Book Review

Molecularly Imprinted Materials: Science and Technology Edited by Mingdi Yan (Portland State University) and Olof Ramström (Royal Institute of Technology, Stockholm). Marcel Dekker: New York. 2005. xiv + 734 pp. $179.95. ISBN 0-8247-5353-4.

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BOOK REVIEWS

Characterization of Porous Solids and Powders: Surface Area, Pore Size and Density. By S. Lowell (Quantachrome Instruments, Boynton Beach), J. E. Shields (C. W. Post Campus of Long Island University), M. A. Thomas, and M. Thommes (Quantachrome Instruments). Kluwer Academic Publishers: Dordrecht, The Netherlands. 2004. xiv + 348 pp. $159.00. ISBN 1-4020-2302-2.

Porous solids are regarded as an important class of solid-state materials. There has been an ever-increasing interest and largely interdisciplinary research effort toward the design, synthesis, characterization, and functionalization of nanoporous materials. Hence, adequate characterization of the surface area and pore size of these solids has become progressively more important, but there have not been many all-inclusive sources available to help researchers. This book, co-written by a team of authors from academia and industry, closes the gap, providing a professionally useful handbook for researchers in both industry and academia who are in need of accurate and comprehensive information on the characterization of pore size and surface area of porous solids and powders.

The authors cleverly split the contents of this 19-chapter volume into two sections: theoretical concepts and experimental guidelines. The book covers, in great detail, methods based on gas sorption (physisorption and chemisorption), mercury porosimetry, and pycnometry. It addresses not only the theoretical and experimental basics of these techniques, but also the most recent developments in theory and molecular simulation needed to characterize challenging nanoscale-structured porous materials.

Well-established principles, such as the BET theory of gas adsorption and its use for surface area determination of various types of materials, are succinctly reviewed. The mechanisms of adsorption in porous materials and resulting methods for the characterization of pore size of nanoporous materials are discussed on the level of thermodynamic and macroscopic theories, as well as within the framework of advanced microscopic theories based on statistical mechanics (including density functional theory and molecular simulation). Specialized chapters dealing with chemisorption-based characterization of catalysts give this book an even broader appeal and additionally serve to illustrate the flexibility of modern gas sorption technology for both physi- and chemisorption. Furthermore, the authors describe experimental and theoretical aspects of mercury porosimetry, a technique that allows analysis of pore size over a wide range, routinely from ca. 0.003 μm up to more than 400 μm. The authors clearly demonstrate the capability of this technique to uniquely reveal pore size/volume distribution of macroporous materials where the scale of pore diameters lies beyond the range accessible to gas adsorption. Although density is usually thought of as an "obvious" intensive property of solids, the authors have given it due consideration here, including a chapter of its own.

Summarizing, the book demonstrates a good balance between experimental and advanced theoretical concepts. Sufficient details and practical examples are given throughout the text to establish a better understanding of available methods and background for students and professionals alike, with many references for follow-up study. The book appears to be an extremely useful handbook that should provide the necessary tools for students and researchers, in both industry and academia, to tackle and solve problems associated with the state-of-the-art characterization of porous solids and powders.

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Molecularly Imprinted Materials: Science and Technology. Edited by Mingdi Yan (Portland State University) and Olof Ramström (Royal Institute of Technology, Stockholm). Marcel Dekker: New York. 2005. xiv + 734 pp. $179.95. ISBN 0-8247-5353-4.

Molecular imprinting involves the formation of a substance around a molecular template. Often the imprinted matrix is an organic polymer, although inorganic materials are also used. When the template is removed by extraction, a binding site remains imprinted into the matrix. Molecularly imprinted sites can have a variety of properties engineered into them, ranging from selective binding of specific molecules (molecular recognition) to enzyme-like catalysis.

Molecular imprinting has a long history, dating back to 1931. Modern methods using polymer chemistry were developed in the 1970s, with continued significant progress to the present. Recently, new and improved techniques have enhanced the quality of molecularly imprinted substances. In addition to traditional applications in chromatography, new applications in sensors and catalysis are emerging.

This book is a collection of 27 chapters on diverse aspects of contemporary molecularly imprinted materials. The 40 authors of these chapters are a true "who's who" in the field. Many of them regularly write review articles on their specialized topics in journals and other venues. In this book, they have each applied their expertise to produce excellent authoritative chapters. Each chapter provides an abundance of relevant references, with many being to the literature from the past few years. The editors have done an excellent job in soliciting chapters on specific topics and organizing them thematically to provide a volume in which the chapters complement each other, even though they were written more or less as independent review articles.

The book is organized into six major areas, with appropriate chapters in each. Part I, "Introduction", has two chapters: the first an introduction to molecular imprinting and the second a somewhat personal and anecdotal history of the "new era" of

molecular imprinting. The introduction achieves two objectives by providing a brief but high-level introduction to the topic and a guide to the other topics in the book and how they relate to the field, to the book, and to each other. The history of the "new era" is enjoyable reading about people and personalities, and it also provides some valuable perspective on the field.

Part II, "Approaches to Molecularly Imprinted Polymers", has four chapters on noncovalent imprinting, covalent imprinting, and other types of stoichiometric imprinting, semicovalent imprinting, and metal coordination in molecular imprinting, respectively. The next part, entitled "Synthetic Strategies", covers functional and structural monomers, combinatorial approaches, surface imprinting, scaffold imprinting, imprinting in inorganic matrixes, modification of imprinted polymers after imprinting (post modification), and the use of hybrid materials (defined as synthetic materials with hydrophobic organic and hydrophilic inorganic components). The three chapters in Part IV, "Design and Analysis of Molecular Imprinting", are reviews of thermodynamic considerations and molecular modeling to predict the performance of molecularly imprinted polymers, selectivity in molecularly imprinted matrixes, and binding isotherms, respectively. Part V, "Preparation of Uniformly Sized and Shaped MIPs", also has three chapters: one on molecularly imprinted polymer beads, one on molecularly imprinted polymer films and membranes, and one on micromonoliths and microfabricated molecularly imprinted polymers. The final section, comprising eight chapters and entitled "Applications of Molecularly Imprinted Materials", encompasses the following wide variety of topics: chromatographic techniques, capillary electrophoresis, metal ion selective materials, solid-phase extraction and byproduct removal, enzyme mimics, antibody mimics in immunoassays, the use of molecularly imprinted polymers in mass and electrochemical sensors, and the use of molecularly imprinted polymers in optical sensors.

This volume provides a broad, deep, and comprehensive coverage of the field of molecularly imprinted materials. Although it is not a monograph prepared by a single author or set of authors, it is effectively equivalent to one and may even be superior to such a monograph since it draws on the expertise of so many leading experts in the field. It is an excellent source of current information, has an abundance of references, and could be used as the primary textbook for a full-term college course on molecularly imprinted materials. This book would be an excellent acquisition for any institutional library. In addition, the modest price for such a comprehensive and authoritative work makes it an excellent value for inclusion in a personal library. If one were to acquire only one book on this topic published in 2005, it should be this one.

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Nanophotonics. By Paras N. Prasad (SUNY, Buffalo). John Wiley & Sons, Inc.: Hoboken, NJ. 2004. xvi + 416 pp. $84.95. ISBN 0-471-64988-0.

Nanophotonics, a frontier science defined as the study and application of light−matter interactions occurring on a scale shorter than the wavelength of the light itself, covers a lot of ground and despite being a young field is already beginning to impact how we think about high-bandwidth and high-speed communications, data storage, display devices, analytical chemistry/forensics, and even some aspects of health care. When exciting progress is made in a field that by its very nature is both divergent and quickly evolving, capturing the state-of-the-art in a coherent and unified way is immensely difficult, not to mention the fact that some content may become obsolete by the time the book reaches press. Taking a balanced and fair account of the important developments is particularly challenging when you are one of the established leaders in the field. Despite these challenges, Prasad succeeds in communicating the excitement and potential of a still-evolving field of science in this book.

According to the author in his prefatory statement, one of the aims of the book is to "stimulate the interest of researchers, industries, and businesses". Certainly, with the introduction of this excellent text, nanophotonics will gain the attention of a broader scientific community. The current volume, comprising transcripts and notes refined from his popular lecture course offered at the University at Buffalo and also at SPIE professional society meetings, is a timely publication of key advances in the area of photonics, broadly defined. It is an important contribution to both nanoscience and photonics and is a particularly useful source of reference for those currently engaged in or interested in a career at the interface of these two fields. It affords postgraduates, academics, and industrial and government researchers alike with a thorough examination of nanophotonics and surveys a broad array of topics, key concepts, realities, and methods. It also gives a thoughtful preview of where the field might be headed. This book purports to provide the first systematic and comprehensive framework of research topics in the area, and although several earlier books have focused on narrow topics in nanophotonics, no authoritative global "snapshot" of nanophotonics has previously been available on the market.

It is not sensible to mention all the subjects covered in this monograph, but the main topics are summarized below. In the introductory chapter, the author very briefly defines the scope of and rationale for the book. Chapter 2 is a primer on photon versus electron spatial confinement and tunneling, band gaps, cooperative effects, and excitation localization. Details on near-field scanning optical microscopy (NSOM), its various modes, experimental arrangements, and several applications are found in Chapter 3, whereas in Chapter 4, the most detailed and extensive in the entire book, quantum-confined materials exemplified by semiconductor quantum dots, wells, and wires are discussed. Aspects of plasmon-type resonances from metal nanostructures and nanocontrol over excitation dynamics (e.g., up-conversion and quantum cutting) are described in the following two chapters. Chapter 7 begins with an introduction to traditional semiconductor processing methods for growing nanomaterials, such as molecular beam epitaxy, and concludes with a more lengthy discussion of some of the key tools used in the characterization of nanomaterials. Soft supramolecules, such as dendrimers and Langmuir−Blodgett films, are the topic of Chapter 8, and photonic crystals are considered in the excellent chapter that follows. Chapter 10 highlights the broad

topic of nanocomposites followed by a review of several types of nanolithography, including two-photon approaches and dip-pen lithography. The next two chapters cover the emerging class of bio-inspired and -derived materials for nanophotonics and applications in nanoclinics, bioimaging, and biosensors, respectively. The volume closes with a thought-provoking and forward-looking critical analysis of the current photonics commercial market where Prasad describes how current knowledge of nanophotonics is inspiring new strategies and identifies future business opportunities in the field. This is a really interesting feature that is typically absent in books on nanotechnology.

Nanophotonics provides readers with a one-stop opportunity to become familiar with a vast range of techniques and many still-evolving topics. As an outgrowth of a short course presented at photonics conferences and classroom lectures, it follows a didactic approach, with clear articulation of the topics discussed. Each individual chapter is formatted to include a brief overview and contains, besides references, a bulleted summary highlighting the take-home points of the chapter. The text is written in a generally very accessible and inviting manner and assumes little prior knowledge other than the foundations provided by an undergraduate degree in chemistry. Surprisingly, Prasad is able to describe several complex nonlinear optical phenomena with a minimum of mathematical formalism.

As the author acknowledges in the Introduction, there is some emphasis on local achievements from the author's own lab in certain places; however, this is not seen as a major weakness and examples are not drawn exclusively from the author's own work. Indeed, this "emphasis" provides a unique perspective on the topic by an internationally accredited frontline researcher who has been heavily engaged in nanophotonics research for many years.

One real caveat about this text, however, is that methods for producing nanomaterials are given relatively little attention. In particular, a few relevant wet chemical methods are identified in Chapter 7 but only briefly discussed. Better choices can be found for such topics in, for example, *Nanoparticles: From Theory to Application*, which was recently reviewed by this reviewer (*J. Am. Chem. Soc.* **2004**, *126*, 15632). Some topics that were not covered in this book include nanoscale photocatalysts, nano-optoelectronics, and photovoltaics. Other noticeable omissions are the lack of coverage of the so-called "molecular logic gates" and other niche areas, such as luminescent calixarene chemosensors and bio-inspired antireflective surfaces. Overall, however, this is a highly literate and affordable volume that belongs in the personal library of every researcher who is interested in entering the field. One could fairly say that, if *Nanophotonics* had not already existed, it would have been necessary to write it.

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Ultrathin Electrochemical Chemo- and Biosensors: Technology and Performance. Springer Series on Chemical Sensors and Biosensors, 02. Edited by Vladimir M. Mirsky (University of Regensburg). Series edited by Otto S. Wolfbeis. Springer-Verlag: Berlin, Heidelberg. 2004. xx + 358 pp. $129.00. ISBN 3-540-21285-X.

Traditional electrochemical sensors based on enzymatic receptors and potentiometric or amperometric transduction schemes have been described extensively in many textbooks and review articles; in some cases, they have been adapted to commercial products. This new book focuses on alternative types of chemical and biological sensors that function on different electrical and electrochemical detection schemes. Particular emphasis is directed toward applications involving linear and nonlinear impedance measurement strategies. While the basic methodologies described here have already been researched extensively in the context of adsorption on polarizable metal electrodes and are thus quite old, the more recent development of methods involving self-assembled monolayers has created fertile ground for development of alternative sensing methodologies. Immobilization of organic molecules on electrode surfaces along with the formation of chemically stabilized receptor layers and the development of sophisticated organic nano- and microstructures have afforded sensing ensembles that are readily adapted to electrochemical and impedance-based measurements. These advanced chemically modified electrodes and methodologies for impedance measurements are the major subjects of this book.

The volume consists of four main parts. The first covers receptors with emphasis on engineered antibodies as receptors for biosensors and molecularly imprinted polymers as recognition elements in sensor systems. The second part deals with impediometric and amperometric chemical and biological sensor methodologies with a focus on capacitance affinity biosensors, immunosensors, and DNA sensors based on impedance spectroscopy, resistance measurements of ultrathin metal layers, and superoxide and nitric oxide sensors. Part 3 covers noninvasive electrical monitoring of living cells, and Part 4 is a description of electrodes modified with lipid membranes that serve as biosensor systems.

This collection of mini-reviews covers a rapidly developing area of science that should be of interest to researchers in electrochemistry, biophysics, biochemistry, material science, and nanoscience as they develop new sensor methodologies based on electrochemical principles. Many of the areas described in this book have yet to be fully developed and translated into fully functional sensor applications. For those outside of the electrochemical community who may not have a detailed understanding of the mainstream enzymatic potentiometric and amperometric sensor systems, this book will not provide adequate coverage of these popular and established electrochemical sensing strategies. Furthermore, this book does not cover such subjects as lab-on-a-chip, micro-total-analysis systems, and microfluidics systems and thus represents a significant shortcoming for those interested in development of integrated and miniaturized sensor systems. However, these subjects are well covered in other reviews and textbooks. This book does provide many interesting examples of the evolving electrochemical transduction schemes that may serve as the basis for a variety of new sensing methodologies. For the electrochemical community, this text is a useful update of newly evolving

ultrathin electrochemical chemo- and biosensors systems. Most of the references are reasonably current and provide a good starting point for further investigation of the methods described. The combination of comprehensive analysis and straightforward description of the main concepts will allow graduate students and research scientists to achieve a basic understanding of the new chemo- and biosensors with electrochemical transduction schemes.

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