

Methods of preparing thermoelectric materials are described in Chapters 8 and 9, which deal with crystal growth and the chemistry of mixed valence materials. Chapter 8 covers techniques and problems in crystal growth from the melt. Methods of manipulating the solute concentration, including zone melting, are reviewed, and the distribution equation for various conditions is given. The difficult subject of the atomic and macroscopic morphology of solid melt interfaces is well treated, as are the mechanisms of incorporation of imperfections during growth from the melt. The mathematical treatment of the problems introduced by supercooling at the interface and temperature fluctuations at the heat source is apparently new, and should be very useful in helping to estimate the seriousness of these problems in practice. The chapter concludes with a review of methods of obtaining phase diagram data, problems of diffusion layer control and thermal control, and a brief description of conventional methods of growth from the melt. Chapter 9 reviews the general chemical principles of mixed valence materials, describes various methods of preparation with particularly useful references to specific problems, and ends with a discussion of the analytical techniques useful in evaluating mixed valence materials. These chapters provide an excellent and comprehensive introduction to the rather difficult and important field of material preparation.

Chapter 10 on measurements of properties of thermoelectric materials should be one of the most interesting sections for the student investigating properties of specialized materials for use in thermoelectricity. The emphasis is on techniques of measurement rather than design of apparatus. Topics discussed include: thermal conductivity, the Seebeck coefficient, electrical resistivity, the maximum temperature difference, and contact resistance. The theory of the measurements of these effects is well described.

The theory of thermoelectric materials is described in Chapter 11. A detailed treatment of this subject is difficult and the authors emphasize that the present state of solid state physics is inadequate to handle the problem. Nevertheless it is possible by empirical methods for the worker to obtain guidance in the selection and improvement of materials. The basic problem is to find substances with the highest figure of merit. This involves simultaneous control of the three parameters: Seebeck coefficient, thermal conductivity and electrical resistivity. The treatment is divided mainly into two parts: (a) figure of merit of broad-band semiconductors and (b) figure of merit for narrow-band semiconductors, ionic crystals and liquids. A concluding section of this chapter treats the problems of materials selection and improvement of already known materials.

Low temperature Peltier cooling is the subject of Chapter 12. For this case efficiency is not the main consideration, but instead the lowest attainable temperature. It turns out, however, that these properties are not incompatible. The materials which have proved most valuable for Peltier cooling in the room temperature range can be understood in terms of the extrinsic semiconductor model. Some semiconductors at low temperature encounter a temperature range in which the Seebeck effect rises precipitously with decreasing temperature. This phenomenon is attributed to the so-called "phonon drag effect." Use of metals is discussed for Peltier cooling. The advantage possessed by metal is a low ratio of thermal to electrical conductivity. However, their low Seebeck coefficient is a disadvantage and makes them unsuitable for Peltier cooling.

Chapter 13 gives a survey of known thermoelectric materials, including those with a high figure of merit. The properties of thermal conductivity, electrical resistivity, Seebeck coefficient and figure of merit are given for a number of well known thermoelectric materials. Some materials discussed are: ZnSb, Pb(Te, Se), (Bi, Sb)₂(Te, Se), In(Sb, As, P), MnTe and (Ge, Bi)Te. The thermoelectric properties of these materials are discussed in the light of various physical characteristics: carrier type, crystal structure, electron band structure, ionic vacancies, atomic spacing, etc.

A short chapter (14) is devoted to the subject of thermionic conversion. This is done because of (a) the close physical relation between the effects of thermoelectricity and thermionic conversion and (b) the fact that the processes are competitive and complementary. They are competitive in the sense that they use similar power sources and complementary because thermoelectric devices operate at low

temperature while thermionic conversion works best at high temperature. The basic theory of thermionic converters is given and a discussion of power and heat flow in the devices is presented. Space charge effects in the thermionic conversion process are discussed and it is shown how they complicate the results and how these complications in turn are circumvented.

The last three chapters in the book deal, respectively, with the three specific aspects of thermoelectric devices: (a) theoretical calculation of device performance, (b) heat transfer problems in thermoelectric devices, and (c) technology of thermoelectric devices. The final chapter gives a description of a number of commercial thermoelectric devices which have been developed to a state of useful performance and practical simplicity.

This book on thermoelectricity can be highly recommended to a wide variety of readers, including the beginning student in this field, the development engineer interested in the materials and manufacture of these devices and the general scientist interested in the present status of the devices in this field. The reader will find the summaries at the beginning of each chapter very helpful.

KODAK RESEARCH LABORATORIES
ROCHESTER, N. Y.

J. H. WEBB

Mineral Metabolism. An Advanced Treatise. Volume I. Principles, Processes and Systems. Part B. Edited by C. L. COMAR, Cornell University, Ithaca, New York, and FELIX BRONNER, Hospital for Special Surgery, Cornell Medical Center, New York, New York. Academic Press Inc., 111 Fifth Avenue, New York 3, N. Y. 1961. xv + 538 pp. 16 × 23.5 cm. Price, \$14.50.

The two parts of Volume I carry the same sub-title: "Principles, Processes and Systems." In part A, the vocabulary of mineral metabolism is defined in brief discussions of thermodynamic principles, cybernetics, information theory applied to biology, the properties of chelates, compartmental analysis, and ion transport mechanisms. This part is completed by detailed descriptions of mechanisms for the passage of minerals through body fluids especially in the intestine, the kidney and certain extrarenal structures (*J. Am. Chem. Soc.*, 83, 4110 (1961)).

Part B presents (a) the bafflingly complex hormonal control of mineral metabolism, (b) the composition and kinetics of mineral turnover in the three sorts of tissues most involved (connective tissue, bone, teeth) and (c) the roles of mineral (especially metal) ions in enzyme reactions. The hormonal control of minerals is described in two chapters, one devoted primarily to the actions of the anterior pituitary and the parathyroid hormones on calcium, inorganic phosphorus, iodine and iron metabolism (sulfur, magnesium and other minerals are discussed briefly; summaries are presented of the roles of the target organs—adrenals, thyroid, ovaries, testes); the other delineating how the hormones of the posterior pituitary, the adrenal cortex and the gonads affect the metabolism of water, sodium, potassium and chloride. Clinical data are drawn on. An occasional light touch adds to the presentation, for example, "Figure 3 illustrates some of the fact and fancy concerning the regulation of aldosterone as well as ADH secretion." Three chapters are devoted to the interplay between mineral and organic components in connective tissues, in bone and in teeth. From the four classes of connective tissues, examples are chosen (e.g., blood, lymph, lens, cornea, tendon, skin) and the present knowledge of mineral content and flux is summarized. The chapter on bone emphasizes the kinetics of the bone mineral constituents especially as revealed by isotope studies. The chapter on teeth gives a brief morphological description followed by a careful delineation of chemical composition and metabolism with emphasis on isotopic studies. The final chapter entitled, "Inter-relationships with Enzymes" begins with a survey of the principles of enzyme reactions. Considerable attention is then paid to modifiers: "Most effects of inorganic ions on enzyme reactions are of the modifier type" (page 760). Summaries with extensive tables are given of metalloprotein enzyme and metal-activated enzyme reactions. Several specific mechanisms, e.g., those of phosphate-transferring, the metalloflavoprotein and the heme enzymes are diagrammed and discussed. "The inorganic modifier provides the link between the reaction and the environment. There

probably does not exist a single enzyme-catalysed reaction in which either substrate, product, enzyme, or some combination within this triad is not influenced in a very direct and highly specific manner by the precise nature of the inorganic ions which surround and 'modify' it" (page 856).

Carefully selected modern bibliographies constitute in total nearly 100 pages, almost one-sixth of the book. The book ends with a 45 page index of which 17 pages are devoted to subject matter.

The editors and the chapter authors deserve our thanks and our compliments. As the preface states, "Even now the subject area will no longer be encompassed by two volumes and two editors." The material included is well-selected. Volume I successfully consolidates "existing knowledge for the specialist" and is admirably suited to "serve as a reference text for . . . advanced students in biology, medicine and agriculture."

DEPARTMENT OF PHARMACOLOGY
UNIVERSITY OF ROCHESTER
ROCHESTER 20, N. Y.

HAROLD C. HODGE

An Index of Published Infra-Red Spectra. Volumes I and II. Edited by Mrs. M. B. B. THOMAS, with some assistance from Mr. E. R. ADAMS. British Information Services, 45 Rockefeller Plaza, New York 20, N. Y. 1960. x + 805 pp. 21 × 33.5 cm. Price, \$18.40 postpaid.

These two volumes are not sold separately. In the first are listed organic compounds of C₁-C₉; in the second, organic compounds of C₁₀ onward plus those of undetermined structure or ill-defined composition, along with inorganic compounds. Most of the infrared spectra published up to 1957 are to be found in these volumes, and data from 1957 and succeeding years will be included in a third volume which is now in active preparation. Those who would use any index of published spectra would like to know the limiting criteria for inclusion of data, the method of listing and the information provided. These facts are well set forth in the introduction to these volumes by Dr. L. J. Bellamy, who played a role in the initiation and encouragement of the project.

The requirements for the inclusion of a reference to an infrared spectrum are "that either a fairly extensive range should have been covered at normal rock-salt resolution, or a more limited range at higher resolution." Let it be clearly understood that the present work is an index for the location of spectra rather than a compilation of actual spectra. Moreover, no reference will be listed for a reported partial spectrum, where, for example, only one or two characteristic infrared bands are mentioned. These are often extremely useful to the organic or inorganic chemist but would admittedly be almost impossible to index. A different measure of usefulness is intended for the spectra which qualify for inclusion in these volumes.

The listing of compounds is by molecular formula, which provides a convenient method of searching for a given compound. By contrast, the complementary and possibly competing book, H. M. Hershenson's "Infrared Absorption Spectra, Index for 1945-1957," Academic Press, Inc., New York, N. Y., 1959, lists compounds by name, following the *Chemical Abstracts* system, and reference only. In "An Index of Published Infra-Red Spectra," after the molecular formula entry the compounds with the same formula are listed alphabetically. The references (given *fully*, which is a blessing since no special journal code need be consulted) to a single compound are listed chronologically. The state in which the sample was studied is indicated, the spectral range covered is expressed in either wave length or wave number, as in the original paper, and the optics are given. Thus, one can determine from a glance at the listings under state, range and optics whether the original reference to a compound contains the spectral information desired. These are time-saving volumes. They will prove most useful if brought up to date regularly by the issue of additional volumes. Dr. Bellamy states in his introduction that the intention will be made possible if libraries (especially) support the venture by purchase.

DEPARTMENT OF CHEMISTRY AND CHEMICAL ENGINEERING
UNIVERSITY OF ILLINOIS
URBANA, ILLINOIS

NELSON J. LEONARD

Progress in Cryogenics. Volume 3. Edited by K. MENDELSSOHN, D. Phil. (Berlin), M. A. (Oxon), F. Inst. P., F.R.S. Academic Press Inc., 111 Fifth Avenue, New York 3, N. Y. 1961. vii + 173 pp. 16 × 25 cm. Price, \$8.00.

This book is the third volume in a series intended to provide up-to-date information in the field of cryogenics. The chapters (each written by experts in their respective fields) are titled 1. Helium Liquefiers, 2. Low Temperature Heat Exchangers, 3. Novel Refrigeration Cycles and Devices, 4. Cryogenic Rocket Propellants, 5. Paramagnetic Substances for Nuclear Orientation, and 6. Dynamic Nuclear Orientation.

The first three chapters are concerned with the practical business of liquefaction methods and devices. Included are detailed and critical descriptions of commercial and laboratory-made liquefiers. The accompanying diagrams and photographs should prove useful. The third of these chapters discusses new refrigeration methods which "promise the possibility of achieving temperatures even as low as liquid helium with equipment which can be very small. . . . and as reliable as household Freon refrigerators."

The chapter on liquid rocket propellants is brief and discusses the problems of selection, handling and measurement.

Two chapters (nearly half of the volume) are devoted to nuclear orientation. The first considers the requirements and suitability of various paramagnetic substances for nuclear orientation. The second, dealing with dynamic nuclear orientation, discusses in some detail methods, techniques and apparatus. Applications and results are given in the final section.

BERKELEY THERMODYNAMICS LAB.
BUREAU OF MINES
226 HEARST MINING BUILDING
BERKELEY 4, CALIFORNIA

E. G. KING

The Enzymes. Second Edition, Completely Revised. Volume 5. Hydrolytic Cleavage (Part B). Phosphate Ester Cleavage. Acid Anhydride Cleavage. Phosphorolytic Cleavage. C-C Synthesis and Cleavage. Isomerization. Hydration and Dehydration. Edited by PAUL D. BOYER, Department of Physiological Chemistry, University of Minnesota, Minneapolis, Minn.; HENRY LARDY, Institute for Enzyme Research, University of Wisconsin, Madison, Wis.; and KARL MYRBÄCK, Institute for Organic Chemistry and Biochemistry, University of Stockholm, Stockholm, Sweden. Academic Press Inc., 111 Fifth Avenue, New York 3, N. Y. 1961. xix + 645 pp. 16 × 23.5 cm. Price, \$20.00.

The first edition of "The Enzymes," edited by Sumner and Myrbäck, rapidly gained acceptance as the standard reference for this field. The publication of a second edition approximately 10 years later is fully justified by the increased insight into the nature of enzymatic processes and properties as well as the large amount of descriptive information about individual enzymes published during this time. The field of biochemistry has been the recipient, or victim, of a logarithmically expanding number of reviews that omit few subjects. Nevertheless, it is a service to all to provide a comprehensive treatise that includes surveys of the entire field of enzymology by active workers in specialized areas. It is apparent that these investigators are concerned with problems of current interest, so that this edition must be viewed as a tool for the next several years, to be superseded by an even more expanded series when problems reach a more sophisticated level. It is to be hoped that eventually precise knowledge of enzyme structure and mechanism of action will permit brief statements of fact to replace the elaborate circumlocutions now required to construct images of enzymes from indirect evidence.

In Volume 5 of the present series, the editors have succeeded admirably in organizing a series of topics that are profitably surveyed in addition to being described in separate articles. The six general groupings of reactions included in this volume are the subjects of review articles of exceptional interest. The authors of these surveys have been allowed to explore many facets of their subjects, leaving the more complete descriptions of individual enzymes to the authors of more specialized articles.