Principles of Condensed Matter Physics

P.M. Chaikin and T.C. Lubensky
(Cambridge University Press, New York, 1995)
719 pages, $49.95
ISBN: 0-521-43224-3

P.M. Chaikin and T.C. Lubensky are active research scientists, specializing in organic metals and liquid crystals, respectively. Their book is a description of half of a course on condensed matter physics that they have taught at the University of Pennsylvania. They are not happy with the available textbooks, and feel a need for a book covering the non-quantum-mechanical methods that are useful in the study of such "soft" materials as liquid crystals, superfluid helium, incommensurate crystals, quasicrystals, and systems in one and two dimensions. The development relies heavily on the concepts of symmetry and symmetry breaking. Most of the theoretical discussion is in the area of statistical physics, going beyond mean-field theory to renormalization group theory and methods for calculating critical exponents. As an example of their approach, they start with a lengthy discussion of the physics of water in the solid, liquid, and gaseous phases. They also devote a number of sections in the book to liquid crystals.

The second semester of the course covers the more standard subject matter of solid state physics. It focuses on the way that electrons bind atoms together and are responsible for most of the interesting properties of condensed matter. This material is not included in the book.

The authors are no doubt correct in their assertion that most of the classical books on solid state physics do not prepare the student for research on the ever-growing range of materials that are now being investigated by condensed matter physicists. The difficulty is that, once one leaves the boundaries of the "conventional" treatment, many paths to follow are available. There will be little agreement on the choices made. The book will be greeted with enthusiasm by physicists and materials scientists who are working with the "soft" materials described. Others will have to wait for future books with a different emphasis.

Reviewer: *Sam Faulkner is a professor of physics and co-director of the Alloy Research Center at the Florida Atlantic University. His research is primarily on the theory of the electronic structure of disordered solids.*

Flat Panel Display Technologies

L.E. Tannas, Jr., W.E. Glenn, and J.W. Doane
(Noyce Publications, Park Ridge, New Jersey, 1995)
592 pages, $72.00
ISBN: 0-8155-1387-9

This book is based on research and field reports prepared through the Japanese Technology Evaluation Center (JTEC) and the World Technology Evaluation Center (WTEC), sponsored by the National Science Foundation (NSF) and administered by Loyola College in Maryland. It describes research and development efforts in Japan, Russia, Ukraine, and Belarus in the area of display technologies. The topics covered include liquid-crystal-display (LCD) materials and related technologies; liquid crystal and other nonemissive displays; and vacuum fluorescent, electroluminescent, field emission, phosphors, and other emissive materials.

Part I is based on a JTEC final report completed in June 1992 that summarized the findings in a field trip to Japan in prior years. Each JTEC committee member wrote a chapter on a specific topic related to LCD technology such as flat-panel-display (FPD) materials, manufacturing and infrastructure of active matrix LCD, passive and active matrix LCD technology, and projection displays. These chapters contain well-written tutorial material and are useful for newcomers to LCD technology. A fairly comprehensive collection of trip reports to various LCD makers, equipment manufacturers, material suppliers, government research agencies, and universities is included in one of the appendices. Most of these reports are opinion surveys of the FPD industry collected in the early 1990s and are probably outdated by now. However, some reports include very detailed and informative technical discussions.

Part II is an update of Part I, prepared by L.E. Tannas, Jr., co-chair of JTEC, and presented in the February 1994 issue of *Information Display* magazine. Although still an outdated report, it is a closer assessment of the present Japanese LCD industry than the earlier coverage in Part I. Unfortunately, the update is still not current enough to cover some of the recent most dramatic events in FPD industry in recent years such as the price collapse and over supply of 10-in. diagonal color TFT LCDs in 1995 and the demonstration of wide viewing angle TFT-LCD using in-plane switching techniques.

Part III of the book is based on a WTEC final report issued in 1994 which summarized research and findings from a field trip to Former Soviet Union (FSU) countries, including Russia, Ukraine, and Belarus. For this survey, the WTEC committee included emissive display technologies and phosphors in addition to LCDs. The format of the presentation is the same as in Part I, with chapters on specific topics such as LCD materials, LCD and other nonemissive displays, vacuum fluorescent (VF), electroluminescent (EL), field-emission displays (FED), phosphors, and other emissive materials, and followed by a thick collection of trip reports in an appendix. Compared to the chapters in Part I, however, some of these chapters, such as the ones on emissive display and phosphor technologies, are weak in technical content; they only report the specific display technologies the FSU countries were working on (some were esoteric) without commenting on how these works compare with the state-of-the-art and how relevant they are to practical applications. Readers who are interested in collaborating with FSU countries will find chapters on the social and economical infrastructure and business perspectives. The trip reports are mainly more detailed descriptions of the research and development activities at FSU research institutions and companies. No assessment of the future technical direction of the display technologies is made since none of the FSU research institutions or corporations appears to be a leader in any of the FPD technologies.

In summary, it is hard to judge who will benefit most from this book. Readers seeking a good reference on the latest development in FPD technologies may not be disappointed by the chapters on LCDs which contain enough basic information and will serve as good tutorials. Unfortunately, the same thing cannot be said about the chapters on VFD, EL, FED, and phosphors where the emphasis is on the work of FSU countries which can hardly be considered as leading-edge efforts in these fields. The readers will also be overwhelmed by the trip reports which take up almost half of the book and may have a hard time trying to sort out the useful technical information from the rest. On the other hand, this book could benefit people who are interested in knowing the social and economical structure of the FPD industries in Japan and FSU countries, which was the original intention for these studies. If these surveys had been conducted to find out who the leaders in each FPD technology were and what they were doing in their field, and if the lead authors had spent extra effort to reduce the trip reports to

essence, this book could be a definitive reference for FPD technologies as the book title portends to be.

Reviewer: Sey-Shing Sun is a principal scientist in Advanced Technology Group of Planar America, Inc., Beaverton, Oregon. His primary interest is in the development of thin film phosphor materials for color TFEL displays.

Diamond Chemical Vapor Deposition: Nucleation and Early Growth Stages

Hiumin Liu and David S. Dandy
(Noyes Publications, Park Ridge, NJ, 1996)
207 pages, $64.00
ISBN: 0-8155-1380-1

While a number of books on chemical vapor deposition (CVD) diamond are available, this work by H. Liu and D.S. Dandy is distinct because it focuses on nucleation and early growth. The first two chapters provide background information on the historical development of CVD diamond, basic crystal structure, and growth morphology. This is appropriate background material, particularly for individuals who are less familiar with the details of CVD diamond. Chapter 3 is an overview of different CVD techniques that have been used to produce diamond films and coatings. This chapter also reviews work on diamond growth mechanisms, which have been studied extensively in recent years. This includes descriptions of experimentally observed relationships between process variables and diamond growth.

The remainder of the book is a detailed review of research on the specific topic of nucleation and early growth. Chapters 4 through 7 are organized to present primarily experimental observations and associated analyses. Chapters 4 and 5 review work on basic diamond nucleation, epitaxy, oriented growth, and morphology, including relatively detailed descriptions of nucleation and growth mechanisms that have been proposed by various researchers. Chapter 6 presents work on surface conditions (i.e., substrate effects), including both chemical effects associated with different substrate materials and physical effects such as surface topology. Chapter 7 describes the observed relationships between nucleation and key process variables (i.e., temperature, pressure, gas composition, and gas activation). Chapter 8 reviews work on theory and modeling. As noted by the authors, this final area is not well-developed at this time.

During the last decade, extensive research has been conducted on nucleation and early growth in CVD diamond, which is pulled together in this book into one detailed review, with close to 400 references. Thus the book provides a valuable resource for both researchers and for individuals involved in the development of CVD diamond technology. It is also worth noting that nucleation and growth mechanisms during CVD are poorly understood for most other polycrystalline materials. Thus, this detailed review of the large body of recent work on nucleation and growth in diamond also provides a case study of potential interest to researchers who are studying the initial formation of other polycrystalline, vapor-deposited films and coatings.

Reviewer: Brian W. Sheldon is an associate professor in the Division of Engineering at Brown University in Providence. His primary research interest is the processing of advanced ceramics, including CVD diamond.

Intermetallic Compounds: Principles and Practice, Vols. 1 and 2

J.H. Westbrook and R.L. Fleischer, Editors
(John Wiley & Sons, New York, 1995)
1,932 pages, $575.00
ISBN: 0-471-94219-7 and 0-471-93454-2

The vision of the editors of this comprehensive two-volume set (J.H. Westbrook and R.L. Fleischer) has been to produce a key reference source on intermetallic compounds for the next 25 years. The review follows a similar organizational style as an earlier review conducted by Westbrook in 1967, reviewing the historical background, current status and future prospects of the theory, experimental development, and applications of intermetallic compounds. Because of the burgeoning research on intermetallics in recent decades, this review has necessarily become much more extensive, and it was necessary to divide it into two volumes. The first volume, on the theme *principles*, is directed at the science of structure-property relationships of intermetallics, and the second volume on *practice* considers their commercial production and engineering applications.

To my knowledge, the coverage of intermetallic compounds—including not only all metal-metal compounds, but also some metal-metalloid compounds, such as silicides, tellurides, and semiconductors—is far broader than anything previously attempted. The two-volume set consists of 75 chapters authored by a total of 114 specialists, almost equally divided between the United States and 14 other countries. After the introduction (I), the first volume is divided into six parts on bonding and stability (II), crystal structures (III), defect structures (IV), formation and constitution (V), kinetics and phase transformations (VI), and property fundamentals (VII). The second volume is divided into four types of applications: namely, structural, electromagnetic, chemical and metallurgical, and miscellaneous applications. Each volume includes extensive lists of acronyms and crystal structure nomenclature, author and subject indexes, as well as an innovative index of compounds.

This work should prove an invaluable source for both scientists and engineers who wish to learn about intermetallics as their research area and also those who wish to expand their knowledge of intermetallics beyond their particular area of expertise. The most important contribution is Part III of Volume 1: ten chapters on crystal structures which provide by far the most authoritative coverage on the subject. With the aid of the crystal structure nomenclature, arranged alphabetically by both Pearson-symbol designation and Structurbericht designation, readers may use the compound index to identify the crystal structures of most binary and some ternary compounds and search for their fundamental properties.

Several chapters in Volume 1 also offer helpful summaries of both ab initio calculated and experimental results of some bulk and defect properties in tables. Lattice parameters and heat of formation (Chapter 3), elastic properties (Chapters 9 and 37), and antiphase boundary energies (Chapters 3 and 21) are cases in point. In other areas, such as thermodynamic properties (II), kinetics and phase transformations (VI), and formation and constitution of multicomponent systems (V), the current status of modern theoretical and experimental methodologies does not permit such a quantitative comparison. Though more formal in their content, these chapters still prove useful as reference material for special seminar courses at the advanced undergraduate and various graduate levels.

In considering commercial production and engineering applications of intermetallic compounds, the concluding sections of most chapters in Volume 2 give the authors' critical assessment of the state of their subjects and of where they believe further effort is merited. For example, while future research in nickel-based superalloys is turning away from strength enhancement toward processing improvements (Chapter 1), for structural

applications of Ni_3Al-based alloys the authors recommend further research and development in a number of specific areas of the structure-property-processing relationships (Chapter 2).

Given the ambitious scope of the project and the "exponential proliferation" in the number of research papers on intermetallic compounds in the past decade, it was perhaps inevitable that this collective work would omit some key papers, particularly in fast-growing areas such as point defects and diffusion (Volume 1), and gamma TiAl and its alloys (Volume 2). Despite this shortcoming, this treatise's comprehensive discussion of crystal structure, the utility of its subject and author indexes and lists of acronyms and nomenclature, and the innovation of its index of compounds should significantly enhance further intermetallics research and development over the next few decades and should guarantee that this work will remain one of the key references on intermetallic compounds for a long time to come.

Reviewer: *Man H. Yoo is a senior research staff member in the Metals and Ceramics Division, Oak Ridge National Laboratory. His research work includes physical properties and mechanical behavior of structural materials including intermetallic compounds.*

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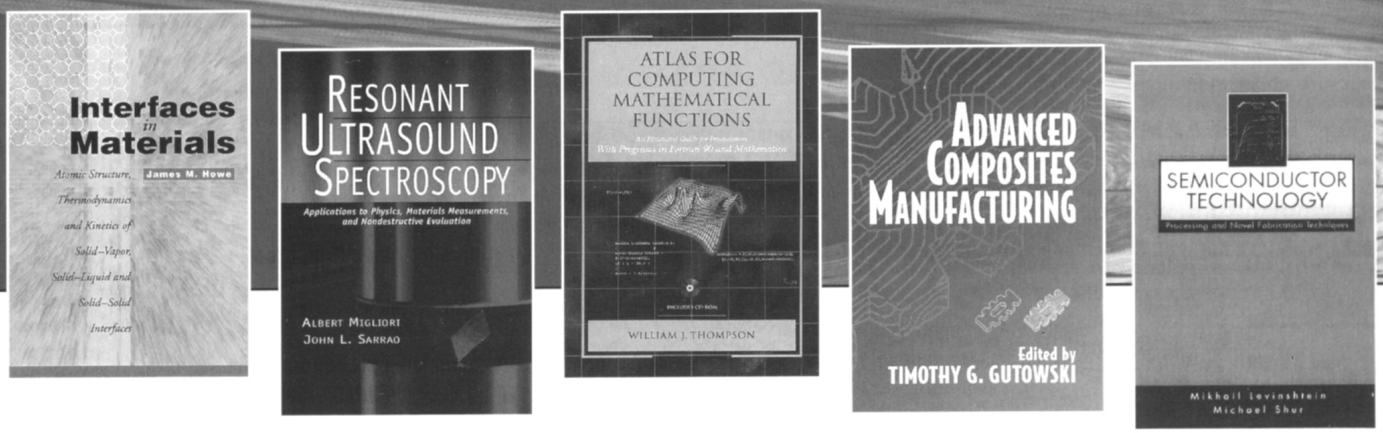

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