions in the same manner as the preceding chapters. It includes titrimetric, gasometric, oxidative, and colorimetric methods.

Chapter 10 (37 pp.), "The Unsaturated Functions," deals with compounds which have double or triple bonds between carbon atoms. Addition of halogens, mercuric salts, thiocyanogen, nitrogen tetroxide, ozone, mercapto compounds, etc., as well as hydrogenation, oxidation, formation of metal acetylides, etc., are all discussed.

Chapter 11 (84 pp.), "Miscellaneous Functions," covers such subjects as the determination of active hydrogen, C-methyl, water, arsenic, boron-, mercury-, phosphorus-, and silicon-containing compounds, etc. It also includes a number of useful tables, particularly those dealing with titration information. They show titrants and solvents for the determination of various functions, and Table 11.3 lists the electrode systems for potentiometric determinations.

**Part Three. Experimental Procedures.**—Chapter 12 (74 pp.), "Microdetermination of Functional Groups with Ordinary Equipment," describes procedures for 30 determinations using flasks, pipets, burets, pH meters, spectrophotometers, etc. These procedures give detailed information which includes the principle, apparatus, reagents, calculations, and notes. There are also some very informative comments which explain what the experiment demonstrates, what else can be determined by the same procedure, interferences, etc.

Chapter 13 (72 pp.) is the last chapter. Entitled "Microdetermination of Functional Groups Using Special Apparatus," it describes 27 functions using such apparatus as the Kjeldahl, alkoxy, hydrogenation, gas chromatographic, etc. The presentation is the same as in Chapter 12. Table 13.1 presents a good summary of the procedures and apparatus used for the determination of the functions treated in the chapter.

Appendix A lists a few supply houses for equipment and apparatus which will be helpful to the beginner, and Appendix B gives a schedule for a one-semester course.

In conclusion, it is the reviewer's opinion that this book will make an extremely valuable addition to the library of any research or analytical chemist who deals with organic compounds.

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**Boron-Nitrogen Chemistry.** Advances in Chemistry Series No. 42. An International Symposium Sponsored by the U. S. Army Research Office, Durham, at Duke University, Durham, N. C., April 23–25, 1963. KURT NIEDENZU, Symposium Chairman. Edited by ROBERT F. GOULD. American Chemical Society, 1155 Sixteenth St., N. W., Washington 6, D. C. 1964. x + 330 pp. 16 × 23.5 cm. Price \$7.50.

The isoelectronic analogy between B–N and C–C compounds has attracted the interest of organic and physical-theoretical chemists alike, leading to a large development of new chemical variety. The extremely fast growth of the B–N chemistry within the past ten years is apparent even from a glance at the table of contents of this printed version of the symposium held last year at Duke University. Dr. Niedenzu is to be congratulated on his ability to bring to one place so many B–N experts from so many countries and representing such a wide range of chemical experience.

Of the 32 papers, 20 would be classified as new syntheses. Many of these represent the introduction of B–N bonds into organic chemistry, with results which must seem quite spectacular from that viewpoint. There are five papers devoted primarily to bonding theory; four are concerned mostly with vibrational spectra; and only two deal especially with nuclear magnetic resonance—but most of the other papers depend in some part upon these modern sources of understanding.

The arrangement of papers roughly follows the order of types  $R_3NBR_3$ ,  $R_2NBR_2$  and polymers, and  $(RNBR)_n$  polymers, but many compounds do not fit these type-formulas even with a very broad interpretation of the symbol R. The whole impression of the book is somewhat like an issue of a well-refereed journal, in which it is difficult to detect any errors of either detail or general understanding. This book should do much to arouse the interest of chemists having widely different backgrounds of experience, and for the further progress of a subject offering great opportunities for still more chemical novelty.

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