Liquid Crystals: Experimental Study of Physical Properties and Phase Transitions

Satyendra Kumar, Editor
(Cambridge University Press, Cambridge, 2000)
x + 483 pages, $110.00
ISBN 0-521-46132-4

In this book, Satyendra Kumar and 10 distinguished co-authors provide a detailed survey of experimental techniques used to investigate liquid crystals. Kumar is a professor of physics at Kent State University, and his co-authors are mostly professors at other centers of liquid-crystal research. They often deal with students who are familiar with the basic concepts of liquid crystals but only know a few methods for studying them in the laboratory. For that reason, they wrote this book to explain carefully how to set up and interpret data from a wide range of experiments. Aside from students who do experimental work, another possible audience for the book are scientists who do theoretical work like myself, who need to understand experiments at some level of detail in order to assess what experiments can test theoretical predictions.

The book begins with a brief introduction to liquid crystals, which defines the major concepts used later. It then presents two chapters on major techniques for identifying liquid-crystal phases, including microscopy, thermal analysis, and x-ray diffraction. Because microscope images of liquid-crystal textures provide a particularly powerful method for recognizing phases, the book includes a large set of beautiful color images of various phases. Next is a chapter on techniques for measuring fundamental physical properties of liquid crystals, including elastic, viscous, optical, dielectric, and diamagnetic properties. That chapter is likely to be a useful reference for many scientists who do liquid-crystal work; indeed, it has already been helpful for my research.

Subsequent chapters provide detailed descriptions of nuclear magnetic resonance (NMR), light-scattering, and calorimetric methods for studying bulk liquid crystals, with the principles of each technique, instructions for setting up the experiments, and examples of how each technique has been useful. The book then shifts to methods for x-ray diffraction from freely suspended films and from free surfaces of liquid crystals. It closes with a chapter on the empirical relationships between the chemical structure and physical properties of liquid crystals, which summarizes the work of a large community of chemists who work in the area of synthetics.

In reading a broad survey book like this, any reviewer will inevitably find some favorite topic that has been omitted. Personally, I missed a discussion of the Caillé prediction for power-law peaks rather than Bragg peaks in the x-ray diffraction from smectic liquid crystals, arising from layer fluctuations that diverge logarithmically with system size. This is a central result in x-ray diffraction from liquid crystals, which deserves more than just a brief mention. Other than that, I should note that the theoretical level is inconsistent from chapter to chapter. The earlier chapters on microscopy, thermal analysis, and x-ray diffraction are fairly descriptive, with limited theoretical background on why particular phases have characteristic textures or diffraction patterns. Some of the later chapters, particularly those on NMR and light scattering, present much more theory, perhaps beyond the taste of most experimental students.

Aside from these quibbles, the book succeeds well in its goal of presenting a detailed description of the major experimental techniques for liquid-crystal research. It will be very useful for many students and researchers in this area.

Reviewer: *Jonathan V. Selinger is a research physicist at the Naval Research Laboratory, working on the theory of liquid crystals and other types of soft condensed matter.*

Alloying: Understanding the Basics

J.R. Davis, Editor
(ASM International, Materials Park, 2001)
ix + 647 pages, $156.00
ISBN 0-87170-744-6

Alloying is at the heart of metallurgy and this book is most definitely about alloying. However, the rest of the title is misleading: The detailed and knowledgeable text is not about understanding, nor is it pitched at basic level. Neither is it clear who has written most of it, but what J.R. Davis has put together, as nominal editor, is a magnificent recipe book for users of alloys. If you want to know what the 7150 series of aluminum alloys contain, and how they are related to the generic 7075, or if you need a table listing 13 properties of each of 35 copper alloys, then this is most definitely for your bookshelf. If, however, you want to know why 7150 alloys have higher strength than 7050 in thicker sections (which is what I mean by understanding), then you will have to look elsewhere.

The coverage of the volume is amazingly comprehensive. Unsurprisingly, there are more than 200 pages on steels, but there are also seven pages on zinc alloys and two on gold alloys. Each section is filled with experimental data on strength, toughness, ductility, corrosion resistance, creep rate, weldability, formability, embrittlement, and a lot more. The data are presented in tables and graphs, most of which display two sets of units (MPa and ksi; °C and °F; mm and inches) that render this text usable on both sides of the Atlantic (and the Pacific).

An endearing feature is the short introductory section by Hugh Baker, which could be reasonably retitled "All of physical metallurgy in 14 pages." On the other hand, the micrographs are uniformly disappointing; they are poorly reproduced and lacking in crispness. Luckily, micrographs are not the key feature of the book. If you want a good read to deepen your understanding of metallurgy, choose elsewhere. If, however, you want a book on your shelves that you can consult when you need to know what is in a cemented carbide machine tool, or the machinability ratings for plain carbon steels, or the effect of composition on the weldability of superalloys, then this is definitely the one book you must have. It is a reference manual par excellence.

Reviewer: *Peter Goodhew is Henry Bell Wortley Professor of Materials Engineering at the University of Liverpool, United Kingdom, and director of the U.K. Center for Materials Education.*

CRC Materials Science and Engineering Handbook, *3d Ed.*

James F. Shackelford and William Alexander, Editors
(CRC Press, Boca Raton, 2001)
xiv + 1949 pages, $189.95
ISBN 0-8493-2696-6

Every materials person knows the "Rubber Bible," the handbook of physics and chemistry that graduated from being a business gift for good customers of a maker of rubber laboratory goods (such as stoppers) to becoming at length *the* standard compilation of numerical information for physical scientists. Recently, a version of this handbook specifically aimed at materials scientists and engineers appeared, and is now offered in a third edition. In summary, it is thick and "meaty," but odd.

For a start, there is no preface, so the user does not know on what principles the compilers worked or how topics for inclusion and sources were selected. Many of the tables have footnotes to the effect that they were "compiled by J.S. Park from...," then the name of a book follows. We are not told who J.S. Park is! Various explanations from the compilers would indeed have been useful; for instance, the index is arranged in an intriguing, original way, but one has to work out for oneself how best to make

use of it. It is not too difficult to use, in fact, though cross-references are few: Thus "fusion" is included, "melting" is not.

Some tables are centered on particular families of materials (aluminum alloys, steels, or polymers) and all are assembled in broad categories such as thermal properties, electrical properties, chemical properties (mostly corrosion rates), mechanical properties, and notably thermodynamic and kinetic data. Two-thirds of the way through the book, the tables become selective; what this means (again, a preface would have helped the user here) is that various properties (such as hardness) are listed in ascending order for a broad category (such as all aluminum alloys), whereas in the earlier part of the book different subsets (e.g., a particular family of aluminum alloys) are listed separately, again in internally ascending order. Some tables are surprising: Who would have dreamt up the idea of listing activation energies for diffusion of a range of metallic combinations in ascending order? Once this approach is understood, it can be useful. Units are sometimes distinctly unusual; thus, corrosion rates of 1020 steel at 70°F in different agents are listed in "ipy," which surely must mean inches per year!

I tried to look up the densities of gold of different caretage, such as 9 carats (i.e., 9/24 purity), but only pure gold is listed. An alloying element—usually copper—is essential to harden objects like medals and many types of jewelry. Thus this situation is reminiscent of the experience of the goldsmith who was subjected to the ingenuity of Archimedes 2250 years ago.

The book contains no phase diagrams but offers some advice to the reader where (s)he can find them.

There is a huge mass of useful engineering information here, not always easy to locate but still representing a major resource. The book is unmistakably an engineering resource, not a scientific one. Scientists will probably continue to be better off with the familiar Rubber Bible.

Reviewer: *Robert W. Cahn is a materials scientist attached to Cambridge University. He is a member of the Editorial Board of* MRS Bulletin, *and a Volume Organizer for 2002.*

The following recently published books, relevant to materials science, have come to *MRS Bulletin's* attention. Some of the books listed here may be reviewed in future issues of *MRS Bulletin*.

Books

Adaptive Meshing with Boundary Elements, J.C. Miranda-Valenzuela and K.H. Muci-Kuchler, WIT Press, Southampton, 2001, 304 pp., $169.00, ISBN 1-85312-888-0.

Adsorption: Theory, Modeling, and Analysis, Jozef Toth, Marcel Dekker, New York, 2002, 904 pp., $250.00, ISBN 0-8247-0747-8.

Applications of Synthetic Resin Lattices, H. Warson and C.A. Finch, John Wiley & Sons, West Sussex, 2001, *Vol. 1:* **Fundamental Chemistry of Lattices and Applications in Adhesives**, 700 pp., $210.00, ISBN 0-471-95268-0; *Vol. 2:* **Lattices in Surface Coatings: Emulsion Paints**, 1148 pp., $195.00, ISBN 0-471-95461-6; *Vol. 3:* **Lattices in Diverse Applications**, 1667 pp., $175.00, ISBN 0-471-95462-4.

Biopolymers, Alexander Steinbuchel, ed., New York, 2001, 500 pp., $225.00, *Vol.1:* ISBN 3-527-30220-4, *Vol. 2:* ISBN 3-527-30221-2.

Cells, Gels, and the Engines of Life, Gerald H. Pollack, Ebner and Sons Publishers, Seattle, 2001, 305 pp., $27.95, ISBN 0-9626895-2-1.

Colloid and Surface Properties of Clays and Related Materials, Rossman F. Giese and Carel J. van Oss, Marcel Dekker, New York, 2001, 312 pp., $150.00, ISBN 0-8247-9527-X.

Colloidal Dispersions: Suspensions, Emulsions, and Foams, Ian D. Morrison and Sydney Ross, John Wiley & Sons, New York, 2002, 616 pp., $99.95, ISBN 0-471-17625-7.

Computational Methods in Contact Mechanics, V.J. Dominguez and C.A. Brebbia, WIT Press, Southampton, 2001, 344 pp., $178.00, ISBN 1-85312-872-4.

Computer Aided Optimum Design of Structures VII, S. Hernandez and C.A. Brebbia, WIT Press, Southampton, 2001, 464 pp., $237.00, ISBN 1-85312-868-6.

Damage Tolerance and Durability of Material Systems, Kenneth L. Reifsnider and Scott W. Case, John Wiley & Sons, New York, 2002, 435 pp., $99.95, ISBN 0-471-15299-4.

Dendrimers and Other Dendritic Polymers, M.J. Frechet and Donald A. Tomalia, John Wiley & Sons, West Sussex, 2001, 647 pp., $225.00, ISBN 0-471-63850-1.

Diamond Films Handbook, Jes Asmussen and D.K. Reinhard, Marcel Dekker, New York, 2001, 665 pp., $185.00, ISBN 0-8247-9577-6.

Diffusion Phenomena, Richard Ghez, Kluwer Academic/Plenum Publishers, New York, 2001, 315 pp., $65.00, ISBN 0-306-46526-4.

Direct-Write Technologies for Rapid Prototyping Applications: Sensors, Electronics, and Integrated Power Sources, Alberto Pique and Douglas B. Chrisey, Academic Press, San Diego, 2002, 726 pp., $119.95, ISBN 012-174231-8.

Elastic Waves in Anisotropic Laminates, G.R. Liu and Z.C.Xi, CRC Press, Boca Raton, 2002, 452 pp., $149.95, ISBN 0-8493-1070-9.

Electrochemistry of Nanomaterials, Gary Hodes, Wiley-VCH, Weinheim, 2001, 310 pp., $149.95, ISBN 3-527-29836-3.

Electrochemistry of Silicon, Volker Lehmann, Wiley-VCH, Weinheim, 2002, 277 pp., $115.00, ISBN 3-527-29321-3.

Electron Microscopy and Analysis 2001, M. Aindow and C.J. Kiely, Institute of Physics Publishing, Bristol, 2001, 529 pp., $135.00, ISBN 0-7503-0812-5.

Fiber Optic Sensors, T.S. Yu and Shizhuo Yin, Marcel Dekker, New York, 2002, 510 pp., $175.00, ISBN 0-8247-0732-X.

Fundamental Aspects of Electrometallurgy, Konstantin I. Popov, Stojan S. Djokic, and Branimir N. Grgur, Kluwer Academic/Plenum Publishers, New York, 2002, 305 pp., $135.00, ISBN 0-306-47269-4.

A Glossary of Plastics Terminology in 5 Languages, *5th Ed.*, Wolfgang Glenz, ed., Hanser Gardner, Cincinnati, 2001, 385 pp., $39.95, ISBN 1-56990-328-X.

Handbook of Applied Surface and Colloid Chemistry, Krister Holmberg, John Wiley & Sons, West Sussex, 2002, *Vol. 1:* 591 pp., *Vol. 2:* 485 pp; $515.00 (set), ISBN 0-471-49083-0.

High Performance Pigments, Hugh M. Smith, Wiley-VCH, Weinheim, 2002, 435 pp., $125.00, ISBN 3-527-30204-2.

Highlights in Solute-Solvent Interactions, Wolfgang Linert, ed., and H. Taube, Springer Verlag Wien, New York, 2002, 220 pp., $129.00, ISBN 3-211-83731-0.

Impurity Scattering in Metallic Alloys, Joginder Singh Galsin, Kluwer Academic/Plenum Publishers, New York, 2001, 516 pp., $135.00, ISBN 0-306-46574-4.

Interfacial Electrokinetics and Electrophoresis, Angel V. Delgado, ed., Marcel Dekker, New York, 2001, 1008 pp., $250.00, ISBN 0-8247-0603-X.

Introduction to Macromolecular Science, *2d ed.*, Petr Munk and Tejra M. Aminabhavi, John Wiley & Sons, New York, 2002, 609 pp., $99.95, ISBN 0-471-41716-5.

Introduction to Solid-State Lighting, Arturas Zukauskas, Michael S. Shur, and Remis Gaska, John Wiley & Sons, New York, 2002, 207 pp., $49.95, ISBN 0-471-21574-0.

Macromolecular Symposia, B. Voit, H.-J. Adler, and F. Bohme, eds., John Wiley & Sons, Weinheim, 2002, 191 pp., $180.00, ISBN 3-527-30467-3.

Materials Science of Thin Films, Deposition and Structure, *2d ed.*, Milton Ohring, Academic Press, San Diego, 2002, 794 pp., $89.95, ISBN 0-12-524975-6.

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Mesoscopic Systems: Fundamentals and Applications, Yoshimasa Murayama, Wiley-VCH, Weinheim, 2001, 245 pp., $99.95, ISBN 3-527-29376-0.

Numerical Methods for Experimental Mechanics, Donald Berghaus, Kluwer Academic Publishers, Boston, 2001, 295 pp., $135.00, ISBN 0-7923-7403-7.

Particle Adhesion: Applications and Advances, David J. Quesnel, Donald S. Rimai, and Louis H. Sharpe, eds., Taylor & Francis Publishing, Inc., New York, 2002, 504 pp., $135.00, ISBN 0-56032-982-3.

Polymer Analysis, Barbara Stuart, John Wiley & Sons, West Sussex, 2002, 279 pp., $105.00, ISBN 0-471-81363-X.

Polymer Extrusion, *4th ed.*, Chris Rauwendaal, Hanser Gardner, Cincinnati, 2001, 777 pp., $99.95, ISBN 1-56990-321-2.

Polymer Gels and Networks, Yoshihito Osada, Alexei R. Khokhlov, Marcel Dekker, New York, 2001, 400 pp., $185.00, ISBN 0-8247-0669-2.

Polymer Solutions: An Introduction to Physical Properties, Iwao Teraoka, John Wiley & Sons, New York, 2002, 338 pp., $79.95, ISBN 0-471-38929-3.

Polymeric Biomaterials, *2d ed.*, Severian Dumitriu, ed., Marcel Dekker, New York, 2001, 1184 pp., $275.00, ISBN 0-8247-0569-6.

Polymers in Particulate Systems: Properties and Applications, Vincent A. Hackley, P. Somasundaran, and Jennifer A. Lewis, Marcel Dekker, New York, 2001, 384 pp., $150.00, ISBN 0-8247-0678-1.

Practical Aspects of Finite Element Modelling of Polymer Processing, Vahid Nassehi, John Wiley & Sons, West Sussex, 2002, 273 pp., $135.00, ISBN 0-471-490-42-3.

Principles of Coordination Polymerization, Witold Kuran, John Wiley & Sons, West Sussex, 2001, 522 pp., $180.00, ISBN 0-470-84141-9.

Processing by Centrifugation, Liya L. Regel and William R. Wilcox, Kluwer Academic/ Plenum Publishers, New York, 2001, 372 pp., $150.00, ISBN 0-306-46654-6.

Random Heterogeneous Materials: Microstructure and Macroscopic Properties, Salvatore Torquato, Springer Verlag, New York, 2002, 701 pp., $69.95, ISBN 0-387-95167-9.

Supercritical Fluid Technology in Materials Science and Engineering: Synthesis, Properties, and Applications, Ya-Ping Sun, Marcel Dekker, New York, 2002, 600 pp., $195.00, ISBN 0-8247-0651-X.

Surface and Thin Film: Analysis A Compendium of Principles, Instrumentation, and Applications, H. Bubert and H. H. Jenett, eds., Wiley-VCH, Weinheim, 2002, 336 pp., $84.95, ISBN 3-527-30458-4.

Surface Treatment V: Computer Methods and EXperimental Measurements for Surface Treatment Effects, C.A. Brebbia, WIT Press, Southampton, 2001, 464 pp., $239.00, ISBN 1-85312-873-2.

Thermoelastic Fracture Mechanics using Boundary Elements, D.N. Dell'Erba, WIT Press, Southampton, 2002, 168 pp., $109.00, ISBN 1-85312-849-X.

Thermosetting Polymers, Jean-Pierre Pascault, Henry Sautereau, Jacques Verdu, and Roberto J.J. Williams, Marcel Dekker, New York, 2002, 477 pp., $185.00, ISBN 0-8247-0670-6.

Understanding Materials: A Festschrift for Sir Peter Hirsch, C.J. Humphreys, ed., Maney Publishing, Cambridge, 2002, 343 pp., $115.00, ISBN 1-902653-58-0. □

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