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BOOK REVIEWS

Nanoparticle Assemblies and Superstructures. Edited by Nicholas A. Kotov (University of Michigan, Ann Arbor). CRC Press/Taylor and Francis Group: Boca Raton, FL. 2006. xx + 626 pp. $199.95. ISBN 0-824-2524-7.

The objective of the editor in compiling this book is to present research efforts in the organization of nanoparticles into complex nanostructures and superstructures, including nanowires, nanotubes, nanorods, and two- and three-dimensional structures. Because the organization of nanoparticles into nanostructures with specific functionalities has important applications in the electronic, biotechnology, and catalysis industries, this objective is well justified.

Organized nanoparticles should have specific properties. The desired properties of nanowires for electronic applications (molecular electronic and electroluminescence devices and nanocircuits) and nanoscaled biosensors are outlined in the first chapter and discussed in subsequent ones. Fundamental concepts related to the synthesis of complex nanostructures from nanoparticles are presented at the end of the first chapter and further expanded later in the book.

Physical chemists and chemical physicists will enjoy Chapters 3−9 of the book on the electronic and optoelectronic properties of isolated nanoparticles and nanoparticle assemblies, such as quantum dots, nanowires, and nanorods. Among these, Chapter 3 is a must read for the chemical physicist. The results of fluorescence yield and lifetime measurements on single quantum particles are well presented here. This is a very active research topic that has facilitated the study of fluctuations in chemical systems and accelerated the development of tools for single particle spectroscopy measurements in recent years. Other topics of interest to physical chemists include the use of ultrafast laser spectroscopy to study vibrational modes in noble metal nanostructures and calculations that provide insight into conductance spectroscopy.

The technical and economic limitations of conventional lithography to the synthesis of functional nanostructures are covered in several areas of the book. Chapters 10−23 are dedicated to a discussion of methods for the chemical assembly of functional nanostructures, a promising alternative to lithography-based methods. Among these are three interesting chapters on magnetic nanoparticle research. Magnetic nanoparticles self-assemble into two- and three-dimensional superstructures due, in part, to magnetic interactions among particles. Their magnetic properties are sensitive to the particle morphology. This book provides an adequate overview of magnetic nanoparticles that include topics related to their synthesis, magnetic properties, phase transformations, and applications.

The organization of the book reflects the diverse number of approaches to assemble nanoparticles into functional nanostructures. Some of the methods described include linkers for nanoparticle organization through known chemical reactions of terminal groups as well as a wide range of template systems including DNA, molecular lithography, microemulsions, micelles and reverse micelles, polymers and copolymers, and porous inorganic materials. The use of fundamental principles drawn from nature, or simply supramolecular chemistry, to organize nanoparticles into functional nanostructures, is also well addressed throughout the book.

The contributors to the book also cover many other important issues related to nanotechnology and stress important challenges that require further research by the chemical community. Organizing nanoparticles into one-dimensional structures, for instance, makes a functional nanostructure, the nanowire. To have a useful device, the nanowires must be attached to specialized terminals or interconnected to device elements. The contributors to Chapter 15 present approaches to assemble metal and organic nanowires for electronic applications, a step clearly beyond nanoparticle organization. In subsequent chapters, like Chapters 17 and 19, there are elegant descriptions of the organization of functional nanostructures into superstructures using concepts drawn from supramolecular chemistry. References are current to 2003 throughout the book.

Overall, this volume is a delightful read for chemists, as it highlights the important role organic, bioorganic, and inorganic chemists must play in advancing nanotechnology. It is targeted for a chemical audience with an advanced degree in chemistry and a good background in all the traditional disciplines. Even those specializing in chemical education can find useful information in the book to introduce advanced nanotechnology concepts and experiments into undergraduate course and laboratory work, like the layer-by-layer method of assembly described in Chapter 16. Active researchers will also benefit from finding important and promising research topics worth pursuing. The book certainly highlights the important role chemists must play in future developments of nanotechnology, particularly in regard to nanoparticle assembly and superstructure synthesis.

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JA059899G

10.1021/ja059899g

Metal Oxides: Chemistry and Applications. Edited by J. L. G. Fierro (National Council for Scientific Research (CSIC), Madrid, Spain). CRC Press/Taylor & Francis Group: Boca Raton, FL. 2006. xxii + 783 pp. $179.95. ISBN 0-8247-2371-6.

This volume comprises 23 chapters, 15 of which are focused directly on catalytic chemistry and applications of transition-metal oxides. The opening paragraph of the preface suggests that this volume was intended to be a comprehensive survey that should serve as both an introductory source and a reference on metal oxides. While the content should be of significant interest to anyone seeking introductory and reference material on catalytic transition-metal oxides, it is less likely to appeal to those seeking general coverage of metal oxides. Several of the

Unsigned book reviews are by the Book Review Editor.

10.1021/ja059899g CCC: $33.50

chapters in this collection do provide excellent coverage of basic topics in the chemistry and applications of metal oxides, but they are few in number and the logic of their organization is vague, apart from the fact that the more fundamental topics are found early in the volume.

The first five chapters contain a variety of topics that do not appear to have any particular logical order. Chapters 1 and 2 deal with molecular species of early transition-metal oxides on various metal oxide supports. These are followed by a short, but well-written, general chapter on point defect thermodynamics and the kinetics of transport in oxides. The fourth chapter jumps to a discussion of the characterization of metal valence states using electron energy loss spectroscopy (EELS) and energy-filtered imaging in transmission electron microscopy, illustrated with several well-chosen examples. The uninitiated reader may have problems appreciating the key issues with EELS spectra that make this approach succeed or fail in providing valence quantification. The topic for Chapter 5 is the evaluation of surface composition, which is a critical issue for understanding the catalytic chemistry on transition-metal oxide surfaces and is an area in which unambiguous characterization poses some very significant challenges.

Chapters 6 and 7 are appropriately paired, the first dealing with electronic properties and the second with magnetic and optical properties. Chapter 6 is the longest of the contributions, providing a very nice overview of the electronic structure of metal oxides. It is perhaps the most important chapter in this volume in terms of utility for those needing a general introduction to the fundamentals of bulk metal oxides. Chapter 7 is perhaps less helpful as an introduction because it focuses narrowly on manganite colossal magnetoresistance (CMR) materials and high-T_c superconductors. This contribution rapidly launches into second quantization approaches that will surely lose many readers, especially those whose primary interest is tied to catalysis. Also woven into this chapter is a section on resonant X-ray scattering, but the presentation is focused on orbital ordering phenomena in manganites and thus is not likely to be informative for the typical reader. This is unfortunate since the same technique can be a very powerful tool for applications in oxide characterization for cases where elemental distributions are difficult to resolve with conventional (off-edge) X-ray diffraction.

Chapters 8−11 survey redox and acid−base properties of a variety of catalyst systems, including zeolites. Chapter 12 is the lone contribution dealing with synthetic methods and is specifically aimed at combinatorial synthesis and high-throughput evaluation. Chapters 13−15 cover alkane reactions on metal oxides, specifically propane selective oxidation, methane oxidation, and oxidative dehydrogenation of lower alkanes, and are followed by a chapter, coauthored by the editor, on olefin metathesis. Chapters 17 and 18 target total combustion of volatile organic compounds and hydrogenation reactions, respectively. Photocatalysis for splitting water is covered in Chapters 19 and 20 for TiO_2-based systems and RuO_2-promoted p-block (d^{10}) metal oxides, respectively. Chapter 21 covers selective catalytic reduction for NO_x abatement using ammonia or hydrocarbons for selective reduction on metal oxides, and Chapter 22 is a discussion of semiconducting SnO_2 gas sensors. The volume concludes with an overview of solid oxide fuel cell anode materials.

Overall, this volume contains many useful contributions, particularly for those working in transition-metal oxide catalysis. A wealth of references are given with each chapter, providing a valuable starting point for those new to each area of focus.

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JA0598964

10.1021/ja0598964

Organic Reaction Mechanisms 2002. Edited by A. C. Knipe (University of Ulster). John Wiley and Sons, Ltd: Chichester. 2006. x + 654 pp. $525.00. ISBN 0-470-02203-5.

This book is a survey of research on organic reaction mechanisms published in 2002. The titles of the chapters remain the same as they were last year, although the chapter "Molecular Rearrangements" has been divided into two parts in this edition. Also new to this volume are the indications in the margin (*de* or *ee*) of reactions that occur with significant diastereomeric or enantiomeric excess. Author and subject indices complete the book.

JA069753X

10.1021/ja069753x

Carbon Nanotubes. Edited by Valentin N. Popov (University of Sofia, Bulgaria) and Philippe Lambin (Facultes Universitaires Notre-Dame de la Paix, Namur, Belgium). Springer: Dordrecht. 2006. xvi + 254 pp. $139.00. ISBN 1-4020-4572-7.

This book is based on the proceedings of the NATO Advanced Study Institute entitled "Carbon Nanotubes: From Basic Research to Nanotechnology", held in Sozopol, Bulgaria in May 2005. The 51 chapters are organized into the following sections: (I) Synthesis and structural characterization; (II) Vibrational properties and optical spectroscopies; (III) Electronic and optical properties and electrical transport; (IV) Molecular adsorption, functionalization, and chemical properties; (V) Mechanical properties of nanotubes and composite materials; and (VI) Applications. Subject and author indices complete the book.

JA069740J

10.1021/ja069740j