An Introduction to Materials Engineering and Science for Chemical and Materials Engineers

Brian S. Mitchell
(John Wiley & Sons, 2004)
xv + 954 pages; $145.00 (cloth)
ISBN 0-471-43623-2

and

Introduction to Materials Science

Jean P. Mercier, Gérald Zambelli, and Wilfried Kurz; translated by Alan Gay
(Elsevier Editions Scientifiques & Médicales, 2004)
xiv + 461 pages; $79.95 (paperback)
ISBN 2-84299-286-5

The first, and far more voluminous, of these two books is explicitly directed at undergraduate students, specifically those aiming at qualifications in chemical engineering or materials engineering. The author is attached to a chemical engineering department. The second book, shorter and considerably less advanced in its level, is stated to be "perfectly suited to engineering students, as well as to physicists or chemists who are not specialized in materials but who, nevertheless, wish to be aware of this discipline.... It will be equally very useful to those who left University benches more than ten years ago." This book was originally published in French and, I gather, sold well in the francophone market. Two of the authors are at a university in Belgium (disciplines not specified), while the third is at a Swiss university and is certainly a materials scientist.

Those academics who seek to educate budding materials science and engineering (MSE) practitioners can easily spend their entire reading time critically comparing the numberless textbooks at their disposal, and here are two more to induce them to burn the midnight oil. The first book is entirely new.

The two books have a number of features in common, and these are clearly a sign of the times. There is far more emphasis on polymers than there used to be even a few years ago, and their treatment is sophisticated; likewise, there is a good deal of matter about what Mitchell terms "'biologics"; that is, the chemistry and microstructure of zoological and medical features, but not biomimetic design. Metals receive distinctly less attention in Mitchell's book, but an adequate proportion in that by Mercier et al. Both books, at the beginning of each chapter, set out clear didactic objectives, and both include extensive exercises. Here, Mitchell's exercises are distinctly more sophisticated, and many of these are designed for collaboration between two or three students. Both books have sections in which highly specific applications are concisely set out. Thus, Mitchell has a most interesting account of the permeability of diverse inorganic glasses to helium and its relation to "fine structure," while Kurz (presumably), true to his Swiss upbringing, has a fascinating account of wire ropes as used for alpine cable cars, and there is another on the materials for contact lenses.

In both books, the quality and information content of the illustrations is impressive. Almost every one of Mitchell's figures is taken from other texts: I do not intend this as a criticism, since so many sophisticated graphics have been assembled by earlier authors, and redrawing would be a waste of time. I shudder to reflect how much time Mitchell must have spent in securing permission to reproduce—an increasing burden on authors of textbooks!

I have identified two problems, applicable more especially to Mitchell. One is the common problem of the best order to introduce concepts. Thus, kinetic processes are treated before diffusion has been introduced; this kind of "timing" difficulty cannot be avoided altogether, but should be moderated by numerous cross-references, which does not happen here. The other problem, common to both books, refers to thermodynamics. Gibbs free energy is pulled out of a hat, without real explanation, and the concept of entropy of mixing is lamely referred to as an outcome of statistical mechanics, so that the form of free-energy curves that lead to phase diagrams is not properly explained. Likewise, Arrhenius's great kinetic equation is simply quoted, without explanation. I do not think that any textbook author in recent years has achieved the crystal clarity of Cottrell's presentation of thermodynamic concepts, in configurational terms, in his 1948 book, *Theoretical Structural Metallurgy* (Longmans, Green, & Co., London), unfortunately long out of print! A further concern is that neither book devoted the desirable amount of attention to "dopants" (intentional impurities), especially in their role as active segregants at interfaces such as grain boundaries. Mitchell seems to be unaware that spheroidal cast iron needs specific dopants to bring about that desirable microstructure.

Both books represent a considerable advance on many earlier texts: Thus, the level of the French text is similar to that of the short texts by John Wulff and coauthors in 1964, but the treatment is more quantitative and varied. Mitchell's book has achieved a new level and range of information and deserves serious consideration as a backing text for undergraduate MSE courses (even though Mitchell specifically concerns himself only with the E of MSE). Whether the price will permit either text to be widely adopted is a separate question.

Reviewer: *Robert W. Cahn is a physical metallurgist turned materials scientist, currently attached in nominal retirement to the University of Cambridge. In 2001, he brought out a historical book,* The Coming of Materials Science. *He has served for many years as a member of the Editorial Board and the Book Review Board of* MRS Bulletin.

Metal and Ceramic Matrix Composites

B. Cantor, F.P.E. Dunne, and I.C. Stone, Eds.
(Institute of Physics Publishing, 2004)
429 pages; $125.00
ISBN: 0-7503-0872-9

This book is a collection of papers on composites based on talks given at the 3rd Oxford–Kobe Materials Seminar in September 2000. The papers cover four areas: applications, processing, mechanical behavior, and new fibers and composites. Most are a snapshot of the authors' research at the time of the meeting. At first sight, there appears to be some overlap, but where this occurs one finds that the topics are covered from very different angles. I particularly enjoyed reading the papers where a wider view was presented, for instance, the papers by Lewis and by Knowles, both on ceramics. Perhaps this is simply a reflection of the saying that one likes what one already knows, but all were enjoyable. For instance, the paper by Carmai and Dunne was a real effort to quantitatively understand the processes involved in making the metal–monofilament composites by pressing metal-coated fibers together. It was good to read Nawa and Niihara's work demonstrating the use of zirconia "nanocomposites" in biomedical applications, despite the constant reminders elsewhere about costs. It is clear that cost is one of the most important issues facing the metal and ceramic composites community and in particular those who are trying to use these materials with commercial concerns. It was therefore a shame, I thought, to see that there was almost no discussion about costs that might be useful to a researcher trying to think about suitable material processing routes and structures. There was no mention even of the scale of the task, such as whether we are trying for a 10-fold or 10% decrease, and in what areas this is most pressing. This would have been genuinely valuable and, especially given the nature of the meeting, is, in my view, a missed opportunity.

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As the papers are generally reviews of work in progress, graduate students working in the specific areas covered would benefit most, although much has happened since 2000. Despite this, the book gives an interesting record of the work in these areas.

Reviewer: *William Clegg is a Reader at the University of Cambridge with research interests in the deformation of hard materials and ceramics processing. He joined Cambridge from Imperial Chemical Industries in 1992.*

Superconductivity, Superfluids, and Condensates

James F. Annett
(Oxford University Press, 2004)
198 pages; $45.71
ISBN: 0-19-852756-9

James F. Annett has produced a new book on superconductivity and related topics slated for the upper-level undergraduate student. As such, the material is appropriate, and the level of math is consistent with the background of the well-prepared science major. Annett covers the mathematical background and basic phenomenology of superconductivity, superfluids, and condensates with good mathematical completeness, complemented by discussions and photos of relevant experimental results. The material covered makes the book timely. The mathematical exposition of the topics is at a relatively high level, but nonetheless well presented and approachable. The exercises are well thought out and in keeping with the tone of the book. As such, the book would represent a good text on the topics covered. Unfortunately, in my opinion, the book is incomplete. I believe a lack of full understanding of and connection to the experimental aspects of these topics has led to clear lapses in the interpretation and presentation of the material. In addition, at least one figure is geometrically incorrect. I think there is considerable potential to create a good text, but what I have seen needs further revision by experts in the field.

Reviewer: *Steven Ruggiero is professor of physics at the University of Notre Dame and has worked in experimental superconductivity, magnetism, and device physics.*

The Handbook of Advanced Materials: Enabling New Designs

James K. Wessel, Ed.
(Wiley–Interscience, 2004)
645 pages; $125.00
ISBN 0-471-45475-3

The book under review should not be categorized as a handbook, in the conventional sense of the word. A better title would have been *Some Selected Topics in Advanced Materials*. In all, there are 14 chapters spanning from composites (polymer, ceramic, and metal-based) and intermetallics to metallic alloys like Ni, Ti, and Al. In addition, there are chapters on "Corrosion of Engineering Materials" (Chapter 11), "Standards and Codes for Advanced Materials" (Chapter 12), "Nondestructive Evaluation of Structural Ceramics" (Chapter 13), and "Advances in Rapid Prototyping and Manufacturing Using Laser-Based Solid Free-Form Fabrication" (Chapter 14).

The editor of this handbook is a well-known consultant located in Oak Ridge. In all, there are 20 contributors, ranging from academia (11), industry (4), and research and development organizations (4) to consultancy (1). As noted in the preface, the handbook is supposed to cover advanced materials so as to inform the readers as soon as possible of materials that may improve the product or process. The editor also informs readers that the book is not to provide all the data one needs to select the materials.

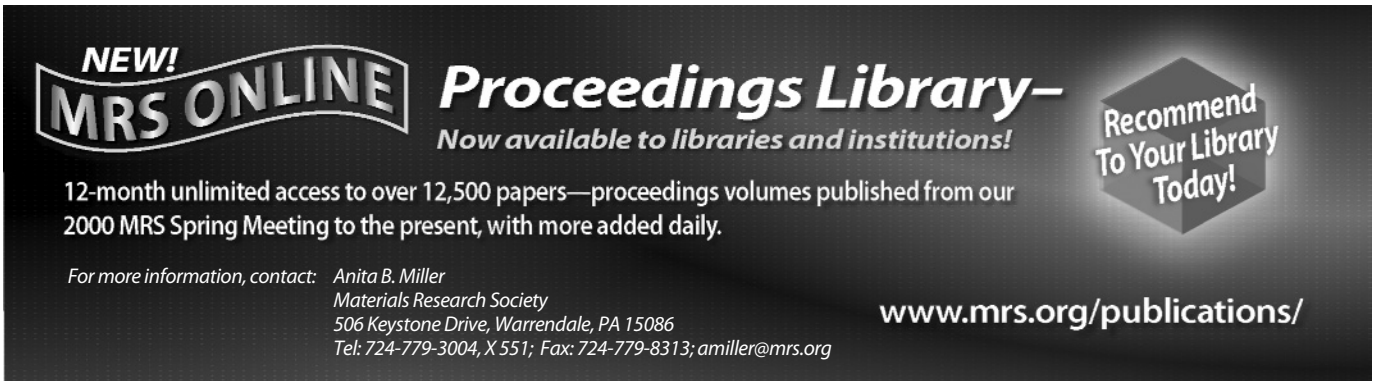
From the detailed contents given in the beginning of each chapter, it is evident that the editor has given enough freedom to the individual contributors that at times there is a lack of uniformity in presentation. The book title includes the word "designs," but only five chapters (1, 6, 8, 11, and 12) contain some elements of design aspects.

The largest chapter (143 pages) is on "Aluminum and Aluminum Alloys," contributed by J.R. Kissell, S.G. Pantelakis, and G.N. Haidemenopoulos from the United States and Greece. The subsections of the chapter are on properties, products, joining, and corrosion aspects. In addition, there is a brief overview on recent developments (i.e., Al-Li alloys, new Al automotive alloys, Al foam, Al-MMCs, friction stir welding, and hydrotalcite coatings). The weakest part of this chapter is that it devotes only one paragraph (p. 401) to aluminum powder. The consolidation through powder metallurgy route for Al alloys or MMCs is not described at all. The portion in this chapter related to corrosion and hydrogen embrittlement is written in the style of a research paper, covering subsections on experimental procedure, results, and discussion. Such a drastic change in the writing style of this very interesting chapter is on the negative side.

Chapter 13 (41 pages), related to nondestructive evaluation (NDE) of structural ceramics, is a unique one covering NDE of monolithic and composite ceramics. For creep studies, NDE methods like backscattered laser light and ultrasonic have been adequately elaborated. An x-ray computed tomography imaging system is also highlighted.

In brief, the editor has partially succeeded in his goal of projecting a detailed guide to the latest advanced materials. It is hoped that in the next edition, some of the limitations will be improved upon.

Reviewer: *Gopal S. Upadhyaya is a materials consultant based in Kanpur, India. Formerly, he was a professor in the Department of Materials and Metallurgical Engineering at the Indian Institute of Technology, Kanpur, and a fellow emeritus at the same institute. His specializations are in materials engineering and powder metallurgy processing, particularly sintering.*



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