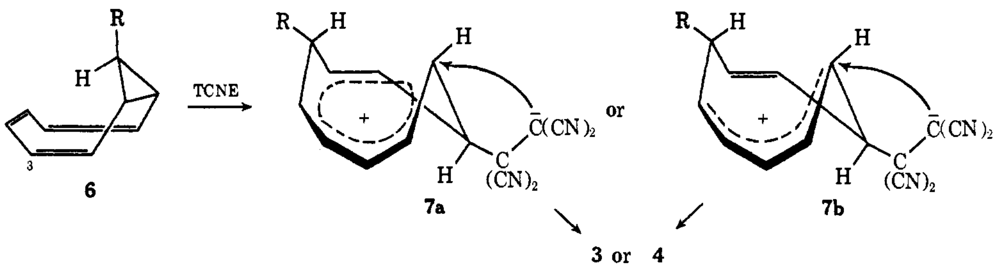

and 4.4 (AB pattern, $J_{AB} = 11$ Hz, 2, bridgehead). The three-dimensional features of **4b** as unambiguously established by X-ray diffraction are shown in the computer-generated drawing given in Figure 2.[6]

With the structures of **3** and **4** now resolved, some commentary on their mechanism of formation appears in order. The possibility of concerted $({}_{\pi}2_{s} + {}_{\pi}2_{s})$ cycloaddition to *cis*^{4}-cyclononatetraenes (conceivably present in low concentration) is not tenable for reasons of ring juncture stereochemistry and because of the negative control experiments of Baxter and Garratt.[3b] Nor is direct $({}_{\pi}2 + {}_{\pi}8)$ cycloaddition to **1**[3a] compatible with the structural data. Concerted $({}_{\pi}2_{a} + {}_{\pi}2_{s})$ fusion to *cis*^{2},*trans*,*cis*-cyclononatetraene (thermally producible from **1**)[7] must likewise be considered inoperative because exclusive cis ring fusion in the adduct would result. Similarly, the postulate of stepwise ${}_{\pi}2 + {}_{\pi}2$ cycloaddition to this tetraene does not seem warranted because it is not entirely reconcilable with the high level of stereoselectivity associated with the substituent at C-6 in **4a** and **4b**. Rather, the above data, when taken in consort with our additional observations that only anti-9 and not syn-9 substituted bicyclo[6.1.0]-nonatrienes react with TCNE under the stated conditions, seemingly point again[1] to that pathway which involves initial electrophilic attack of TCNE at C-3 of the less stable bicyclononatriene tub conformation **6**. Generation of **7a** or **7b** is followed by C–C bond formation as shown to afford uniquely a trans-fused cyclobutane ring.

Earlier,[3] the capability of TCNE for nonconcerted cycloaddition to *cis*-bicyclo[6.1.0]nonatrienes with the formation of bifunctional dipolar ions was not considered. Yet, the ionic character of numerous TCNE cycloadditions to a variety of alkenes,[8] strained unsaturated hydrocarbons,[9] and cyclic polyolefins[10] is well recognized. In the particular case of **1**, the development of stabilizing electronic delocalization in intermediates **7a** and **7b**[1] apparently constitutes a significant driving force for the ionic pathway.[11]

(6) Complete details of the two X-ray analyses will be outlined in our full paper. All bond distances and angles agree well with generally accepted values. For **3**, full-matrix least-squares refinements converged smoothly to the present minimum of 8.5% for the conventional discrepancy index. In the case of **4b**, a relatively high *R* factor of 12.9% has been realized because of crystal decomposition which was detected in the check reflections but not corrected for.

(7) A. G. Anastassiou and R. C. Griffith, *J. Amer. Chem. Soc.*, **93**, 3083 (1971).

(8) P. D. Bartlett, *Quart. Rev., Chem. Soc.*, **24**, 473 (1970).

(9) See, for example: S. Nishida, I. Moritani, and T. Teraji, *J. Chem. Soc. D*, 36 (1971); J. E. Baldwin and R. E. Peavy, *J. Org. Chem.*, **36**, 1441 (1971); J. E. Baldwin and R. K. Pinschmidt, Jr., *Tetrahedron Lett.*, 935 (1971); R. Noyori, N. Hayashi, and M. Katô, *J. Amer. Chem. Soc.*, **93**, 4948 (1971).

(10) H.-P. Löffler, T. Martini, H. Musso, and G. Schröder, *Chem. Ber.*, **103**, 2109 (1970).

(11) This work was supported in part by the National Science Foundation (O. S. U.) and the U. S. Atomic Energy Commission (I. S. U.) whom we thank.

(12) Holder of a NATO Postdoctoral Fellowship (1970–1972) administered by the Science Research Council.

Jon Clardy, Leonard K. Read
Department of Chemistry, Iowa State University
Ames, Iowa 50010

Michael J. Broadhurst,[12] Leo A. Paquette*
Department of Chemistry, The Ohio State University
Columbus, Ohio 43210

Received November 5, 1971

Book Reviews

Advances in Molten Salt Chemistry. Volume 1. Edited by J. Braunstein (Oak Ridge National Laboratory), Gleb Mamantov (University of Tennessee), and G. P. Smith (Oak Ridge National Laboratory). Plenum Press. New York and London. 1971. xii + 284 pp. $17.50.

This new series will be a valuable reference to those working in the area of molten salts. Contributors and topics in this first volume are: R. E. Hester, University of New York, "Vibrational Spectroscopy of Molten Salts"; Y. Marcus, Hebrew University, "Liquid Extraction from Molten Salts"; C. R. Boston, Oak Ridge National Laboratory, "Molten Salt Chemistry of the Haloaluminates"; D. A. J. Swinkels, Broken Hill Proprietary Co., Ltd., New South Wales, Australia, "Molten Salt Batteries and Fuel Cells"; and J. W. Hastie, National Bureau of Standards, "Thermodynamic Studies, by Mass Spectrometry, of Molten Mixed Halide Systems."

Each article has been written as a review intended to bring the reader up to date in a particular area of molten salt research. Dates on literature references indicate that materials available through 1969 and some early 1970 work have been included.

Hester's article on vibrational spectra includes introductory theoretical material and a review of experimental techniques, both of which are helpful to the nonspecialist. Advantages and disadvantages of transmission, reflectance, and emission infrared methods are discussed as are various sources and cell designs. The section on results includes an interesting summary of complex species and polymers (involving groups II, III, and IVA and I, II, and IVB metals) which have been characterized with infrared and Raman spectra.

Chapter 2 on liquid extraction by Marcus also includes a treatment of introductory theory (mostly thermodynamic but some kinetics) and experimental technique. Data on miscibility gaps are given for binary systems (58 systems) and ternary systems with a common ion (152 systems). Selected distribution systems are surveyed, and the usefulness of distribution data in characterizing species present in the systems is emphasized as is the need for extension of theory to allow prediction of immiscibility in certain reciprocal systems, and the size of the miscibility gap or gaps of binary systems.

C. R. Boston's review of the haloaluminates summarizes information about both the physical and chemical properties of the aluminum halides and their mixtures with other halides. The low melting points and wide range of acid–base properties are emphasized. The comments on melt preparation and handling are brief but contain useful information for those interested in initiating work in these solvents.

Swinkel's chapter on molten salt batteries reviews advantages and disadvantages of molten salt electrolytes for energy conversion devices and the elementary theory of battery characteristics. Discussion of specific battery systems has been limited to those which "have some potential for energy conversion or energy storage applications and have been studied in some detail." Concentration cells and thermal cells are reviewed and special attention is given to lithium–chlorine and sodium–sulfur cells. The fuel cell review is brief; however, this topic has been covered in numerous other monographs.

Thermodynamics of mixed halide systems by mass spectrometry is reviewed by J. W. Hastie. Very little concerning experimental technique is included; however, references are given. Theory is also very briefly treated; a general outline of the use of total vaporization isotherms is given.

The remainder of the review gives results for binary and reciprocal and "similar systems" and briefly summarizes structure of vapor-phase species and unifying concepts.

Drannan C. Hamby, *Linfield College*

Epoxide Resins. By W. G. Potter (Science Research Council, London). Springer-Verlag New York, Inc., New York, N. Y. 1970. 248 pp. $12.80.

This book, which is intended primarily for those studying for the professional examinations of the Plastics Institute (United Kingdom), is a useful introduction to the chemistry and applications of epoxy resins. Its coverage includes synthesis of the raw materials; curing methods and mechanisms; modifying materials; cycloaliphatic and epoxidized olefin resins; utilization as surface coatings, laminates, and adhesives; and uses in the electrical, building, and construction industries. Safe handling of the resins is also discussed.

The style is clear and there are numerous tables and illustrations. The references are selective and generally adequate. It would have been helpful to the industrial chemist if assignees and dates for the numerous patents were included. Also the references to various American Chemical Society symposia, of which there are many, are not sufficiently detailed to be truly useful.

This book should serve its intended purpose well. Because it is relatively small, active workers in the field will probably prefer to consult the larger, but more expensive, books covering the same subject.

Norbert M. Bikales, *N. M. Bikales & Company*

Polymer Colloids. Edited by R. L. Fitch (University of Connecticut). Plenum Press, New York, N. Y. 1971. 183 pp. $14.50.

Twelve papers of an ACS symposium are published here, and ten of these deal with latex polymers. It is gratifying to see the great number of experimental techniques and theoretical approaches that are being applied to this technologically important area and, conversely, how the technique of latex polymerization throws new light on some fundamental aspects of colloid chemistry.

The theory of electrostatic effects on colloidal stability is more precisely than heretofore assessed in three papers by Vanderhoff, Matijevic, and their coworkers. Myers, Krieger, and Vanderhoff are principal authors of several papers which give new insights on the morphology of the assembly of colloidal particles at different degrees of aggregation. Particle formation in emulsion polymerization in the absence of micellar surfactants is treated in three papers with Fitch and Roe as principal investigators. Interesting assessments of ionic polymer end groups are given by Vanderhoff and Palit. Two papers deal with the classical problems of emulsion polymerization: particle size distribution (Sundberg) and copolymerization (Haskell). Weiss and coworkers present a new mathematical formulation of colloidal electrostatic theory.

The understanding of the formation and of the behavior of polymeric colloids requires knowledge of many disciplines. This compendium of papers gives a taste for all or most of these disciplines and provides very stimulating reading.

J. L. Gardon, *M&T Chemicals Inc.*

The Chemical Industry during the Nineteenth Century. By L. F. Haber. Oxford University Press, London. 1969. x + 292 pp. $19.25.

This book, a reissue of the 1957 edition, provides a detailed and well-documented account of nineteenth century chemistry, both industrial and academic. Major emphasis is placed on the economics and development of certain major businesses, primarily the soda and the dyestuffs industries, but the production and trade of other major chemicals in Europe and North America is also discussed. The author (son of Nobelist Fritz Haber) has developed a valuable compendium of data for the chemical historian or economist. Further, his assessments of these data and his general conclusions appear to be both logical and well substantiated. However, the general chemist reading this volume might well find the work more relevant had the author broadened his scope to give greater consideration to the social and political impacts of chemical science and the chemical industry during this period.

Charles A. Eckert, *University of Illinois*

Electrical Conductivity of Vitreous Substances. By Rudol'f L. Myuller (a special research report, translated from Russian). Plenum Press, New York, N. Y. 1971. 198 pp. $30.00.

This book is an English translation of a Russian text. This text is a collection of articles by the late Professor R. L. Myuller selected by an editorial committee consisting of Z. U. Borisova, O. V. Mazurin, and V. S. Molchanov. The text was published by Leningrad University Press in 1968.

The author's articles are closely interrelated where each work was based on the conclusions and results of previous works. Thus there is a surprising degree of continuity. This is particularly apparent in the series of eleven articles concerned with the conductivity of solid ionic-covalent materials. These articles were published in succession and were written in text form.

The book is divided into three parts. The first part is concerned with the Electrical Conductivity of Ionic Glass. In these chapters an experimental physical chemical analysis of the electrical conductivity is reported. The electrochemical approach is the result of a development of the essential electrophysical concepts. Good agreement was indicated between experimental data and theoretical generalizations.

The electrochemical principles for ionic-covalent media are unique and are determined by the structural chemistry and the kinetics of processes in such media.

The second part of the book is concerned with the Electrical Conductivity of Vitreous Semiconductors. An attempt is made in this section to calculate conductivity for covalently bonded semiconductors with low mobility carriers. A model is proposed which is based on a concept of the discrete character of localized electron-pair chemical bonds between the atoms.

The final and shorter part of the book is concerned with the structure of Vitreous Materials. As in the two previous parts, this section attempts to relate experimental studies with a theoretical analysis of vitreous materials.

Most of the articles have considerable data, and this greatly aids in the comprehension of the theoretical considerations. Little if any attempt is made to elaborate on measurement techniques.

W. H. Barney, *Corning Glass Works*