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The Coming of Materials Science

Robert W. Cahn
(Pergamon, Elsevier Science, Oxford, 2001)
xvii + 568 pp, $64.00
ISBN 0-08-042679-4

A great book—a veritable tour de force! Fascinating, inspirational, and useful in several ways, it should be required reading for every student entering the now established field of materials science, and is highly recommended to all now in the profession and to other scientists and engineers as well. Cahn is ideally suited as the author of such a work, in view of his encyclopedic knowledge of the field, his writing skills, and the fact that he personally participated over most of the time the new discipline was in gestation.

The 15 chapters of the book may be divided into three groups. The first five chapters examine, with reference to materials science, such questions as: What is a discipline? How does it arise? How is it influenced by neighboring disciplines? How and why does it spawn subdisciplines (what Cahn calls parepistemes)? How and when does quantification appear? The next six chapters review the evolution of some particular topics: materials characterization, functional materials, polymers, transformation of materials development and processing from a craft to a science, materials in extreme states (processing conditions, shape, microstructure, ambient conditions, and function), and finally materials chemistry, including biomimetics and electrochemistry. The last four chapters treat some particular generic topics—computer simulation, data management, the institutions and literature of materials science—and conclude with a brief epilogue.

What Cahn gives us is not the usual straightforward, chronological development of the history of a topic, but a rich, multifaceted treatment in which important themes are reexamined from different viewpoints. It is also enriched as a result of his personal acquaintance with many of the protagonists and by his emphasis on the international character of the development of the field. Another factor adding interest is the inclusion of pictures of many of the leading scientists in the field (both formal portraits and informal snapshots). It is unfortunate that space limitations apparently prevented the inclusion of some others (Chalmers, Cottrell, Hollomon, Kingery, and Roy come to mind), who are notable, not so much for their own specific research as for their influence on the evolution of materials as a true scientific discipline.

Some enduring truths are articulated that are of general relevance to all of science, not just materials. Among them are (1) experimentation stimulates theory, and theoretical advances stimulate experiment; (2) bridging between disciplines is important in any field; (3) simple concepts tend to be continually replaced by increasingly complicated ones; (4) "no one believes experimental data except the man who takes them, but everyone believes the results of a theoretical analysis except the man who makes it"; (5) three factors—stimulus, theory, and new instruments—are needed for a major advance in experimental research; (6) learning in science begins when an observation is truly surprising, (i.e., at variance with currently accepted theory); and (7) a product champion is vital to the success of any industrial development.

Among the hundreds of references Cahn provides are not only citations of seminal papers, but also of topical reviews with a strong historical slant and particularly influential texts and monographs. It is abundantly clear that Cahn is not simply aware of these sources, but has studied them carefully and used them in his own work.

It is a pity to record, in such an otherwise fine work, some flaws that are the responsibility, not of the author, but of the publisher: more than 60 misprints encountered in a quick reading of the book (incredible in this age of electronic spell-checkers), numerous errors in punctuation, some serious omissions from the index, and instances of the use of the wrong font in several citations, thereby confusing the title of the work with its source. Although Cahn provides ample, clear definitions of terms as he goes along, for those readers outside the main stream of materials science, an appendix collecting the most important of these in a brief glossary would have been helpful.

Reviewer: *Jack H. Westbrook is president and principal consultant of Brookline Technologies. He also serves on the Editorial Board of* MRS Bulletin. *His research interests include intermetallic compounds, effects of grain boundaries and surfaces, and the computerization of materials data files. He also is an active student and writer in the history of science and technology.*

Computational Methods in Surface and Colloid Science

Malgorzata Borówko, Ed.
(Marcel Dekker, New York, 2000)
984 pp, $225.00
ISBN 0-8247-0323-5

Understanding colloidal systems requires understanding interfaces. In this context, the actual focus of Borówko's book is on interfacial systems. Interest in interfacial phenomena has always been strong, in part due to its importance to applications. Yet, measurements on interfaces are more difficult than for the bulk. In a similar vein, theoretical methods for the bulk often break down in interfacial regimes. In recent years, significant advances have enabled experimental and theoretical methods on interfacial phenomena to reach a new level. With the advance of computer resources, compu-

tational methods have been able to treat aspects such as confinement, adsorption, and inhomogeneity that make interfacial regions distinct. Many of these methods have reached a level of maturity such that a reference on such computational methods would be useful to the materials community. This book aims to provide such a reference.

The book contains 18 chapters on various interfacial systems and the computational methods used to study them. The first few chapters are devoted to more general topics. For example, the first chapter by Schoen treats confined fluids; confinement is a generic difference between interfacial and bulk systems. Inhomogeneity is also intrinsic to interfacial systems and is introduced in the third chapter on simple fluids. Chapters 4, 5, 8, and 9 treat adsorption, including chemical reactions. Water and electrolytes at interfaces is discussed in Chapter 5. Chapters 10–14 treat molecular and polymer systems, including surfactants, microemulsions, and micelles. Colloidal simulations, the membrane-fluid interface, double-layer theory, and crystal-growth processes finish the collection.

The editor's purpose is for the book to be a comprehensive reference on computational methods for interfacial systems. The book definitely is a valuable reference. As I am becoming interested in simulating self-assembly of surfactant systems, the article by Schmid was a valuable starting point. This article is a comprehensive review of the various methods and results. Recently, I was searching the literature for papers on confined neutral polymers. Even with the ability to search on the Web, I could not find key articles simply because my keywords did not match. However, I did find the articles and some discussion in Milchev's chapter on polymers adsorbed to hard surfaces.

The use of simulations as a common theoretical tool is relatively young. Practitioners have tended to focus on using a particular method. With computers being so much faster than 20 years ago and with the basic methods widely available, multiple computational methods will be applied to the various aspects of a problem much like various experimental techniques are used to probe different time and length scales, chemistries, and such. The article by Kremer and Müller-Plathe on simulations of dense polymers is directly focused on this issue. Their discussions of when atomistic versus mesoscopic simulations are appropriate and on the relative merits of Monte Carlo versus molecular dynamics are valuable to anyone planning to carry out numerical simulations. From this point of view, the book as a whole shows how the variety of computational methods can be applied to interface problems.

The book is clearly not meant to be a textbook, and a mastery of the basic computational methods is presumed. With a good fundamental background, this book can help a graduate student starting research in the field. Its main use is as a guide to the literature. The details of the computational procedures are typically found in the cited references, not in the text. Finding the most important papers to read is an increasingly difficult task. The number of pages being published is dwarfing the number of significant points to be understood and remembered. Any guide to limit the number of side trails will greatly speed a student's progress. As already noted, I have already used the book as a guide.

Reviewer: *Mark Stevens is a senior member of technical staff at Sandia National Laboratories in Albuquerque, NM. His research interests include polyelectrolytes, self-assembled monolayers, biomembranes, colloids, lubricants, and adhesives.*

Properties of Advanced Semiconductor Materials: GaN, AlN, InN, BN, SiC, SiGe

Michael E. Levinshtein, Sergey L. Rumyantsev, and Michael S. Shur, Eds.
(John Wiley & Sons, New York, 2001)
x + 194 pages, $74.95
ISBN 0-471-35827-4

The purpose of this handbook, as stated in the preface, is to provide a fairly complete documentation for a series of advanced semiconductors. All of these materials except one are wide-bandgap semiconductors. Given the importance of these materials for optoelectronic and electronic device applications, as well as recent rapid progress in this series of semiconductors, a summary of recent available data is timely and useful. The handbook collected data up to 1999. Although many books dealing with these materials have been published, to our knowledge this is the only book with such a broad range of data collection. It provides the most important basic parameters, as well as optical, electrical, thermal, and mechanical properties of these materials. Anyone working with these materials will find the up-to-date information summarized in this handbook extremely useful and handy.

The book would have been more complete if some data for alloys were included. For example, InGaN and AlGaN are very important materials for electrical and optoelectronic device applications; recently, a great deal of information has been published for these alloys. We hope that useful data such as bowing parameters for alloy systems will be added in future editions.

Comparing the Landolt–Börnstein series handbook with this book, one can appreciate how many advances have been made in the last decade for all of these materials. However, it can also be seen that much work still remains to be completed. For example, the uncertainties in some of the most important parameters, such as energy gap and carrier effective mass, are still very large. It thus indicates that many research opportunities still exist in the areas of fundamental studies as well as practical device implementation for this important series of semiconductor materials.

Due to worldwide effort and rapid progress, it has become increasingly difficult to track information and avoid research duplication. We strongly recommend looking into this book before attempting to measure any "new" parameters. With the large number of people involved in the research and development of these materials, this handbook has the potential to become one of the most cited reference books in upcoming years.

Reviewers: *Hongxing Jiang is a professor and Jingyu Lin is an associate professor with the Department of Physics at Kansas State University; they have been working with Group III nitride wide-bandgap semiconductors for the last eight years. Their areas of research include metalorganic chemical vapor deposition, optical and electrical property characterization, micro- and nanophotonics, and electronic device fabrication.*

Managing Science: Management for R&D Laboratories

Claude Geles, Gilles Lindecker, Mel Month, and Christian Roche
(John Wiley & Sons, New York, 2000)
xix + 359 pages
ISBN 0-471-18508-6

In the authors' own words, this book aims to be "a university-quality graduate-level course in the management of scientific laboratories," taking into account the differences between management oriented toward mass production and consumption and management dedicated to research and development (R&D). The focus, therefore, is on an environment that is somewhere between those of a university campus and an industrial plant. The authors have extensive experience working in and managing large national or international laboratories, primarily in Europe, but also in the United States. Their technical and managerial backgrounds are in large accelerators.

While much of the book is relevant to any large research laboratory, some of it is more appropriate to government-funded facilities and, more specifically, to large user facilities such as synchrotrons, neutron sources, and accelerators.

The book is divided into two parts. Part I is titled "The Management Structures." Beginning with the conception and construction of a new organization, it describes the organization and the role of management: defining its purpose, its funding and construction, and its operation once built. Representative chapters range from "Raisons d'Être" to "Policy Implementation" and "Infrastructure." While none of these topics is treated in enough depth for a reader to be able to execute the various components of successful large-laboratory management, the authors give a very good overview of the complexities of such an undertaking, as well as the many levels on which the successful R&D manager must operate. There are, of course, countless resources available on strategic planning, project management, and such to which a seriously interested reader might go if the material in this volume piques an interest.

The second part of the volume is called "The Human Drama" and deals with the people who make up an organization and contribute so significantly to its success or failure. Topics of interest include the important influence of human behavior on the organization, performance (including performance management), money, and judgment. Of particular interest are some provocative scenarios in the chapter on "Judgment" of real management dilemmas. These scenarios leave the reader with a management dilemma to resolve (based on real occurrences). In a classroom situation, these would be an excellent springboard for animated class debate. For an individual reader, however, some discussion of the pros and cons of various possible courses of action would be welcome.

This book provides a concise description of the various facets of management of a large nonprofit R&D laboratory. Many sections are equally relevant to an industrial R&D setting. The volume is likely to be useful in a university course on research management or for any individual seeking an overview of the many facets and challenges of R&D management.

Reviewer: *Julia M. Phillips is director of the Physical and Chemical Sciences Center at Sandia National Laboratories in Albuquerque, NM. She chairs the* MRS Bulletin *Book Review Board.*

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