Book Reviews

Physics, Chemistry, and Technology of Solid-State Gas Sensor Devices. By Andreas Mandelis (University of Toronto) and Constantinos Christofides (University of Cyprus). John Wiley & Sons: New York. 1993. xxiii + 323 pp. $59.95. ISBN 0-471-55885-0.

Mandelis and Christofides offer a thorough description of the genesis and fundamentals of solid-state technologies for gas-phase chemical sensing, including many representative examples from the literature. Unfortunately, there are technical inaccuracies and contradictions that would make this a less-than-optimal textbook. The book is logically organized according to device technology but suffers from repetition of issues common to multiple technologies. Citation of the literature is very thorough, but condensation, interpretation, and reconciliation of disparate results from different sources are lacking.

Following an introductory chapter (4 pages) and another (14 pages) discussing the pivotal role of gas/surface interactions, with the H_2/Pd example treated in-depth, the remainder of the book is organized by technology as follows: Gas-Sensitive Solid-State Semiconductor Sensors (114 pages) includes chemically-sensitive capacitors, diodes, and field-effect transistors based upon bulk semiconductors (Si), as well as various conductivity-based devices that utilize polycrystalline films or bulk materials (SnO_2, ZnO, and others). Photonic and Photoacoustic Gas Sensors (30 pages) focuses on spectroscopic techniques, including reflectance, ellipsometry, surface-plasmon resonance, infrared, photoemission, and photoacoustic methods. Fiber-Optic Sensors (16 pages) details the use of fiber optics to make absorbance, reflectance, and fluorescence measurements and describes fiber-based interferometers that utilize changes in mechanical or optical properties. Conspicuously absent are fiber-based Raman techniques, as well as evanescent-field methods. Piezoelectric Quartz Crystal Microbalance Sensors (40 pages) and the following chapter, Surface-Acoustic Wave Sensors (34 pages), describe the use of acoustic-wave devices to monitor the ad/absorption of gases on/in chemically sensitive films. Pyroelectric and Thermal Sensors (56 pp.) details the history, fundamentals, and application of calorimetry to chemical detection. The book concludes with a brief chapter on Future Trends (4 pages) followed by an appendix (4 pages) that collects and compares the features of various H_2 sensors. Throughout the book, H_2 sensing is used as a nicely unifying theme: the interaction of H_2 with metals, Pd in particular, alters electrical, mechanical, optical, acoustic, and thermal properties, so papers describing H_2 detection with nearly every solid-state sensing methodology have been published.

A wealth of literature on chemical sensors has been summarized and cataloged, and the authors have done an excellent job of citing the appropriate and seminal literature, with chemical sensing references reaching back into the 1960s and 1950s and historical references dating to the 19th century. The other end of the time scale, namely work published since 1990, is not strongly represented, although references from the 1980s do form the backbone for much of the discussion; bear in mind that the focus of the book is fundamentals rather than recent results. While thoroughness with the literature is a strength, it is also related to the most serious weakness: the wealth of collected information lacks adequate filtration and interpretation by the authors. In many cases, contradictory explanations of the same phenomenon are presented in different locations without discussion or resolution of inconsistencies. For example, the discussion of Si/SiO_2/Pd-based H_2 sensors on page 58 leaves the impression that the mechanism of operation remains to be unraveled, while a similar explanation two pages later, from the work of a different author, gives the widely-accepted explanation: population by hydrogen of dipole sites at the SiO_2/Pd interface.

More thorough screening of the literature might have eliminated some confusing statements and errors. It is claimed that H_2 "has attracted attention as a clean energy resource, because of its high heat capacity"; nontrivial electric fields are claimed to be created by the dipoles of isolated atoms; conductivity changes in TiO_2 are attributed to the formation of Ti^-; O_2 is transmuted into OH; "deposited quartz electrodes" are used to excite an acoustic wave; and a chemically sensitive layer of acetone is purported to detect H_2S. Some of the more serious errors include attributing the frequency change for an acoustic-wave-based sensor to the number of moles of analyte sorbed, with no mention of its molecular weight, and chemical irreversibility of plasmon resonance-based sensors being attributed to the sensor platform rather than the chemically-sensitive interface. The fact that acoustic-wave devices can respond to effects other than mass changes is not invoked to explain unusual results, including one response that seemingly requires the absorption of 6000 H atoms per Pd!

Grouping subject matter according to device technology is logical, but it has led to a few shortcomings. Repetition of the interfacial chemistry common to multiple sensor platforms is one: the H_2/Pd interaction mechanism is discussed in at least five separate locations. The MIS (metal/insulator/semiconductor) capacitor and the MOSFET (metal/oxide/semiconductor field-effect transistor) share much of their physics of operation but are discussed independently. A second problem is that topics general to all solid-state gas sensors are typically found only in one corner of a section ostensibly devoted to one particular device: gas-flow test systems appear only in *Piezoelectric Experimental Instrumentation* and pattern recognition is discussed briefly under *MOS Device Integration* and again in the *Array of Piezoelectric Quartz Crystal Microbalances* section. The authors had the right idea in Chapter 2, where the interaction of gases and surfaces was discussed in general; many other topics would have benefitted from being located in such general sections.

While some parts of the book could use some work, the chapter on pyroelectric and thermal sensors, topics on which the authors have published extensively, is a model for quality and quantity of fundamental description and experimental results. Because these devices are among the less-common chemical sensors and because the authors' familiarity with the topic allows it to flow without contradiction or repetition, I found it to be most enjoyable.

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Asymmetric Catalysis in Organic Synthesis. By Ryoji Noyori (Nagoya University). J. Wiley and Sons: New York. 1994. xxii + 378 pp. $54.95. ISBN 0-471-57267-5.

This is an excellent book which describes the state of the art in asymmetric catalysis. It is based on a series of lectures given by Professor Noyori while at Cornell University in 1990. While it is comprehensive in its coverage of the subject, there is an emphasis on Noyori's work, with details and examples of his chemistry. The book is well-written and thoroughly referenced, covering the literature up to 1992. The main focus is synthetic applications of asymmetric catalysis; however, some of the more interesting mechanistic aspects of Noyori's work are described and citations are given to others not discussed in detail. Examples of applications to natural products synthesis are provided where appropriate, thus illustrating the utility of various methods and placing them in context. The book is well-indexed and includes a useful list of abbreviations at the beginning that contains acronyms for common ligands and their chemical structures.

The book is divided into eight Chapters, with Chapters 2, 3, 5, and 6 focusing on Professor Noyori's work. Chapter 1 provides a brief introduction to the basic principles of asymmetric synthesis and transition metal chemistry. Chapter 2 focuses on homogeneous asymmetric hydrogenation of olefins, ketones, and imines. An extensive discussion of the mechanism and nuances of reactions with BINAP as a ligand is included along with a description of reactions with other chiral ligands. Chapter 3 describes the enantioselective isomerization of allylic amines to enamines and also focuses on the use of BINAP Rh complexes, primarily because the majority of the work has been performed with these species. Chapter 4 describes other enantioselective metal-catalyzed processes. This chapter includes transition metal and main group element catalysts, covering the work of others. While short on detail, many topics are covered and citations are given to the primary literature. The topics covered in this chapter include transfer hydrogenation, hydrosilylation, hydroboration, epoxidation, dihydroxylation, hydroformylation and related processes, polymerization, Grignard coupling, arylation of olefins (Heck reaction), additions to π-allyl systems, carbene reactions (cyclopropanation and insertion reactions), conjugate additions to α,β-unsaturated carbonyls (cuprates and enolates), Lewis acid catalyzed processes (Diels–Alder and related cycloadditions, Claisen rearrangement, ene reactions, and aldol reactions), and miscellaneous functional group transformations. Chapter 5 begins with

synthetic aspects of the addition of organometallic reagents to aldehydes and ketones, focusing primarily on dialkylzinc additions. The mechanism of DAIB-catalyzed addition, including chiral amplification, follows. This discussion leads into other nonlinear effects in the interactions of chiral molecules and the chemical and spectroscopic consequences thereof. Chapter 6 is somewhat out of place in this book, since it does not focus on catalysis per se, but on the three-component synthesis of prostaglandins, an area which Professor Noyori has pioneered. General strategies for the synthesis of prostaglandins are described with an emphasis on the three-component coupling method. This is followed by a discussion of the asymmetric synthesis of the starting materials for this approach. Chapter 7 describes asymmetric catalysis with purely organic compounds. There is a potpourri of methods described which rely on covalent interactions, noncovalent interactions (such as hydrogen bonding and ion pairing), and phase transfer catalysis. The final chapter describes heterogeneous catalysis and includes chiral-modified surfaces as well as polymer-bound reagents related to those used for homogeneous catalysis.

Overall this is a very readable and interesting book that covers an important topic in organic synthesis. I would recommend it as a reference for anyone actively pursuing research in the field as well as those who are contemplating an asymmetric synthesis and are interested in using catalytic methods. The book is complementary to one recently edited by Ojima (*Catalytic Asymmetric Synthesis*; Ojima, I., Ed.; VCH: New York, 1993) in that it covers the same material but treats certain subjects in more depth and others in less. Overall, Ojima's book provides a more balanced overview of the field; however, the fact that Professor Noyori chose to describe his research in detail does not detract from his book, rather it allows the reader to appreciate his extensive contributions to this field.

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Progress in the Chemistry of Organic Natural Products. 61. Fortschritte der Chemie Organischer Naturstoffe. Edited by W. Herz (Florida State University), G. W. Kirby (University of Glasgow), R. E. Moore (University of Hawaii), W. Steglich (Universitat Munchen), and Ch. Tamm (Universitat Basel). Springer-Verlag: Wien, Germany. 1993. x + 206 pp. DM 220.00. ISBN 3-211-82388-3.

The entire Volume 61 in this renowned Zechmeister series is devoted to taxol and other taxane diterpenoids. It is a timely contribution in this rapidly-moving field, and the authors have compiled a valuable reference work. The contents include nomenclature, isolation methods, spectroscopic characterization, X-ray structures, reactivity of the functional groups, total and semi-synthesis efforts, biosynthesis, biotransformations, biological activity, and SAR work. Pharmacology has not been included. The publication date is 1993 and, with the Addendum, includes work published as late as August 1992. It is clearly written, well-organized, and nicely-illustrated.

More than one hundred naturally occurring taxanes are described. One nice feature is the inclusion of two sets of proton and carbon NMR data, 11 tables in all, sure to be useful to those involved in isolation or total synthesis efforts. Many researchers will also appreciate the concise 20-page account of functional group reactivity in these richly-adorned molecules.

The intense interest in taxol and related molecules has spawned nearly a dozen earlier reviews, and the authors reference these at the appropriate points in the text. In some cases, such as the coverage of taxane synthesis, readers concerned with comprehensive coverage are advised to consult earlier reviews as well, since this one is somewhat selective. Nevertheless, the discussion of synthesis efforts takes up more than 60 pages, one-third of the entire volume.

Author and subject indexes and more than 370 references complete the volume, certain to be a primary reference work for anyone interested in the chemistry of the taxanes.

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Anticancer Drugs from Animals, Plants, and Microorganisms. By George R. Pettit, Fiona Hogan Pierson, and Cherry L. Herald (Arizona State University). J. Wiley and Sons: New York. 1994. xiv + 670 pp. $89.95. ISBN 0-471-03657-9.

This book provides an exhaustive tabular compilation of natural products with anticancer activity that were reported in the literature between January 1986 and January 1989. In addition, it also contains a substantial amount of material beyond what might be expected from the title. The first chapter deals briefly with cancer-causing viruses (mostly HIV) and antiviral agents that afford potential therapies against them, updating to January 1991 a previous treatment of this subject in *Biosynthetic Products for Cancer Chemotherapy*, Volume 6 (1989), by two of the present authors (G. R. Pettit and C. L. Herald) and C. R. Smith. The second chapter describes tumor promoters and carcinogens, including tables of such compounds, both synthetic and natural, as well as tables of antitumor drugs that are themselves carcinogens, and carcinogenic irradiation.

The survey of New Biosynthetic Antineoplastic And/Or Cell Growth Inhibitory Agents (Section A) is arranged in nine chapters according to the type of source and type of compound (e.g., Higher Plant Terpenoids) and the compounds within each chapter are arranged in order of their molecular formulas. The information includes the compound name, molecular weight, bioactivity, physical data (mp and specific rotation), types of reported spectra, organism, location, and references. Synthetic and semisynthetic analogs and their activities are also included at the end of each chapter. Two additional sections on Marine Animal Biosynthetic Products (Section B, seven chapters) and Marine Plant Biosynthetic Products (Section C, one chapter with seven subsections) comprise nearly one-half of the entire book. These include all compounds of established structure in these categories that were isolated and characterized between January 1986 and January 1989, regardless of biological activity. Although not all of these compounds are directly related to the title of the book, the author's rationale for their inclusion is that many of them will eventually prove to have anticancer or other useful biological properties.

The individual compounds in Sections B and C are arranged according to compound types (e.g., Hydrocarbons, Alcohols, and Esters) and within each category by formulas. Each entry provides similar information, as in Section A, as well as the type of biological activity (e.g., antimicrobial, antiinflammatory, etc.) if known. A detailed subject index containing mostly the names of the compounds and their source organisms and a molecular weight index, but no formula index, are provided. The bibliography is extensive, with 1228 entries. In general, this book follows a similar pattern to that established in the later volumes of *Biosynthetic Products for Cancer Chemotherapy*. As was true of the latter series, it is a useful and comprehensive compilation of data, not only of the title compounds but also of all marine natural products that were reported during that period. This book should, therefore, prove a useful reference volume to chemists, biologists, and other scientists with interests in anticancer drugs or natural products in general.

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Organic Synthesis. Concepts, Methods, Starting Materials. Second, Revised and Enlarged Edition. By Jurgen-Hinrich Fuhrhop (Freie Universitat Berlin) and Gustav Penzlin (Beilstein Insitut). VCH: New York. 1994. xiv + 432 pp. $50.00. ISBN 1-56081-814-x.

This book provides an excellent survey of the field of organic reactions and synthesis. The first four chapters, which contain subject matter included in the first edition (1983), have been significantly expanded and updated, and a fifth chapter on the synthesis of supramolecular systems has been added. It is estimated that this edition contains 20−25% more material than the first edition.

In the first chapter, the concept of electron donor and electron acceptor synthons is introduced, and the more important methods of carbon−carbon bond formation and their uses in the synthesis of acyclic and cyclic compounds are discussed. The new material in this chapter focuses on enantio- and diastereoselective reactions, e.g., aldol reactions and allylations of carbonyl compounds. In Chapter 2, functional group interconversion reactions such as reductions, oxidations, eliminations, and functional group protection reactions are described. Sections on other selected topics are also included. Again, the material incorporated since the first edition emphasizes recent advances in asymmetric synthesis, such as the Sharpless epoxidation of allylic alcohols, olefin hydrogenation, and ketone reduction. Chapter 3 on Retro-Synthetic Analysis of Simple Organic Compounds provides a detailed compilation of commercially available, inexpensive starting materials and an introduction to the planning of syntheses using the disconnection approach pioneered by E. J. Corey. New emphasis is placed upon the

development of retrosynthetic pathways which lend themselves to the enantioselective synthesis of chiral molecules.

Chapter 4, Methods in the Construction of Complex Molecules, is the most extensively-revised of the four chapters in the original edition of this book. In just 123 pages, it provides a remarkably complete survey of some of the more important syntheses of a wide variety of classes of complex natural and unnatural products. Some of the topics of current interest to the organic synthesis community are extensive discussions of (1) modern methods of construction of oligonucleotides, including the polymerase chain reaction (PCR) for the synthesis of DNA fragments, (2) the techniques of gene cloning for the synthesis of important proteins, (3) the synthesis of mono-, di-, and oligosaccharides, and (4) the synthesis of macrolides. In the latter section, the authors describe recent syntheses of (9*S*)-dihydroerythronolide A seco acid and FK 506, which provide compelling illustrations of the way the synthesis of complex molecules has been facilitated by the judicious use of the stereoselective carbon−carbon bond formation, epoxidation, and reduction reactions developed over the past 15 or so years.

Chapter 5, Concepts in Nanometer Size Architecture, gives the reader a glimpse of the relatively young and growing field of supramolecular chemistry. The topics that are covered briefly here include supramolecular nucleic acid complexes, host−guest complexes based on Kemp's acid, and artificial vesicles and micelles.

In this work, the authors have achieved admirably their stated purpose of conveying "knowledge about concepts, methods, starting materials, and target molecules that play important roles in modern organic syntheses", while at the same time producing a book that is of modest size and probably affordable by individuals. The text is very readable, and the authors are especially gifted at explaining complex concepts clearly and succinctly. Also, the ample structures, schemes, and tables are well-illustrated and easy to follow. Up-to-date literature citations are provided for those seeking more in-depth information on particular topics. This book is highly recommended reading for anyone wishing to gain an overview of organic synthesis, and it would be a useful addition to the personal library of organic chemistry graduate students and others engaged in research in this field.

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Clusters and Colloids: From Theory To Applications. Edited by Günter Schmid (Universität GH Essen). VCH: New York. 1994. xvi + 556 pp. $198.00. ISBN 1-56081-753-4.

In this introductory chapter, the editor describes the scope of the subsequent sections of the book by leading scientists involved in the "chemistry" of large clusters and colloids. Interest in this field over the past 20 years can be largely attributed to three factors: the fascination of chemists with beauty, symmetry, structural order, and diversity; the cluster surface analogy and potential for cluster catalysis; size, structure, and physical and chemical property relationships in the transition from bulk material to nano-sized particles and molecular species. This book covers aspects of all these topics, often in depth, sometimes in passing. A particular focus and a strength of the overall text is the effort made by the various authors to correlate structure and chemical bonding with physicochemical measurements and materials properties. As such, it gives a strong indication of where the field is heading and what the challenges are in this rapidly-developing interdisciplinary area. The varied synthetic techniques and the novel physical and chemical properties of these large isolable molecules are thoroughly addressed, whereas the chemistry and physics of so-called "naked clusters", as generated in molecular beams, are largely precluded from discussion, except in Chapter 2, where theoretical approaches to structure and bonding are described. The content of all chapters is essentially devoid of mathematical and physical equations, relying instead on the qualitative information extracted from the measured and calculated properties of cluster/colloidal systems. The book is geared toward active researchers in the field; however, it will also, as suggested by the editor, be of significant use and interest to senior graduate students in chemistry, physics, and materials science. Whether the latter will be able to afford this book at $198 remains to be seen!

In Chapter 2, Electronic Structure of Metal Clusters and Cluster Compounds, N. Rösch and G. Pacchioni provide a brief summary of the various theoretical and computational techniques currently available to examine the bonding in cluster compounds. What follows naturally is an examination of the structure, bonding, and selected physical properties of both bare and ligated clusters with comparisons made between the two. The chapter ends with a thoughtful analysis of the analogy between metal clusters and surfaces.

Chapter 3, Clusters in Ligand Shells, is by far the longest chapter in the book, and it is subdivided into three main sections, each written by different authors. In the first of these, Low Valent Organometallic Clusters, G. Longoni and M. C. Iapalucci detail the balance between electronic and steric factors governing ligated molecular clusters and review the synthetic pathways leading to higher nuclearity (homo and hetero) transition metal carbonyl cluster complexes. There is a separate section devoted to those molecules containing interstitial or partially-exposed main group atoms. Although this treatise does not entail a comprehensive listing of all possible examples (nor is it meant to), the selected references clearly exemplify the strategies put forth by the authors. In the second section of the chapter, Metal Rich Large Clusters with P and N Ligands, G. Schmid presents a detailed examination of the many interesting physical and chemical properties exhibited by a class of molecules very well known to the author. Although most examples focus on the chemistry of large gold clusters, selected references to related systems of other precious metals are also provided. The third and final section, Transition Metal Clusters with Bridging Main Group Elements, is written by D. Fenske. This section gives an eloquent and comprehensive report detailing the author's and other researchers' success at generating a plethora of large, mixed transition metal−P/S/Se/Te cluster systems. Structural similarities between these large clusters and the corresponding bulk binary phase materials are also described. Overall, this chapter provides convincing evidence of the very important role which the external ligand shell plays in stabilizing large molecular clusters.

The fourth chapter in this book, Clusters in Cages by S. Kawi and B. C. Gates, provides the reader with a wealth of information on the so-called "ship in a bottle" synthetic techniques employed to access transition metal and metal−main group clusters in zeolite cages. A brief review of the structural aspects of these open cage frameworks is followed by a thorough description of the synthesis, properties, and technological applications of the confined clusters within them. An excellent review of the available structural characterization techniques is also provided, emphasizing the usefulness, limitations, and shortcomings of each method with appropriate examples.

A. Simon examines the bonding in octahedral and non-octahedral clusters in Chapter 5, Discrete and Condensed Transition Metal Clusters in Solids. The author then develops the properties of these and other condensed cluster systems, examining their structure property relationships. The final chapter, The Chemistry of Transition Metal Colloids by J. S. Bradley, introduces the reader to metal colloid science by providing a brief historical perspective on the subject and its relevance to modern day chemistry and industry. A well laid out and thorough description of numerous synthetic approaches to homo- and heterometallic colloid particles and factors governing size distributions, as well as a detailed account of the characterization techniques for such systems is given. A review of the spectroscopic properties and catalytic uses of colloidal materials is also provided.

In summary, the reader will find this book easy to read, and it will be an excellent source of information for a diverse body of scientists. One of the book's strongest points is the extensive lists of references to the current literature with examples in all chapters having been chosen to highlight the most recent development in each area. It will prove to be a valuable tool for both experts and nonexperts alike. This book's greatest attribute, however, is the ability the authors and editor have shown in bringing into perspective the often wide and varied chemistry of metal cluster and colloidal sciences.

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