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Electronic Basis of the Strength of Materials

John Gilman

(Cambridge University Press, Cambridge, UK, 2003)

290 pages, \$95.00

ISBN 0-521-62005-8

At the outset of his book, *Electronic Basis of the Strength of Materials*, John Gilman emphatically states that continuum mechanics is inadequate to account for the strength properties of materials. Most textbooks contain a gap between continuum and dislocation mechanics. Many phenomena and properties (such as elastic constants of materials) are left unaccounted for. The reason for this is that the electronic structure of materials has a seminal role in the mechanical response. Gilman fills this gap. His book provides a unified view enabled by Gilman's extraordinary career spanning 50 years in which he made seminal contributions to the understanding of mechanical behavior in materials.

Descartes, in the 17th century (*Discours de la Méthode*), separated and emphasized two aspects of research: analysis and synthesis. The second should periodically follow the first if one is to gain a profound, unified understanding of a field. Gilman's book is a remarkable expression of synthesis, and it represents an impressive accomplishment. It connects bonding with elasticity, plasticity, and fracture of materials. It does this at a level that can be comfortably assimilated by a graduate student, avoiding unnecessary esoteric convolutions of theory and explaining basic facts that are avoided in other textbooks.

The book is well suited as a graduate text and, indeed, students will gain insight into the mechanical response of materials. As Gilman states in the foreword, this book relates the complete set of strength characteristics to the electronic structure. This part is completely ignored in continuum mechanics, where the properties are elusive, mysterious parameters that are mathematically operated on. Atoms are not even mentioned. In the conventional treatments of the topic of mechanical behavior of materials, atoms form the foundation for the mechanisms. Gilman takes us one step further in the dimensional scale: Electrons are the starting point. He uses Heisenberg's principle and the principle of polarizability as cornerstones of his vision. From there, he obtains bulk and shear moduli (in elastic deformation) and explains key aspects of plastic deformation, strength, and fracture. Throughout the book, historical aspects of importance are interjected, helping the reader understand the flow of ideas and seminal developments.

Reviewer: Marc Meyers is a professor of

materials science in the Department of Mechanical and Aerospace Engineering at the University of California, San Diego.

True Genius: The Life and Science of John Bardeen

L. Hoddeson and V. Daitch

(Joseph Henry Press,

Washington, DC, 2002)

482 pages, \$27.95

ISBN 0-309-08408-3

Inasmuch as John Bardeen spent the major part of his professional career at the University of Illinois, it is not surprising that the university took the lead in 1991 (just a few weeks after his passing) to generate a biography under the leadership of Lillian Hoddeson, who has a PhD degree in physics and is a professor of the history of science at the university. She was soon joined by Vicki Daitch, then a graduate student in history. Together, over a 10-year period, they carried out the necessary research and wrote the biography. Initially intended only as a scholarly biography, it eventually developed as well into a general exploration of scientific genius and creativity, with Bardeen as the exemplar.

The book is organized into 16 chapters plus an epilogue, a 28-page bibliography, 82 pages of notes, some acknowledgments, and a detailed index. Following the introduction, most chapters each treat a particular period of Bardeen's career—his roots, his education, his employment, and his final illness. Two other chapters address the particular themes of Bardeen's industrial contacts and his activities as a citizen of science, while the epilogue examines the nature of genius and creativity, particularly as exemplified by Bardeen's life and work.

A genius is characterized as one who makes a lasting contribution to human culture, who is associated with a particular domain of structured knowledge, and who combines intelligence, passion, confidence, focus, perseverance, and the ability to break down large problems into smaller, solvable parts. Hoddeson and Daitch show that Bardeen excelled in all of these areas. Other factors contributing to Bardeen's success are held to be his mathematical skills, his capability for divergent thinking, his knowledge of the relevant scientific literature, his focus—although a theorist—on experimental results, and his discernment in the selection of problems and of mentors and students. All in all, the book provides a profound and entertaining analysis.

With so much to recommend the work as an informative and fascinating book, it is a pity to have to record some significant shortcomings. The so-called bibliography

is hardly that. It is simply an alphabetical listing of sources the authors used, including many interviews and unpublished letters and notes, none of which are explicitly cited within the text. Similarly, the notes, arranged at the rear of the book by chapter and page, are more for the use of the authors as justification for their statements made in the text, rather than being useful to the reader. If, in addition to a conventional bibliography of citations made, the authors had presented a comprehensive, chronologically arranged listing of all Bardeen's publications, the reader would have been able to learn much from the sequence of subjects treated, the names of all co-authors, and the time-dependence of Bardeen's productivity. Similarly, readers would have benefited from the inclusion in an appendix of a concise timeline of significant events in Bardeen's career, such as his education, his employment, awards, and personal data, all of which are there but scattered throughout the text. Finally, the services of a good copy editor might have eliminated misspellings, garbling of people's names—even one of the dedicatees, Betsy (Bardeen) Greytak!—and improper scientific nomenclature (e.g., NbSe³).

Reviewer: Jack H. Westbrook is owner of and principal consultant with Brookline Technologies, a consulting firm in Ballston Spa, N.Y., where he consults on materials and technical information systems. He was an early pioneer in research on intermetallic compounds as potential high-temperature structural materials and also has strong interests in the history of science and technology. He serves on the MRS Bulletin editorial board.

The following recently published books, relevant to materials research, have come to MRS Bulletin's attention. Some of the books listed here may be reviewed in future issues of MRS Bulletin. To review a book from the list or to offer recommendations of additional books, contact K. Wilson, Editorial Assistant, MRS Bulletin, 506 Keystone Drive, Warrendale, PA 15086-7573, USA; e-mail bulletin@mrs.org.

Books

Inorganic Chemistry, Electrochemistry, and Ceramics

Corrosion of Ceramic and Composite Materials, 2nd ed., Ronald A. McCauley, Marcel Dekker, 2004, 405 pp., \$175.00, ISBN: 0-8247-5366-6.

Environmental Issues and Waste Management Technologies in the Ceramic and Nuclear Industries IX, Ceramic Transactions, Vol. 155, J.D. Vienna and Dane Sparing, ACerS Books, 2004, 400 pp., \$129.00, ISBN: 1-57498-209-5.

Environmental Issues and Waste Management Technologies in the Ceramic and Nuclear Industries X, Ceramic Transactions, Vol. 168, Connie C. Herman, ACerS Books, 2004, 220 pp., \$109.00, ISBN: 1-57498-489-7.

International Tables for Crystallography; Vol. D: Physical Properties of Crystals, A. Authier, Kluwer Academic Press, 2003, 536 pp., \$220.00, ISBN: 1-4020-0714-0.

Oxide Thin Films, W. Prellier, Institute of Physics, 2004, 450 pp., \$110.00, ISBN: 0-7503-0920-2.

Refractories Handbook, Charles A. Schacht, Marcel Dekker, 2004, 499 pp., \$175.00, ISBN: 0-8247-5654-1.

Materials Processing

Advances in Fusion and Processing of Glass III, Ceramic Transactions, Vol. 141, James Varner, Thomas Seward, and Helmut Schaeffer, ACerS Books, 2004, 478 pp., \$129.00, ISBN: 1-57498-156-0.

Computer Modelling of Heat, Fluid Flow and Mass Transfer in Materials Processing, Chun-Pyo Hong, Institute of Physics Publishing, 2004, 350 pp., \$55.00, ISBN: 0-7503-0445-6.

Innovative Processing and Synthesis of Ceramics, Glasses and Composites VIII, Ceramic Transactions, Vol. 166, Narottam Bansal, ACerS Books, 2004, 200 pp., \$79.00, ISBN: 1-57498-187-0.

Joining of Plastics: Handbook for Designers and Engineers, 2nd ed., Jordan Rotheiser, Hanser Gardner Public, 2004, 565 pp., \$129.95, ISBN: 1-56990-354-9.

Melt Chemistry, Relaxation, and Solidification Kinetics of Glasses, Hong Li, ACerS Books, 2004, 230 pp., \$109.00, ISBN: 1-57498-191-9.

Surfactants and Interfacial Phenomena, 3rd ed., Milton J. Rosen, Wiley InterScience, 2004, 444 pp., \$99.95, ISBN: 0-471-47818-0.

Theory of Cortical Plasticity, Leon N. Cooper, N. Intrator, B.S. Blais, and H.Z. Souval, Imperial College Press, 2004, 320 pp., \$68.00, ISBN: 981-238-746-3.

Metallurgy

Statistical Thermodynamics and Stochastic Theory of Nonlinear Systems Far from

Equilibrium, Werner Ebeling and Lutz Schimansky-Geier, World Scientific, 2004, 200 pp., \$59.00, ISBN: 981-02-1382-4.

Physics and Electronics

Advanced Dielectric, Piezoelectric and Ferroelectric Thin Films, Bruce Tuttle, ACerS Books, 2004, 120 pp., \$79.00, ISBN: 1-57498-183-8.

Advances in Photonic Materials and Devices, Ceramic Transactions, Vol. 163, Suhas Bhandarkar, ACerS Books, 2004, 120 pp., \$79.00, ISBN: 1-57498-184-6.

Developments in Dielectric Materials and Electronic Devices, K.M. Nair, ACerS Books, 2004, 300 pp., \$109.00, ISBN: 1-57498-188-9.

Developments in Fuel Cells and Lithium Ion Batteries, Arumugam Manthiram, ACerS Books, 2004, 180 pp., \$79.00, ISBN: 1-57498-182-X.

Diode Lasers, D. Sands, Institute of Physics, 2004, 320 pp., \$39.99, ISBN: 0-7503-0726-9.

Elementary Electronic Structure, rev. ed., Walter Harrison, Imperial College Press, 2004, 840 pp., \$86.00, ISBN: 981-238-707-2.

The Handbook of Electroluminescent Materials, D.R. Vij, Institute of Physics, 2004, 500 pp., \$175.00, ISBN: 0-7503-0923-7.

High-Temperature Superconductor Materials, Devices, and Applications, Ceramic Transactions, Vol. 160, M. Parans Paranthaman, ACerS Books, 2004, 120 pp., \$79.00, ISBN: 1-57498-181-1.

Introduction to Quantum Mechanics in Chemistry, Materials Science, and Biology, S.M. Blinder, Elsevier, 2004, 319 pp., \$47.95, ISBN: 0-12-106051-9.

Photonic Crystals: Nanostructures for Controlling Light, M. Charlton and G. Parker, Institute of Physics, 2004, 350 pp., \$115.00, ISBN: 0-7503-0968-7.

Small Fuel Cells for Portable Applications, 5th ed. proceedings, Knowledge Press, 2004, 404 pp., \$599.00, ISBN: 1-59430-094-1.

Solid State Physics, S.A. Holgate, Institute of Physics, 2004, 250 pp., \$39.99, ISBN: 0-7503-0972-5.

The Theory of Magnetism Made Simple, D.C. Mattis, Imperial College Press, 2004, 400 pp., \$64.00, ISBN: 981-238-579-7.

Polymer Chemistry and Biomaterials

Bioceramics: Materials and Applications V, Ceramic Transactions, Vol. 164, Richard Rusin, ACerS Books, 2004, 130 pp., \$79.00, ISBN: 1-57498-185-4.

Biomaterials Science: An Introduction to Materials and Medicine, 2nd ed., Buddy D. Ratner, A.S. Hoffman, F.J. Schoen, and J.E. Lemons, Elsevier, 2004, 851 pp., \$95.00, ISBN: 0-12-582463-7.

Polymeric Foams and Foam Technology, 2nd ed., Daniel Klempner and V. Sendjarevic, Hanser Gardner, 2004, 584 pp., \$199.95, ISBN: 1-56990-336-0.

Rubber Compounding: Chemistry and Applications, Brendan Rodgers, Marcel Dekker, 2004, 645 pp., \$195.00, ISBN: 0-8247-4871-9.

Structure of Materials

Advances in Ceramic Matrix Composites X, Ceramic Transactions, Vol. 165, J. Singh, ACerS Books, 2004, 170 pp., \$179.00, ISBN: 1-57498-486-2.

Ceramic Nanomaterials and Nanotechnology III, Ceramic Transactions, Vol. 159, Songwei Lu, ACerS Books, 2004, 120 pp., \$79.00, ISBN: 1-57498-187-1.

Characterization and Modeling to Control Sintered Ceramic Microstructures and Properties, Ceramic Transactions, Vol. 157, Christopher DiAntonio, ACerS Books, 2004, 120 pp., \$79.00, ISBN: 1-57498-187-1.

Macromolecules Containing Metal and Metal-Like Elements, Vol. 3, Alaa S. Abd-El-Aziz, C.E. Carraher, Jr., C.U. Pittman, Jr., J.E. Sheats, and M. Zeldin, Wiley InterScience, 2004, 230 pp., \$109.00, ISBN: 1-57498-181-9.

Nanoporous Materials: Science and Engineering, G.Q. Lu, Imperial College Press, 2004, 700 pp., \$176.00, ISBN: 1-86094-210-5.

Order, Disorder and Criticality: Advanced Problems of Phase Transition Theory, Yuri Holovatch and Ivan Franko, Imperial College Press, 2004, 300 pp., \$64.00, ISBN: 981-238-583-5.

Surfaces, Interfaces and Science of Ceramic Joining, Ceramic Transactions, Vol. 158, K. Scott Weil, ACerS Books, 2004, 190 pp., \$79.00, ISBN: 1-57498-179-X. □

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