X = *p*-chlorophenyl), m.p. > 320°; λ_{max}^{EtOH} 228, 265 mμ (ε = 8,330, 4,730); λ_{max}^{Nujol} 2.92, 3.10, 6.05, 6.23, 6.47, 6.60 μ; calcd. for $C_7H_6BClN_2O_2$ (196.42): Cl, 18.05; N, 14.26; found: Cl, 18.48; N, 14.27.

The cyclization of *o*-aminobenzaloxime with benzeneboronic acid furnished the deep yellow compound VI, m.p. 249–251°; λ_{max}^{EtOH} 224, 337 mμ (ε = 40,100, 9,750); λ_{max}^{Nujol} 2.95, 6.13, 6.20, 6.40, 6.95 μ; calcd. for $C_{13}H_{11}BN_2O$ (221.05): B, 4.90; N, 12.68; found: B, 4.88; N, 12.42.

Finally, *o*-aminobenzenesulfonamides and arylene- or aralkyleneboronic acids afforded compounds of type VII. Thus, 5-amino-α,α,α-trifluoro-2,4-toluene-disulfonamide and 2-phenylethaneboronic acid gave VII (R = $C_6H_5CH_2CH_2$, Y = H_2NSO_2), m.p. 210–212°; λ_{max}^{Nujol} 3.03, 6.20, 6.40, 6.66, 6.96 μ; calcd. for $C_{15}H_{15}BF_3N_3O_4S_2$ (433.23): B, 2.50; N, 9.70; found: B, 3.09; N, 9.48, which had diuretic activity of the order of that of chlorothiazide.

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BOOK REVIEWS

Die Hochmolekularen Organischen Verbindungen. Kautschuk und Cellulose. By HERMANN STAUDINGER, Dr. Phil., O. Professor, Direktor des Chemischen Laboratoriums der Universität, Freiburg *I*. Br. Springer-Verlag, Heidelberger Platz 3, Berlin-Wilmersdorf, Germany. 1960. xv + 540 pp. 17 × 25 cm. Price, DM 59.—.

This book represents a reprint of the original publication (1932) which at that time summarized the work of Staudinger and his groups in the then very new and controversial field of high polymers.

The review of the original book by W. H. Carothers (*J. Am. Chem. Soc.*, 54, 4469 (1932)) reflects the wealth of new ideas and fields of research which were just being discovered and indicates the problems and difficulties encountered by the pioneers in this area.

The present reprint will allow a larger number of polymer chemists not only to become acquainted with a large part of the early history of polymer research; it probably will surprise them by its scope, and still may be a source of suggestions for future investigations.

The book is well printed and gives an index and a bibliography of Staudinger's papers up to 1932.

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Thermoelectricity: Science and Engineering. By ROBERT R. HEIKES and ROLAND W. URE, Jr., Westinghouse Research Laboratories, Pittsburgh, Pennsylvania. Interscience Publishers, Inc., 250 Fifth Avenue, New York 1, N. Y. 1961. xi + 569 pp. 16 × 23 cm. Price, $18.50.

This book contains a valuable store of information prepared by a group of sixteen experts including the two principal authors, Heikes and Ure. It covers the subject of thermoelectricity, one of several methods of direct energy conversion being vigorously pursued at the present time. Other schemes are thermionics, fuel cells and magneto hydrodynamics. The scientific and engineering aspects of the subject are well covered, about equal space being devoted to the topics: (1) physics and chemistry of thermoelectric materials, (2) the design of materials, and (3) the technology of thermoelectric devices.

The book begins at an easy level with a short introductory chapter on the elementary effects of thermoelectricity. These include the reversible phenomena: Seebeck, Peltier and Thompson effects; and the irreversible phenomena: joule heating and thermal conduction. The discussions of these effects and the calculation of the device efficiency constitutes a pleasing introduction. From a historical standpoint, the references to Kelvin's original treatment (1854) in Chapter 2 and the narration of the vindication of Kelvin's theory following Onsager's development of irreversible thermodynamics are interesting sidelights.

Chapter 3 treats the electronic properties of semi-conduction and semi-metals. It begins with a clear description of the band theory of solids, and treats the topics of density of energy states and the mass factor of current carriers. In turn, the subjects of defect electron levels, Fermi–Dirac distribution function, relaxation time and mobility of carriers are discussed. The Peltier and the Seebeck effects are then discussed from the standpoint of band theory and the reader begins to sense the desirable properties of materials for thermoelectricity. Other subjects discussed are transport properties and electron scattering mechanisms. The treatment of the latter subject is especially illuminating, dealing as it does with all the major classes of electron scattering.

In Chapter 4, transport phenomena for narrow-band semiconductors, ionic crystals and liquids are discussed from the band structure model. In spite of some lack of detailed knowledge about the motion of the charge carriers in these cases, the theory is adequate for the treatment of thermoelectric phenomena.

There is an interesting chapter on thermal conduction in thermoelectric materials, this being one of the main considerations in the development of thermoelectric devices. An excellent description is given of the mechanisms by which heat transport can take place and the factors which influence it.

An entire chapter is devoted to the effects of high energy radiation on thermoelectric materials. This is pertinent because of the prospects of using thermoelectric generators in combination with nuclear reactors. The mechanisms by which changes are produced by radiation are discussed: transmutation, ionization by electrons, fission of atoms, production of thermal or displacement "spikes," creation of interstitial atoms and vacancies, and ordering or disordering of atoms. Experimental data are included to illustrate the effects of radiation.

Because of the importance of diffusion processes in thermoelectricity and in the preparation of materials for this purpose, a chapter is devoted to the theory of diffusion and experimental results of diffusion for various semiconducting materials. Atomic migration resulting from thermal diffusion and ionic migration resulting from electric field gradients are also included.

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 imcompatible. 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), $(Bi, Sb)_2(Te, Se)_3$, 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.

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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