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Aerosol Processing of Materials

Toivo T. Kodas and Mark Hampden-Smith
(Wiley-VCH, New York, 1999)
x + 680 pages, $175.00
ISBN 0-471-24669-7

The use of aerosols in materials synthesis has been investigated extensively in the past decade. Although there have been several thorough literature reviews of aerosol materials synthesis during this time, this book is unique in that it provides a comprehensive summary of what has been done in the field together with a treatment of the fundamental physical and chemical processes involved. The book provides a comprehensive discussion of the use of aerosols in particle and thin film synthesis, though it primarily addresses only inorganic materials. The book is very clearly written throughout, with a consistency of style and philosophy that is a welcome change from most edited multiple-author monographs. Concepts are clearly explained, with an emphasis on promoting a strong physical grasp and an awareness of relative importance of the different processes involved (e.g. , evaporation, diffusion, and reaction). The authors make extensive use of schematic figures to promote understanding of the processes. The concept of "characteristic times" is developed in the theory portion of the book and is used throughout to put the relative importance of various processes into context. While some scientists may object to the extensive use of such order-of-magnitude calculations, I find that this makes a solid physical understanding accessible to readers without requiring a high level of mathematical detail. Because of the structure of the book, there is significant redundancy in the examples cited and illustrative diagrams that becomes apparent to one reading this book cover-to-cover. However, this same redundancy will be a benefit to the reader selectively reading specific sections.

Following an introductory chapter, roughly one third of the book is dedicated to providing background on the relevant fundamentals of aerosol science (e.g., size characteristics, growth, evaporation, nucleation, coalescence, and aerosol modeling) with many examples related to materials synthesis. Although these chapters certainly do not provide the clarity and depth of treatment found in the classic aerosol science texts, they make the book into a relatively self-contained reference for those readers not already possessing an aerosol science library. Furthermore, these chapters are well referenced and would provide a very solid starting point for anyone wishing to understand or explore the theoretical or fundamental aspects at a deeper level. A chapter dedicated to the chemistry of aerosol materials synthesis is noteworthy and welcome. That chapter discusses high-temperature chemistry of inorganic and metalorganic precursors at some depth, including some relevant tabulated properties.

Most of the materials synthesis discussion is classified into gas-to-particle conversion, intraparticle (gas-solid / liquid-solid) conversion, and film formation. Each of these categories is broken into a chapter that emphasizes qualitative behavior and a chapter discussing the technology involved. These chapters are broad in their coverage, including discussion of virtually all processes that produce or use particles dispersed in the gas phase (e.g., spray, flame, plasma, and laser-driven processes; supercritical expansion; and aerosol-assisted chemical vapor deposition). Specific examples from the literature are cited, and conveniently categorized tables summarizing key previous work are provided at the end of the "technology" chapters. The book concludes with chapters on aerosol reactor components and measurement characterization methods. These chapters are not particularly deep in their treatment, but provide an adequate overview to the technology and techniques available. Finally, a chapter related to nanostructured materials is included that provides an overview of the scientific issues and properties of these materials, and the potential attributes of aerosol methods for their synthesis.

Though aerosol synthesis has been widely investigated in the research community for some years, aerosol processing in industry has remained limited to some select (but important) applications. There is an increasing awareness of the possible economic viability of aerosol materials processing, which should lead to increased interest in industry and the broader materials research community. This book will serve as an excellent introduction to the field for newcomers, as well as a useful reference to experienced researchers in the field.

Reviewer: *Timothy L. Ward is an associate professor in the Department of Chemical and Nuclear Engineering at the University of New Mexico. His research interests include aerosol and vapor phase processing of inorganic films and powders, and the application of these methods to inorganic membrane fabrication.*

Advanced Computing in Electron Microscopy

Earl J. Kirkland
(Plenum Press, New York, 1998)
x + 250 pages, CDROM included, $72.50
ISBN 0-306-45936-1

Earl J. Kirkland has written an interesting book which will be very useful for graduate students who are starting image simulation, or, at a more advanced level, for researchers who wish to gain a deeper understanding of the simulations they have been using to model their specimens. For most microscopists, myself included, who have performed image simulations without concern about how they work, this book is very welcome. Kirkland begins at a fundamental level and carefully describes how electrons interact with a specimen, how the interaction can be simplified with suitable approximations, and how the computer is used to calculate the interaction efficiently. This gives one a working knowledge of the advantages and limitations of image simulations which is not easily obtained from the literature or more general microscopy textbooks. A particularly valuable feature is that Kirkland treats conventional and scanning transmission electron microscopy on an equal footing, describing simulation strategies in both cases. Among other areas, he discusses the approximations valid for thin and thick specimens, and how thermal vibrations, coherence and specimen tilt are included. He also provides practical guidance, with detailed descriptions of how simulations of images and diffraction patterns are carried out in typical cases. I found the discussion of unit cell size and sampling in real and reciprocal space to be especially helpful in quickly setting up an efficient and accurate simulation.

The book is sold with a CD-ROM containing multislice simulation programs for the Macintosh and PC and a modern compilation of electron scattering factors. I used the PC version to calculate "forbidden reflection" intensities in silicon, as part of an ongoing project on imaging surface steps in the TEM, and found the programs worked quickly and easily. The programs are very simple, using only rectangular unit cells and requiring the same data to be typed in each time the program is run. In line with this simplicity, data is output as TIFF files or as text: This is convenient as the results can be further processed with any commercial image or graph plotting package.

Overall the book is logically arranged and the concepts are clearly presented. Familiarity with Fourier transforms is required, but other knowledge is not assumed. The book has more production errors than I might have expected, and it would have been nice to see a deeper discussion of strategies for quantitative matching of simulations with experimental images. However, these are minor criticisms, and this is an excellent book which fulfills a valuable purpose in helping materials scientists use image simulations more professionally.

Reviewer: *Frances Ross uses electron microscopy to study semiconducting materials in the Physical Sciences Division of the IBM T.J. Watson Research Center.*

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