Statistical Physics of Crystals and Liquids: A Guide to Highly Accurate Equations of State

Duane C. Wallace
(World Scientific, 2003)
328 pages, $58.00
ISBN: 981-238-122-0

Duane Wallace's text fulfills its subtitle of being a guide to building highly accurate equations of state for solid and liquid systems. Beginning from a Hamiltonian treatment, the book includes a tight review and introduction of statistical mechanics and its physical interpretation. The book provides both a historical context as well as recent results with which to make comparisons of predictive models. While the text lacks a treatment of orientational order to complement its treatment of positional order and discussions of solid–solid transitions and melting, the book comprises a brisk overview of solids that reaches timely topics of nonequilibrium processes.

While the text is probably not good as a first exposure in a classroom setting, its structure lends itself well to being used as an instructional text in either an advanced undergraduate course or a graduate treatment of the subject. As an instructor, I appreciate the section-by-section listing of exercises that would allow one to include and omit sections without having to determine what problems could then be assigned or not. The review of statistical mechanics is straightforward to anyone with prior exposure to the subject, and is nearly complete, lacking only a discussion on the virial theorem in terms of major topics. Those should not be seen as detrimental shortcomings, however, as Wallace has done an excellent job of achieving the goals set out in the introduction of the book in a format that is clean and easy to read with a notation that is not confusing.

My only real criticism of the book is that it ends about a hundred pages sooner than I would have liked. The text establishes a solid foundation of statistical mechanics and a thorough discussion of lattice dynamics including a valuable treatment of nuclear motion, with multiple examples demonstrating strong agreement between the equations of state and measurement from experiments. With such a convincing treatment of well-understood systems, I would have liked to have seen the text continue with more of a discussion of open problems in nonequilibrium systems and the glass transition. Those personal preferences should not take away from what I see as a successful text that delivers on its goals in fine fashion.

Reviewer: *Jeffrey S. Olafsen is an assistant professor in the Department of Physics and Astronomy at the University of Kansas. He does research in nonlinear and nonequilibrium systems and has taught undergraduate and graduate courses in statistical mechanics.*

Polymer Physics

Michael Rubinstein and Ralph H. Colby
(Oxford University Press, 2003)
454 pages, $99.95
ISBN: 0-19-852059-X

When you practice in a field, you usually feel that there can never be enough textbooks to choose from, and this new text is certainly a welcome addition to those that are currently available (including Strobl, Gedde, and Sperling). The focus of this book by Rubinstein and Colby is on the conformation and energetics of polymer chains. The topics are treated from a contemporary point of view, and the work builds well on the now classic *Principles of Polymer Chemistry* (Cornell University Press) written by Paul Flory back in the 1950s. The discussion now includes concepts of scaling, fractal dimensions, renormalization, and the tube models for chain motion that are needed to understand the unique impact of molecular connectivity on the physical behavior of macromolecules. The discussion of chain conformation in the context of the phase diagram is particularly extensive and detailed. The dynamics of chains in solution and melt are also well described, perhaps better than in any other text currently available.

Particularly appealing for educational purposes are the extensive compilations of homework problems given at the end of each chapter. Of considerable value is the fact that these range from the relatively straightforward to the much more complex and involved. This is especially useful when teaching students with different abilities, and for extracting useful pieces for related classes at different academic levels. The text also includes a number of examples that help to make various points more accessible as well as well-drawn original sketches and cartoons that make complicated topics easier to comprehend. For example, a detailed discussion about the fractal geometry of objects is presented at the beginning of the book, and done so in a manner that is easy to follow. I expect that this section alone will prove useful for many students and practitioners who are trying to grapple with these concepts. Although many other fields of physical science have recently found that objects of non-integer dimensions are important and interesting, the polymer community has embraced these concepts for many years.

From a materials science point of view, however, there are many subjects of current interest that are not addressed in as much detail as might have been expected. The focus is clearly on the isotropic liquid solution and melt state. There is essentially no discussion of crystallization, liquid crystallinity, microphase separation, plasticity, or other topics of particular interest to those of us primarily concerned with polymers as solids. Although there are discussions of gelation and rubbery elasticity, there is no attention given to behavior in the glassy state. The optical and electronic properties of these materials are also not addressed. Hopefully, there will be yet another textbook soon written that can focus on these issues as well.

Reviewer: *David C. Martin is a professor of materials science and engineering and biomedical engineering and the director of macromolecular science and engineering at the University of Michigan.*

Heterogeneous Materials I: Linear Transport and Optical Properties Heterogeneous Materials II: Nonlinear and Breakdown Properties and Atomistic Modeling

Muhammad Sahimi
(Springer, 2003)
Vol. I: 691 pages; $99.00
ISBN 0-387-00167-0
Vol. II: 637 pages; $99.00
ISBN 0-387-00166-2

There has been increasing interest in recent years in the synthesis and study of materials structured on the nanoscale and mesoscale. This two-volume treatment by Muhammad Sahimi of complex, disordered materials is thus particularly timely. He has focused primarily on a thorough discussion of continuum and discrete descriptions of heterogeneous materials, including chapters on atomistic molecular dynamics simulations and multiscale modeling. Both linear and nonlinear properties are discussed (in volumes I and II, respectively) with emphasis on optical properties and conductivity. The second volume also pays significant attention to fracture in heterogeneous materials. Overall, the volumes are dominated by a discussion of the theoretical models and approaches that is impressive in breadth and depth. Although some discussion of experimental data is included, the brief attention paid to experimental methods is disappointing. In addition, the books could benefit from more (and higher-quality) illustrations.

It is likely that this material will be of greatest interest to scientists in physics, engineering, chemistry, and materials science. The books are well written in an accessible and readable style with detailed descriptions of the models and derivations of the theoretical approaches. As such,

they should be useful for graduate students and researchers beginning in the field, particularly as an introduction to the wide variety of theoretical approaches for describing disordered materials. Both volumes are well referenced and provide a useful survey of the literature. The molecular dynamics chapter is a nice review of this area but does not serve as a replacement for some of the excellent modern texts on this topic; Sahimi may have been better served to focus more on molecular dynamics methods (and challenges) specific to heterogeneous materials. The chapter on multiscale modeling is particularly welcome, given the current interest in theoretical approaches for spanning time and length scales; as the final chapter, it serves to connect the discussion of continuum and discrete descriptions that dominates the two volumes.

Reviewer: *Ward H. Thompson is an assistant professor in the Department of Chemistry at the University of Kansas. His research focuses on chemical dynamics in condensed phases including liquids and nanostructured materials.*

The following new journals and 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.

Journals

Small, Wiley-VCH, Postfach 10 11 61, 69451 Weinheim, Germany; tel. 49-6201/606-599, fax 49-6201/606-331 or 49-6201/606-328, or e-mail small@wiley-vch.de; www.small-journal.de. Twelve issues; first issue: January 2005. Subscription rate: Varies, depending on location.

Online Journal of Nanotechnology, Institute of Nanotechnology and AZoM; tel. 44-1786-447520, fax 44-1786-447530, or e-mail o.saxl@nano.org.uk; www.azonano.com. Launch: December 2004. Subscription rate: Free (open access).

Books

Experimental Techniques

Mössbauer Spectroscopy of Environmental Materials and Their Industrial Utilization, Enver Murad and John Cashion, Kluwer Academic Press, 2004, 417 pp., $165.00, ISBN: 1-4020-7726-2.

History, Biography, and Unclassified

The History of Metal, Mining, & Metallurgy: A Selected Annotated Bibliography, *1st Ed.*, Peter M. Molloy, Routledge, 1986, 336 pp., $70.95, ISBN: 0-8240-9064-9.

History of Science and Technology in the United States: A Critical and Selective Biography, *1st Ed.*, Vol. II, Marc Rothenberg, Routledge, 1993, 216 pp., $65.95, ISBN: 0-8240-8349-0.

History of Science in United States: An Encyclopedia, *1st Ed.*, Marc Rothenberg, Routledge, 2000, 640 pp., $200.00, ISBN: 0-8153-0762-4.

Reader's Guide to the History of Science, *1st Ed.*, Arne Hessenbruch, Routledge, 2000, 1000 pp., $185.00, ISBN: 1-8849-6429-X.

Inorganic Chemistry, Electrochemistry, Other Chemistry, and Ceramics

Applied Colloid and Surface Chemistry, Richard Pashley and Marilyn E. Karaman, John Wiley & Sons, 2004, 200 pp., $125.00, ISBN: 0-470-86882-1.

Materials Processing

Handbook of Layered Materials, Scott M. Auerbach, Kathleen A. Carrado, and Prabir K. Dutta, Marcel Dekker, 2004, 646 pp., $195.00, ISBN: 0-8247-5349-6.

Introduction to Dynamic Spin Chemistry: Magnetic Field Effects on Chemical and Biochemical Reactions, Hisaharu Hayashi, Imperial College Press, 2004, 268 pp., $38.00, ISBN: 981-238-423-5.

Nano-Architectural and Nanostructured Materials: Fabrication, Control and Properties, Yannick Champion and Hans-Joerg Fecht, John Wiley & Sons, 2004, 166 pp., $150.00, ISBN: 3-527-31008-8.

Solidification and Crystallization, Dieter M. Herlach, John Wiley & Sons, 2004, 322 pp., $230.00, ISBN: 3-527-31011-8.

Metallurgy

Encyclopedia of Twentieth-Century Technology, *1st Ed.*, Colin Hempstead and William Worthington, Routledge, 2004, 992 pp., $325.00, ISBN: 1579583865.

Physics and Electronics

Color: An Introduction to Practice and Principles, *2nd Ed.*, Rolf G. Kuehni, Wiley InterScience, 2005, 199 pp., $89.95, ISBN: 0-471-66006-X.

Field Mathematics for Electromagnetics, Photonics, and Materials Science: A Guide for the Scientist and Engineer, Bernard J. Maxum, SPIE Press, 2004, 272 pp., $56.00, ISBN: 0-8194-5523-7.

The Nano-Micro Interface: Bridging the Micro and Nano Worlds, Hans-Joerg Fecht and Matthias Werner, John Wiley & Sons, 2004, 351 pp., $135.00, ISBN: 3-527-30978-0.

Novel Nanocrystalline Alloys and Magnetic Nanomaterials, B. Cantor, Institute of Physics Publishing, 2004, 325 pp., $135.00, ISBN: 0-7503-1002-2.

Path Integrals in Quantum Mechanics, Statistics, Polymer Physics, and Financial Markets, *3rd Ed.*, Hagen Kleinert, Imperial College Press, 2004, 1504 pp., $138.00, ISBN: 981-238-106-6.

The Physics and Technology of Thin Films, A.Z. Moshfegh, Imperial College Press, 2004, 500 pp., $112.00, ISBN: 981-238-770-6.

Principles of Quantum Computation and Information, Guiliano Benenti, Guilio Casati, Guiliano Strini, Imperial College Press, 2004, 272 pp., $58.00, ISBN: 981-238-830-3.

Problems and Solutions in Quantum Computing and Quantum Information, Willi-Hans Steeb, Imperial College Press, 2004, 264 pp., $84.00, ISBN: 981-238-789-7.

Quantum Theory of the Optical and Electronic Properties of Semiconductors, Hartmut Huag and Stephan W. Koch, Imperial College Press, 2004, 468 pp., $88.00, ISBN: 981-238-609-2.

The Story of Semiconductors, John Orton, Oxford University Press, 2004, 510 pp., $54.50, ISBN: 0-19-853083-8.

Polymer Chemistry and Biomaterials

Biomineralization: Progress in Biology, Molecular Biology and Application, *2nd Rev. and Ext. Ed.*, Edmund Baeuerlein, John Wiley & Sons, 2004, 361 pp., $199.00, ISBN: 3-527-31065-7.

Biotechnology of Biopolymers: From Synthesis to Patents, *Vols. 1–2*, Alexander Steinbüchel andYoshiharu Doi, John Wiley & Sons, 2004, 1200 pp., $270.00, ISBN: 3-527-31110-6.

Petit Point, Pierre-Gilles de Gennes, World Scientific, 2004, 80 pp., $18.00, ISBN: 981-256-011-4.

A Practical Guide to Understanding the NMR of Polymers, Peter A. Mirau, John Wiley & Sons, 2004, 446 pp., $94.95, ISBN: 0-471-37123-8.

Structure of Materials

The Classical and Quantum Dynamics of Multispherical Nanostructures, Gennadiy Burlak, Imperial College Press, 2004, 350 pp., $88.00, ISBN: 1-86094-444-2.

Crystals that Flow: Classic Papers from the History of Liquid Crystals, Timothy J. Sluckin, David A. Dunmur, and Horst Stegemeyer, Taylor & Francis, 2004, 738 pp., $149.95, ISBN: 0-415-25789-1.

Diffuse X-Ray Scattering and Models of Disorder, T.R. Welberry, Oxford University Press, 2004, 266 pp., $144.50, ISBN: 0-19-852858-2. □

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