Book Review

# Book Review of Inorganic Materials Synthesis and Fabrication

Raul F. Lobo

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BOOK REVIEWS

**Advances in Chemical Physics, Volume 139.** Edited by Stuart A. Rice (The University of Chicago, IL). John Wiley & Sons, Inc.: Hoboken, NJ. 2008. x + 634 pp. $175. ISBN 978-0-470-25389-2.

The 139th volume of *Advances in Chemical Physics* keeps this venerable series as timely as ever. The current volume comprises six chapters on topics of current research interest in chemical physics and physical chemistry. As with most of the previous volumes in this series, these reviews are targeted toward a readership of physical scientists at the graduate level and above. The chapters can serve as topical introductions for Ph.D. students as well as comprehensive reviews for active researchers. Each chapter cites between 100 to 300 up-to-date references.

Each chapter is a self-contained review; the connection between the chapters is solely that each represents one element from a cross section of current research activity in chemical physics. In several of the chapters, only the most fundamental aspects of chemical physics are discussed. The chapter by Stolow and Underwood on time-resolved photoelectron spectroscopy presents an overview with a description of the theoretical underpinnings needed to explain current state-of-the-art experiments, such as femtosecond photoionization with coincidence-imaging detection. The chapter by Bomont on integral equation theories of (atomic) liquids focuses on the bridge function and closure relations for the total correlation function of the liquid and will be of great value for both new and experienced researchers.

The chapters written by Kobrak and by Spasic and Mohanty tackle some very challenging current problems. Kobrak provides a comprehensive introduction to the chemical physics of ionic liquids, a subject that has experienced an explosion of recent research interest. The latest generations of ionic liquids present substantially more complexity than the preceding classes of inorganic molten salts and are of great interest for their ubiquitous range of applications. Some of the exciting applications of ionic liquids include energy storage, electrochemical devices (particularly those based on nanomaterials), enzymatic catalysis, and solubilization of biomaterials such as cellulose. Spasic and Mohanty take on the task of extending the classic work on DNA counterion condensation begun by Manning and co-workers nearly four decades ago. Some fascinating examples are discussed, including branched nucleic acids and ribozymes.

The longest of the chapters, by Henri-Rousseau and Blaise, is a 245-page monograph unto itself on the subject of vibrational lineshapes of centrosymmetric cyclic dimers, such as those of the carboxylic acids. After a detailed theoretical discussion (with derivations included in 20 appendices), the chapter concludes with a brief discussion of the experimental lineshapes for acetic, adipic, glutaric, naphthoic, and propynoic acids. The focus is on the high-frequency X−H stretching lineshapes and not on the intermolecular vibrational frequencies of the dimers.

The chapter with the most applied focus is the fine overview of scanning electrochemical microscopy by Laforge, Sun, and Mirkin. They begin with a detailed description of the instrument, with a clear explanation of the differences between this submicron- to micron-scale method of mesoscale imaging and the scanning tunneling microscope. A detailed account is given for the transport of reactants and products of the redox reactions, including several relevant geometries at both solid−liquid and liquid−liquid interfaces.

Overall, this volume continues the standard of excellence set by its predecessors. It is an essential item for any modern university or research institution library. This somewhat weighty tome of 634 pages is also available online to subscribers (or for purchase) from the Wiley Interscience Web site at the URL http://www3.interscience.wiley.com.

**Edward W. Castner, Jr.,** *Rutgers, The State University of New Jersey*

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**Inorganic Materials Synthesis and Fabrication.** By John N. Lalena (University of Maryland University College-Europe), David A. Cleary (Gonzaga University), Everett E. Carpenter (Virginia Commonwealth University), and Nancy F. Dean(Formerly, Honeywell Electronic Materials). John Wiley & Sons, Inc.: Hoboken, NJ. 2008. viii + 304 pp. $100. ISBN978-0-471-74004-9.

This book is a follow up to the text *Principles of Materials Design* by Lalena and Cleary and was written to bridge the needs of chemists, physicists, materials scientists, and engineers regarding the synthesis and fabrication of single-phase materials for applications to magnetic materials, semiconductors, superconductors, etc.

Thematically it is divided into two sections. Let me start with the second section (Chapters 3−7), which begins with a survey of synthetic and fabrication techniques including solid−vapor, solid−liquid, and solid−solid reactions, followed by a short chapter on the synthesis of nanoparticles, and ending with a discussion of industrial manufacturing techniques. The substantial breadth of techniques the authors attempt to cover is at once the strength and weakness of this compact volume (303 pages). The material is necessarily covered at a superficial level, and the reader will not gain much more than an appreciation for the many possibilities available for inorganic materials synthesis. Although equations are often presented to illustrate relationships between materials properties, these are not used to do any analysis or solve specific problems. There is little effort to compare and contrast various techniques across different chapters, and it is very difficult to apply the information given in the text to laboratory or industrial situations. As such, this book is of very little value for teaching purposes other than as a source of examples for classroom teaching. The references at the end of each chapter are adequate as the basis for further study, although in some chapters the material is not really up-to-date.

In the first part of the book, the authors attempt to provide the conceptual basis upon which the discussion in the second part is based. The first chapter focuses on fundamental crystal-

  

lographic concepts and the basics of crystal growth, and the second emphasizes materials energetics and reaction kinetics. Unfortunately, there is so much ground covered that unless the reader already has a substantial background in crystallography, thermodynamics of the solid state, and surface chemical structure and reactivity, the average graduate student could not be expected to get a real grasp of the concepts and their applicability to materials synthesis. Also, many of the ideas and concepts covered in these two chapters are never put to use later on in the book. For instance, in Chapter 2, density functional theory is very briefly described as a means to calculating the total energy of a solid; however, it is not discussed again later in the text. If such ideas are not useful, why are they included in a volume like this one?

Throughout the text the authors attempt to bring some historical context to the development of the concepts and techniques of materials synthesis. This is mostly done in the form of vignettes interspersed throughout the book, which I found generally interesting and informative and possibly helpful to graduate students or others who are new to the field. Some of the individuals are very well-known, such as Richard Feynman, while others were completely new to me, e.g., Vladimir Segal, the developer of the equal-channel angular extrusion technique. I welcome this attempt to illustrate the contributions that many scientists have brought to the field of materials synthesis.

In summary, this book will be useful to individuals who already have experience in one or more of the topics covered and would like to broaden their perspective on the field or fill in the gaps of knowledge that a focus on specialized literature can leave. However, it should be recognized that this book is mostly a survey and would not be particularly useful to the reader who wants to learn which technique is optimal for a specific problem in materials synthesis.

**Raul F. Lobo,** *University of Delaware*

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