Introduction to the Thermodynamics of Materials, *4th Ed.*

David R. Gaskell
(Taylor & Francis, New York, 2003)
592 pages, $109.95
ISBN 1-56032-992-0

This book is the latest (fourth) edition of the classical introductory textbook *Introduction to Metallurgical Thermodynamics* (the first edition was published in 1973, the second in 1981, and the third in 1995). The title change reflects the extended coverage of the textbook to include nonmetallic materials and processes. The fourth edition has 15 chapters, including a new one (Chapter 14) that describes the pressure-dependent phase diagrams of binary systems, which are critical for understanding many materials processes, from vacuum arc melting to high-pressure crystal growth. The new chapter is a very nice graphical introduction to phase equilibria of binary systems in temperature–pressure–composition space.

The new edition also includes a CD-ROM containing thermodynamic data for 50 commonly used compounds and two Excel workbooks which can be used to solve some practical problems. There are 22 examples of the use of the Excel spreadsheets to solve relatively complex thermodynamic problems. This is a very nice and welcome feature in the fourth edition. It allows readers to practice some thermodynamic calculations without spending time to write their own little programs.

Another major improvement of the fourth edition is the correction of many typographical and mathematical errors found in previous editions that have been annoying to faculty and students. It is hard enough to learn thermodynamics for the first time; it makes things worse with a textbook having many errors in equations. As we often joke, saying that one needs to learn thermodynamics three times to master it, the fact is not far from it. The bitterly-complaining customer reviews on Amazon.com by some students reflect the pain of learning thermodynamics for the first time—it is somewhat overwhelming at the beginning, with all the concepts/terms, equations, laws, rules, principles....

The book is equally useful as a reference source and as a textbook. I have found myself referring to an earlier edition of it often during work. Some practical problems I have encountered required the use of advanced calculation tools such as Thermo-Calc and PandaT; others just needed a quick solution using examples found in the book.

As thermodynamic calculations using commercial software become a daily activity at many industrial and academic laboratories, it may be necessary in future editions to include a chapter to describe the sublattice models, the models to extrapolate from binary to multicomponent systems, the SGTE (Scientific Group Thermodata Europe) standard reference states, as well as the SGTE definition of lattice stability of pure elements. Such a chapter would fill the gap between this textbook and the commercial software, and it would make the transition from school to work easier.

The long life of this textbook is as good an evaluation of its quality as any book reviewer's praise. I believe it will remain as a classic for times to come and I highly recommend it to students and professionals who want to learn and use thermodynamics as an essential tool of materials science and engineering.

Reviewer: *J.-C. Zhao is a materials scientist at GE Global Research, General Electric Company. His research focuses on phase diagrams, thermodynamics, diffusion, and alloy design.*

Nanocomposite Science and Technology

Pulickel M. Ajayan, Linda S. Schadler, and Paul V. Braun
(John Wiley & Sons, 2003)
380 pages, $135.00
ISBN 3-527-30359-6

Research in nanostructured materials and the implications of these materials for technological applications is undergoing an explosive growth. It is difficult to pick up any journal and not be inundated by articles with "nano" somewhere in the title. Consequently, we are faced with an ever-growing body of literature, and a review on the topic is both timely and useful. It would, of course, be most difficult to review the entire field in one text. P.M. Ajayan, L.S. Schadler, P.V. Braun, in their book *Nanocomposite Science and Technology*, cover the areas of bulk and composite nanostructures, polymer-based nanostructures, and biologically inspired nanocomposites. Overall, the reviews in each of these areas are comprehensive in their coverage of existing literature, and summaries of the findings to date are clearly presented in an objective manner. A final chapter in this collection of reviews treats the modeling of nanocomposite materials. However, this chapter was added as almost an afterthought, with minimal in-depth discussion of the area, and cannot be viewed as any serious attempt to treat the field. It is not totally clear why this chapter was included, since the limited pagination does not do justice to the field and to the authors.

I will treat each of the topics separately. In the first chapter, the preparation, fabrication, and measurement of the properties of composite materials made from metallic and inorganic nanoparticulate fillers or such materials prepared with nanoscopic structuring are discussed in great detail. This includes materials prepared by mechanical allotting, sol-gel processes, and thermal spraying. This section focuses predominantly on composites that are derived from ceramic precursors and metals fabricated in what can now be considered well-established methods, although these are quite effective to the end goal. The review fairly treats the property enhancements that can be obtained, indicates where such property enhancement has not been achieved, and points out where further enhancements are possible. Perhaps the only oversight in this section is any discussion of inorganic composites derived from organic materials. An example would be structured inorganic materials that use an organic precursor—for example, a block copolymer—that are subsequently removed by processing steps, like calcination. This, of course, reflects my bias, although materials made by this route are becoming increasingly more important and should have received some mention in this chapter. Nonetheless, the reader will have an extensive compendium that benchmarks the field.

The second chapter deals with polymer-based and polymer-filled nanocomposites, including the use of carbon nanotubes, clays, and inorganic nanoparticles. Topics ranging from the preparation and fabrication of the composite materials are discussed, along with the outcome on the resulting materials properties including toughness, wear, abrasion resistance, and permeability. With all nanocomposite materials, a critical issue is the interactions of the filler with the matrix. As such, interfacial interactions and the modification of the surfaces of the fillers are addressed. While a more in-depth treatment of the surface chemistries could have been done, this may have detracted from the engineering approach of this section. In addition, one of the key problems associated with carbon nanotubes is addressed and recognized as a potential bottleneck in their widespread use. However, recent findings published subsequent to the writing of this review have demonstrated significant advances related to this. A discussion of the influence of fillers on the glass-transition temperature of the matrix material is also presented. However, it is not clear that the discussion really added any subjective judgments on the controversies permeating this field. Overall, the broad area of polymer composites is treated in a thorough manner and will serve as a useful resource.

The final area deals with nanocomposite materials that are inspired by biological systems. One should not be deceived by this title, since the treatment is much broader. Organic–inorganic systems fabricated from biological systems, like metal binding on DNA or the classic mother-of-pearl composite structures, are discussed in detail. However, composite structures using block copolymer, liquid-crystal, and colloid templates are also discussed. As could be expected, there is much less treatment on the properties, and it is realized that widespread use of these composites could be limited by the availability of the materials. However, realistic applications are discussed where the potential of the unique characteristics of these materials can be brought to bear. While the treatment of the field is good, this is perhaps one of the most rapidly changing areas in nanocomposite materials where new templating and scaffolding methodologies are continually emerging. Nonetheless, an excellent review of the area is presented that captures key concepts, highlighting major advances in the field.

Overall, an in-depth review of nanocomposite materials in several key areas is presented that objectively treats the advances that have been realized, with some projections on the potential developments waiting. This treatise serves as a good benchmark of the current state of affairs in nanocomposite materials and will be a very useful resource.

Reviewer: *Tom Russell is a Distinguished Professor of Polymer Science and Engineering at the University of Massachsetts, director of the NSF-supported Materials Research Science and Engineering Center, and associate director of MassNanoTech.*

Magnetism I: Fundamentals Magnetism II: Materials & Applications

É. du Trémolet de Lacheisserie, D. Gignoux, and M. Schlenker, Editors (Kluwer Academic Publishers, Norwell, MA, 2002)
507 pages (vol. 1), 517 pages (vol. 2), $595 for both
ISBN 1-40207-222-8 (vol. 1); 1-40207-223-6 (vol. 2); 1-40207-224-4 (set)

This two-volume set, *Magnetism*, provides a comprehensive overview of magnetic materials. The set covers a wide array of topics in 26 chapters, beginning with some magnetism history and fundamental physics and ending with applications and instrumentation. The volumes are the work of roughly 20 scientists, primarily from the Laboratoire Louis Néel in Grenoble, France.

On the whole, the books are written at a level appropriate for graduate students or for advanced undergraduate students with some previous experience in magnetism. The difficulty of the text varies from topic to topic, but introductory summaries to each chapter provide good guideposts for readers. For instance, the more theoretical chapters discussing local-moment versus itinerant-moment models indicate that they can be skipped by those without the necessary quantum mechanics background. Throughout the text, useful explanatory notes and remarks are included to point out issues such as differences in symbol conventions or special situations in which the discussed treatment does not apply. Some of the chapters include problems (with solutions) to check one's level of understanding. The text is especially adept at helping to bridge the gap between more introductory textbooks on magnetism and the current research literature.

For scientists and engineers active in this area, the two-volume set serves as a useful reference. The descriptions of applications are relatively comprehensive, including not only more standard uses in permanent magnets or magnetic recording, but also the use of magnetism in geology, biology, and medicine. An appropriate number of references is included at the end of each chapter, and the appendices tabulate commonly needed experimental values and constants.

As might be expected for a text of this size with multiple authors and editors, there are some problems in consistency and cross-referencing. Not all of the chapters include problems, and the index could be more extensive. Some sections appear to be misplaced, such as discussions on neutron diffraction and magnetic force microscopy that are located in the fundamentals section as opposed to a section with other instrumentation or detection methods. Additionally, there are a few idiomatic issues in the text, as the original 1999 version was written in French.

In general, however, the books are well written with good links between chapters. The set should be of much use to both students and practitioners of magnetism.

Reviewer: *Yumi Ijiri is an associate professor in the Department of Physics and Astronomy at Oberlin College. Her research has focused on the magnetic properties of unusual thin films and nanoparticles, using neutron scattering and bulk magnetometry methods.*

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 Kristin Wilson, Editorial Assistant, *MRS Bulletin*, 506 Keystone Drive, Warrendale, PA 15086-7573, USA; e-mail bulletin@mrs.org.

Books

Experimental Techniques

Correlation Spectroscopy of Surfaces, Thin Films, and Nanostructures, Jamal Berakdar, Wiley-VCH, 2004, 255 pp., $180.00, ISBN 3-527-40477-5.

The SQUID Handbook, *Vol. I*: **Fundamentals and Technology of SQUIDS and SQUID Systems**, John Clarke, Wiley-VCH, 2004, 409 pp., $180.00, ISBN 3-527-40229-2.

Synthetic Instruments: Concepts and Applications, Chris T. Nadovich, Elsevier, 2005, 256 pp., $49.95, ISBN 0-7506-7783-X.

History, Biography, & Unclassified

Light is a Messenger: A Biography of William Lawrence Bragg, Graeme K. Hunter, Oxford University Press, 2004, 320 pp., $55.00, ISBN 0-19-852921-X.

Inorganic Chemistry, Electrochemistry, & Other Chemistry

Organic Electrochemistry (**Encyclopedia of Electrochemistry**, *Vol. 8*), Hans J. Shafer, Wiley-VCH, 2004, 663 pp., $455.00, ISBN 3-527-30400-2.

Materials Processing

Joining of Materials and Structures: From Pragmatic Process to Enabling Technology, Robert W. Messler Jr., Elsevier, 2004, 816 pp., $125.00, ISBN 0-7506-7757-0.

Mechanical Alloying and Milling (**Mechanical Engineering**, *Vol. 180*), C. Suryanarayana, Marcel Dekker, 2004, 466 pp., $175.00, ISBN 0-8247-4103-X.

Metallurgy

Fundamentals of Creep in Metals and Alloys, M. Kassner, Elsevier, 2004, 400 pp., $195.00, ISBN 0-08-043637-4.

How Gears Break (**Advances in Damage Mechanics**, *Vol. 7*), B. Abersek, WIT Press, 2004, 240 pp., $130.00, ISBN 1-85312-739-6.

Physics & Electronics

Silicon: Evolution and Future of a Technology, P. Siffert, Springer, 2004, 549 pp., $139.00, ISBN 3-540-40546-1.

Springer Handbook of Nanotechnology, Bharat Bhushan, Springer, 2004, 1222 pp., $199.00, ISBN 3-540-01218-4.

Polymer Chemistry and Biomaterials

Metal–Polymer Nanocomposites, Luigi Nicolais, Wiley InterScience, 2005, 300 pp., $99.95, ISBN 0-471-47131-3.

Polymer Brushes: Synthesis, Characterization, Applications, Rigoberto C. Advincula, Wiley-VCH, 2004, 501 pp., $310.00, ISBN 3-527-31033-9.

Structure of Materials

Continuum Scale Simulation of Engineering Materials: Fundamentals, Microstructures, and Process Applications, Dierk Raabe, Wiley-VCH, 2004, 855 pp., $255.00, ISBN 3-527-30760-5.

Crystallography of Modular Materials (International Union of Crystallography Monographs in Crystallography No. 15), Giovanni Ferraris, Oxford University Press, 2004, 400 pp., $124.50, ISBN 0-19-852664-4.

Soft Materials: Structure and Dynamics, John R. Dutcher, Marcel Dekker, 2005, 410 pp., $175.00, ISBN 0-8247-5358-5.

Statistical Mechanics of Membranes and Surfaces, *2nd ed.*, D. Nelson, World Scientific, 2004, 444 pp., $48.00, ISBN 981-238-772-2.

Structured Fluids: Polymers, Colloids, Surfactants, Thomas A. Witten, Oxford University Press, 2004, 240 pp., $69.50, ISBN 0-19-852688-1. □

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