

BOOK REVIEWS

Proton Conductors: Solids, Membranes, and Gels—Materials and Devices (No. 2 in Chemistry of Solid State Materials Series)

Edited by P. Colomban
(Cambridge University Press, 1992,
581 pages).
ISBN: 0-521-38317X

Proton conductors have attracted much attention during the past decade, particularly in relation to electrochemical device applications such as fuel cells and gas monitors. This book aims to fill the gap left by the numerous volumes on fast (superionic) conduction in solids, most of which contain little mention of protonic conductors. The only notable previous publications deal with specialized topics, such as the series of edited contributions on solid-state proton conduction (I, II, and III) edited by the late Johs Jensen, and specialized reviews in journals such as *Solid State Ionics*.

The scope of this work is more ambitious. It attempts to go beyond the narrow definition of fast ion conductors by tying together proton transport in materials as diverse as ice, hydrogen in metals, layered solids such as hydrogen uranyl phosphate, high-temperature protonic conductors, perfluorinated sulphonic polymers, and gels. A compilation of 39 chapters by 38 contributing authors, the book deals with all aspects of proton conduction in solids, including thin membranes. Its editor, Philippe Colomban, firmly sets his stamp on the volume by being the first author in nine of the chapters.

Obviously, with such a large subject, this short review cannot do justice to all of the book's contents. However, the chapters are classified into five broad sections, providing a convenient way to describe the book.

The first section, entitled "The hydrogen bond and protonic species," contains six introductory contributions detailing the nature of the hydrogen bond, protonic species, and a classification of protonic conductors. This classification can be done by the nature of the diffusing species and the dimensionality of the conduction process, or by the method used in the synthesis of the material. Also included is a discussion of structural studies of protonic conductors and a description of hydrogen in metals.

The next section, "Materials preparation, structure and properties," is the largest section in the book, with 14 contributions divided into three subsections. Although a classification scheme is provided in the opening section, it is not

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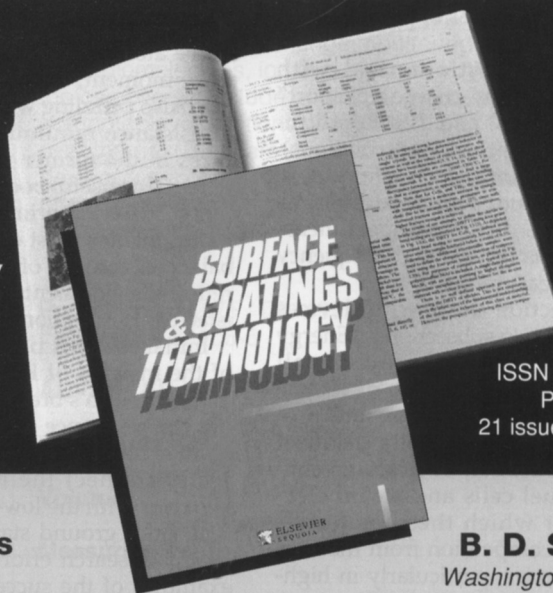
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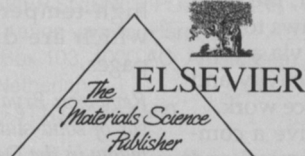
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used to subdivide this section on materials. The first part bears no title, and is followed by a subsection on inorganic ion exchangers, then by a section on layer hydrates. This subdivision is only a minor irritation, for the section contains some particularly interesting contributions, such as Iwahara's chapter on high-temperature protonic conductors based on the perovskite structure. A wide range of materials is covered in this section, and all main classes of protonic conductors are discussed.

The next two sections deal with "Proton dynamics and charge transport" (eight contributions) and "Proton diffusion mechanisms" (three contributions). The proton dynamics cover neutron, NMR, infrared, and Raman studies, as well as the more direct transport measurements such as dc and high-frequency conductivity measurements.

The final section deals with devices and is split into two subsections: "Energy storage and production" and "Small components and microionic devices." The section on energy storage and production deals with potentially the most important application of protonic conductors—in fuel cells and steam electrolyzers—for which these materials receive strong competition from the oxygen ion conductors, particularly in high- and medium-temperature applications. The accompanying section deals with small devices, and covers sensors, batteries, electrochromic devices, supercapacitors, and ice-based devices.

With coverage of such a diverse number of topics, the obvious criticism is that none of the chapters (which average 15 pages in length) goes into enough detail to satisfy both the graduate student and the experienced researcher. Some of the diagrams are not of the quality expected of a modern textbook and give the impression that space has been sacrificed to reduce the size of each section. The assumed starting knowledge varies considerably, as does the depth to which each subject is taken. However, the main value of this book is that it draws together disparate areas of research via a common theme of protonic conductivity and provides an invaluable reference work.

The preface claims "...to give a comprehensive survey of the chemical and physical parameters governing proton conduction." This book achieves its aim and offers an excellent reference for those interested in this fascinating topic.

Reviewer: J.A. Kilner is a reader in the Materials Science Department of Imperial College, London, England.

The Kondo Problem to Heavy Fermions

A.C. Hewson

(Cambridge University Press, 1993, 425 pages).

ISBN: 0-521-36382-9

Correct descriptions of the electronic structures of dilute alloys of 3d and 4f elements in simple metals, and explanations of their properties in terms of such descriptions, challenged solid-state physicists when it became apparent that an Fe atom in Au or Mo carried a magnetic moment, while in Al or Nb it did not. Also puzzling was the observation of a resistance minimum at low temperatures in the former pair, but not in the latter. This useful book, after a clear summary of the experimental history of the topic, devotes most of its space to a well-balanced account of the successive theoretical developments that have led to satisfactory descriptions and explanations.

Initial sections provide brief accounts of the insights of Friedel and Anderson and of Kondo's breakthrough in explaining the resistance minimum. These lead to an account of the long struggle to correctly connect the high-temperature behavior with the low-temperature "non-magnetic" ground state. The trail blazed by this research effort provides striking examples of the success of renormalization group calculations and some surprisingly successful perturbation theory results for Fermi liquid models as it leads to the successful exact solutions associated with the Bethe ansatz.

All of this subject matter is treated thoroughly, and the book should prove beneficial to experimentalists as well as theorists. Only one chapter deals with the theoretical problems raised by inter-metallic compounds with a regular lattice of Kondo impurities, and the author wisely refrains from offering firm answers about the ways some of these are associated with magnetic order and superconductivity. However, he properly indicates their potential relevance to high-temperature superconductors, which are discussed in the last few pages.

Reviewer: Bryan R. Coles is emeritus professor of solid-state physics and senior research fellow in the Department of Physics, Imperial College, London, England.

Books

Below is a list of recently published books and new journals, relevant to materials science, that have come to the *Bulletin's* attention. Reviews of some of the books listed here may appear in future issues of the *MRS Bulletin*.

Advances in New Materials, Contemporary Topics in Polymer Science, Volume 7, J.C. Salamone and J.S. Riffle, eds. Plenum Press, New York, 1992. 380 pp, *hc*, ISBN 0-306-44253-1.

Biomaterials—An Introduction, J.B. Park and R.S. Lakes, eds. Plenum Press, New York, 1992. 394 pp, *hc*, ISBN 0-306-43992-1.

Chaotic and Fractal Dynamics—An Introduction for Applied Scientists and Engineers, F.C. Moon. John Wiley & Sons, New York, 1992. 508 pp, *hc*, ISBN 0-471-54571-6.

Comprehensive Polymer Science—First Supplement, G. Allen, S.L. Aggarwal, and S. Russo, eds. Pergamon Press, New York, 1992. 690 pp, \$300.00 *hc*, ISBN 0-08-037071-3.

Concise Encyclopedia of Materials Characterization, R.W. Cahn and E. Lifshin, eds. Pergamon Press, Oxford, 1993. 641 pp, *hc*, ISBN 0-08-040603-3.

Concise Encyclopedia of Materials Economics, Policy & Management, M.B. Bever, ed. Pergamon Press, Oxford, England, 1993. 460 pp \$240.00 *hc*, ISBN 0-08-037056-X.

Electron Theory in Alloy Design, D.G. Pettifor and A.H. Cottrell, eds. Institute of Materials, London, 1992. 311 pp, \$110.00 *hc*, ISBN 0-901716-17-0.

Electronic Properties of Materials, 2nd edition, R.E. Hummel. Springer-Verlag, New York, 1993. 404 pp, \$49.00 *hc*, ISBN 0-387-54839-4.

Electronic Thin Film Science for Electrical Engineers and Materials Scientists, K-N. Tu, J.W. Mayer, and L.C. Feldman. Macmillan Publishing, New York, 1992. 428 pp, *hc*, ISBN 0-02-421575-9.

Encyclopedia of Materials Science and Engineering, Supplementary, Volume 3, R.W. Cahn, ed. Pergamon Press, Oxford, 1993. 2,229 pp, \$500.00 *hc*, ISBN 0-08-040590-8.

Field Emission and Field Ionization, American Vacuum Society Classics, R. Gomer. American Institute of Physics, New York, 1993. 195 pp, *pb*, ISBN 1-56396-124-5.

The Fullerenes, H.W. Kroto, J.E. Fischer, and D.E. Cox, eds. Pergamon Press, New York, 1993. 318 pp, *hc*, ISBN 0-08-042152-0.

Getting to Know Semiconductors, M.E. Levinshtein and G.S. Simin. World Scientific, River Edge, New Jersey, 1992. 174 pp, *hc*, ISBN 981-02-0760-3.

Handbook of Electron Tube and Vacuum Techniques, American Vacuum Society Classics, F. Rosebury. American Institute of Physics,

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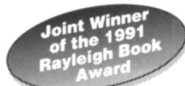
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High Resolution XPS of Organic Polymers—The Scienta ESCA300 Database, G. Beamson and D. Briggs. John Wiley & Sons, Chichester, England, 1992. 295 pp, *hc*, ISBN 0-472-93592-1.

Intense Dynamic Loading of Condensed Matter, A.V. Bushman, G.I. Kane, A.L. Ni, and V.E. Fortov. Taylor & Francis, Washington, DC, 1993. 287 pp, *hc*, ISBN 1-56032-003-6.

Introduction to Physical Polymer Science, 2nd edition, L.H. Sperling. John Wiley & Sons, New York, 1992. 594 pp, *hc*, ISBN 0-471-53035-2.

Life and Times of Modern Physics—History of Physics II, M. Phillips, ed. American Institute of Physics, New York, 1992. 366 pp, *hc*, ISBN 0-88318-846-5.

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Mechanical Properties of Semiconductors, Semiconductors and Semimetals, Volume 37, K.T. Faber and K. Malloy, eds. Academic Press, San Diego, 1992. 375 pp, *hc*, ISBN 0-12-752137-2.

Modern Aspects of Electrochemistry No. 24, R.E. White, B.E. Conway, and J.O. Bockris, eds. Plenum Press, New York, 1993. 466 pp, *hc*, ISBN 0-306-44288-4.

Nuclear Reactions: Science and Trans-Science, Masters of Modern Physics Series, A.M. Weinberg. American Institute of Physics, New York, 1992. 334 pp, \$25.00 *hc*, ISBN 0-88318-861-9.

Particulate Materials and Processes, Volume 9, Advances in Powder Metallurgy & Particulate Materials—1992, compiled by J.M. Capus and R.M. German. Metal Powder Industries Federation, Princeton, New Jersey, 1992. 489 pp, \$140.00 *hc*, ISBN 1-878954-28-8.

Phase Equilibria Diagrams, Cumulative Indexes, Volume I–IX, Annuals '91–'92, High T_c Monograph, M.A. Clevinger and K.M. Hill. American Ceramic Society, Westerville, OH, 1992. 187 pp, *pb*, ISBN 0-944904-54-8.

Phase Equilibria Diagrams, Phase Diagrams for Ceramicists, Semiconductors and Chalcogenides, Volume IX, G.B. Stringfellow, ed. American Ceramic Society, Westerville, Ohio, 1992. 400 pp, \$100.00 member, \$125.00 list, *hc*, ISBN 0-944904-50-5.

Physical Basis of Ultrahigh Vacuum, American Vacuum Society Classics, P.A. Redhead, J.P. Hobson, and E.V. Kornelsen. American Institute of Physics, New York, 1993. 498 pp, *pb*, ISBN 1-56396-122-9.

Properties of Gallium Arsenide, EMIS Datareviews Series No. 7, S. Adachi, ed. INSPEC, Institution of Electrical Engineers, London, 1993. 325 pp, \$195.00 *hc*, ISBN 0-85296-558-3.

Quantum Well Lasers, P.S. Zory Jr., ed. Academic Press, San Diego, 1993. 504 pp, *hc*, ISBN 0-12-781890-1.

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Rapid Thermal Processing—Science and Technology, R.B. Fair, ed. Academic Press, San Diego, 1993. 430 pp, *hc*, ISBN 0-12-247690-5.

Semiconductors for Solar Cells, H.J. Möller. Artech House, Norwood, Massachusetts, 1993. 343 pp, *hc*, ISBN 0-89006-574-8.

Sintering, *Advances in Powder Metallurgy & Particulate Materials—1992*, Volume 3, compiled by J.M. Capus and R.M. German. Metal Powder Industries Federation, Princeton, New Jersey, 1992. 441 pp, \$120.00 *hc*, ISBN 1-878954-22-9.

Soft Magnetism: Fundamentals for Powder Metallurgy and Metal Injection Molding, *Monograph in P/M Series No. 2*, C. Lall. Metal Powder Industries Federation, Princeton, New Jersey, 1992. 141 pp, \$60.00 *pb*, ISBN 1-878954-17-2.

Systematic Analysis of Bipolar and MOS Transistors, U. Çilingiroğlu. Artech House, Norwood, Massachusetts, 1993. 235 pp, *hc*, ISBN 0-89006-625-6.

Temperature: Its Measurement and Control in Science and Industry, *Volume Six, Part Two*, J.F. Schooley, ed. American Institute of Physics, New York, 1992. 615 pp, *hc*, ISBN 1-56396-092-3 (Part Two); ISBN 1-56396-093-1 (set).

Tissue-Inducing Biomaterials, *Materials Research Society Symposium Proceedings, Volume 252*, L.G. Cima and E.S. Ron, eds. Materials Research Society, Pittsburgh, PA, 1992. 407 pp, \$52.00 MRS members, \$60.00 U.S. list, \$70.00 foreign, *hc*, ISBN 1-55899-146-8.

Tungsten & Tungsten Alloys—1992, *Proceedings of the International Conference on*

Tungsten and Tungsten Alloys, November 15–18, 1992, Arlington, Virginia. A. Bose and R.J. Dowding, eds. Metal Powder Industries Federation, Princeton, New Jersey, 1993. 520 pp, \$145.00 *pb*, ISBN 1-878954-30-X.

Underwater Scattering and Radiation, *Physical Acoustics, Volume XXII*, A.D. Pierce and R.N. Thurston, eds. Academic Press, San Diego, 1993. 384 pp, *hc*, ISBN 0-12-477922-0.

Vacuum Technology and Space Simulation, *American Vacuum Society Classics*, D.H. Holkeboer, D.W. Jones, F. Pagano, and D.J. Santeler. American Institute of Physics, New York, 1993. 339 pp, *pb*, ISBN 1-56396-123-7.

Wide Band-Gap Semiconductors, *Materials Research Society Symposium Proceedings, Volume 242*, T.D. Moustakas, J.I. Pankove, and Y. Hamakawa, eds. Materials Research Society, Pittsburgh, PA, 1992. 789 pp, \$53.00 MRS members, \$60.00 U.S. list, \$70.00 foreign, *hc*, ISBN 1-55899-136-0.

XRF Analysis of Ceramics, Minerals and Allied Materials, H. Bennett and G.J. Oliver. John Wiley & Sons, United Kingdom, 1992. 298 pp, *hc*, ISBN 0-471-93457-7.

New Journals

Advanced Cement Based Materials (published in affiliation with the American Concrete Institute), Surendra P. Shah and J. Francis Young, eds. Elsevier Journal Customer Service Department, (212) 633-3950; fax (212) 633-3990. Bimonthly; first issue: October 1993. Subscription rates: Institutional—\$215.00, personal—\$107.00.

Intermetallics, R.W. Cahn, C.T. Liu, G. Sauthoff, and M. Yamaguchi, eds. Elsevier Journal Customer Service Department, (212) 633-3950; fax (212) 633-3990. Quarterly; first issue: May 1993. Subscription rates: £154.00/US\$246.00.

International Journal of Self-Propagating High-Temperature Synthesis, A.B. Merzhanov, V.V. Barzykin, M. Koizumi, and R.M. Spriggs, eds. Allerton Press, (212) 924-3950; fax (212) 463-9684. Quarterly; first issue: September 1992. Subscription rates: Institutional, North America—\$325.00; foreign, add \$40.00. Individual, North America—\$95.00; foreign, add \$15.00.

Laser Physics, A.M. Prokhorov, ed. SPIE, (206) 676-3290; fax (206) 647-1445. Bimonthly. To receive an annual subscription, contact Interperiodica Subscription Office, P.O. Box 1831, Birmingham, AL 35201-1831. Subscription rates: Library, North America—\$400, outside North America—\$436; individual SPIE members, North America—\$320, outside North America—\$349.

Materials Science & Engineering C—Biomimetic Materials, Sensors and Systems, D. De Rossi, P. Calvert, and T. Tateishi, eds. Elsevier Sequoia, P.O. Box 564, CH-1001 Lausanne, Switzerland, 41-21-20-73-81; fax 41-21-23-54-44. Three issues/year; first issue: spring 1993. Subscription rate: SFr 303.00 including postage to most countries.

Polymer Gels and Networks, T. Tanaka, Y. Osada, S.B. Ross-Murphy, and R.A. Siegel, eds. Elsevier Journal Information Center, (212) 989-5800. Quarterly; first issue: May 1993. Subscription rates: £120.00/US\$211.00. □

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