Book Reviews

Electroactive Polymer Electrochemistry: Part 2, Methods and Applications. Edited by Michael E. G. Lyons (Trinity College, University of Dublin, Ireland). Plenum Press: New York, 1996. xi + 332 pp. $85.00. ISBN 0-306-45158-1.

The book *Electroactive Polymer Electrochemistry: Part 2, Methods and Applications* is both a very informative and a comprehensive book on the subject of electroactive polymers as it relates to electrochemical methods and applications. This book is Part 2 in a three-part work and is divided into seven chapters. Chapters 1−4 are presented in Part 1. It concerns a survey of the fundamental principles of electrochemical behavior of electroactive polymers. This review is only concerned with Part 2, which are Chapters 5−11. Part 3 is still in the planning stage according to the editor Michael Lyons but will consist of a discussion of polymer ions.

The first chapter in this work, Chapter 5, written by D. A. Morton-Blake and J. Corish, begins with a review of the theoretical approaches used in studying polymers. These approaches include both empirical and semiempirical techniques, although a brief mention is given to *ab inito* quantum chemical techniques. Molecular dynamics is discussed in some detail, especially as it relates to conductive polymers. A good presentation, along with some useful tables, is provided on potentials and their calculations. Of particular use is a discussion of the simulation of doped polymers.

Chapter 6, written by John F. Cassidy, presents a discussion of various numerical simulation methods as they apply to electroactive polymer films. However, in reading this chapter, one realizes that it is applicable to a much more general class of systems. One very useful feature of this chapter is its appendix of program listings. There are five programs for which a complete listing is presented. Program 1 is an algorithm written in FORTRAN, for the calculation of the potential step method for infinite solution using explicit finite difference. Programs 2−5 are FORTRAN programs for calculating cyclic voltammetry of thin layer systems using several methods. Various tables given within the chapter show typical results of the calculations using these five programs in the appendix. This is a particularly useful feature of this chapter.

In Situ Ellipsometry and FTIR Spectroscopy Applied to Electroactive Polymer-Modified Electrodes by S. Higgins, P. Christensen, and A. Hammett is Chapter 7. This reviewer is somewhat familiar with FTIR spectroscopy but was not familiar with the technique of ellipsometry, so this chapter was particularly educational. It is a very well-written chapter and takes the reader from basic principles of ellipsometry and in situ FTIR, to applications of these techniques to several conductive polymers, including polyaniline, polypyrrole, polythiophene, and related analogues to these polymers. It contains numerous spectra, as well as analysis of the spectra for these molecular systems. This reviewer was particularly interested in how these two techniques were able to provide direct evidence that both polaron and bipolaron formation occurred during the formation of one or more of these polymers.

Chapter 8, authored by D. Kelly and J. Vos, deals with osmium and ruthenium poly(pyridyl) redox polymers as electrode coatings. Perhaps the most useful material in this chapter is a discussion of homogeneous and heterogeneous charge transport. This is very important to an understanding of the coupling between the electrochemical properties of the electrolytic solution and the electroactive polymer.

The last three chapters are concerned with applications of electroactive polymers to biochemical systems. P. Bartlett and J. Cooper have provided a very well-written review of this very important and rapidly expanding area in Chapter 9. In Chapter 10, D. Leech discusses analytical applications of polymer-modified electrodes to voltammetric chemical sensing. The most interesting material in this chapter for this reviewer was a discussion of the modification of electrode surfaces with functional groups for molecular recognition. Chapter 11, written by E. Iwuoha and M. Smyth, concerns polymer-based amperometric biosensors. This chapter overlaps somewhat with Chapter 10, but Chapter 11 concentrates on chemically modified electrodes incorporating biological components, such as enzymes, in a polymer-modified matrix to couple biological activity to electrochemical detection. A notably exciting topic discussed is the use of redox conductive polymers for electrically wiring biopolymers such as an enzyme. This subject involves the direct unmediated electrical communication between a biological polymer such as an enzyme's redox center and an electrode. If this technology is perfected, there would be tremendous applications in many other fields.

In summary, the topics in this work are comprehensively covered as well as very comprehensible. There are over 1000 references, and these references are very up-to-date. The editor has tapped some very good researchers for their expertise, and these researchers have provided a very well-written book which many scientist in this field will find invaluable. I highly recommend this book to anyone with an interest in electroactive polymers, especially to those scientist with an interest in electrochemistry as it applies to electrochemical sensors.

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Molecular Level Artificial Photosynthetic Materials. Progress in Inorganic Chemistry Series, Volume 44. Edited by Kenneth D. Karlin (Johns Hopkins University, Maryland). Wiley: New York, 1996. x + 421 pp. $125.00. ISBN 0-471-12535-0.

This volume is a very timely and welcome addition to a distinguished review series. It is comprised of seven distinct contributions, each written by researchers who are curently active in the areas reviewed. The topics reviewed span the range from the relevant basic chemical studies to the general requirements for the generation of useful devices. The articles each focus on a different class of inorganic substrates: (1) A Supramolecular Approach to Light Harvesting and Sensititzation of Wide-Bandgap Semiconductors: Antenna Effects and Charge Separation by C. A. Bignozzi (Ferrara, Italy), J. R. Schoonover (Los Alamos, NM) and F. Scandola (Ferrara, Italy); (2) Langmuir−Blodgett Films of Transition Metal Complexes by M. K. DeArmond and G. A. Fried (Los Cruces, NM); (3) Layered Metal Phosphonates as Potential Materials for the Design and Construction of Molecular Photosynthetic Systems by L. A. Vermeulen (Carbondale, IL); (4) Light Induced Processes in Molecular Gel Materials by F. N. Castellano and G. J. Meyer (Baltimore, MD); (5) Charge-Transfer Processes in Zeolites: Toward Better Artificial Photosynthetic Models by P. K. Dutta and M. Ledney (Columbus, OH); (6) Native and Surface Modified Semiconductor Nanoclusters by P. V. Kamat (Notre Dame, IN); (7) Molecular and Supramolecular Surface Modification of Nanocrystalline TiO_2 Films: Charge-Separating and Charge-Injecting Devices by T. Gerfin (Laussane, Switzerland), M. Grätzel (Laussane, Switzerland), and L. Walder (Osnabrück, Germany). These contributions vary in length (from 42 pages in the fourth to 95 pages in the first contribution) and literature cited (from 76 references in the fifth to 560 references in the sixth).

There are some distracting errors in the volume. There are a number of typographical and grammatical errors, especially in the fourth and seventh contributions. More troublesome are some problems with the labeling and captions of figures in some contributions (e.g., inconsistency of the labels and parameters in Figure 11 on p 227; "Hand gap" rather than "Band gap" in Figure 10 on p 296; and mislabeled axes or incorrect caption in Figure 23 on p 316).

This volume represents a very important contribution. It presents good, concise surveys of a variety of potential applications of inorganic photochemical systems. The general physical and chemical principles governing photoinduced processes and charge injection into semiconductors are concisely presented in the first contribution. The final contribution presents an exceptionally well balanced survey of the prinicples governing TiO_2-based devices and the performance characteristics and problems encountered in attempts to construct working devices. Most of the contributions contain good introductions to specific technical aspects of the topics reviewed (most extensively in the second, and least in the third). As is appropriate to this general subject, most of the chapters are built around a good core of mechanistic (photophysical and electron transfer) logic. However, the emphasis is decidedly emperical, and the theoretical aspects of the subjects treated are best sought elsewhere.

Overall, this volume is an important and valuable contribution. It represents some of the most active and exciting areas of contemporary research in inorganic chemistry. This volume should contribute to the evolution of research in the areas represented, and it should be very useful to students who are beginning to learn inorganic chemistry.

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Inorganic Membranes for Separation and Reaction. Membrane Science and Technology Series #3. By H. P. Hsieh (Alcoa Technical Center, PA). Elsevier: Amsterdam, 1996. xviii + 591 pp. $297.00. ISBN 0-444-81677-1.

This book provides a broad coverage of inorganic membranes (metal, ceramic, glass) with major emphasis on applications. Chemists and engineers working in this area will find the discussion of many practical matters useful. However, the fundamentals of membrane preparation and membrane transport receive a somewhat superficial treatment and may not be of much interest to the readers of this Journal.

Chapters 1 and 2 are introductory. They provide a classification of different types of membranes and their applications. Membrane materials and preparation are treated in Chapter 3. Among several techniques discussed, extrusion for preparing macroporous α-Al_2O_3 membranes and sol−gel for dip-coating such membranes with mesoporous γ-Al_2O_3 or ZrO_2 layers are covered very well. Anodic oxidation for making alumina membranes with uniform pore size is also discussed in detail. By contrast, zeolite membranes which have attracted a lot of work in recent years are only superficially discussed. Chapter 4 reviews membrane properties, transport mechanisms, and characterization techniques. The discussion of permeation properties in relation to the membrane's porous structure is not up to date with modern treatments of transport in porous solids, and similarly limited is the section on transport in dense membranes.

Progressing from the fundaments to engineering and applications, Chapter 5 is a survey of inorganic membranes used commercially today. It contains useful information on such practical matters as sealing individual membrane tubes into modules and on operational matters like flux maintenance by backflushing and chemical cleaning. Chapter 6 covers established liquid-phase separations such as food processing, biotechnology, and waste-oil treatment. There is a lot of detail and literature references to assist the applied chemist or engineer in the choice of membrane materials and in solving operational problems. Unlike liquid phase separations, gas separations have not yet been commercialized. However, gas filtration—particulate removal—is practiced widely and is covered in this chapter along with current research in gas separations.

The next four chapters (8−11) deal with membranes integrated with catalytic reactors to enhance conversion, enhance selectivity, or eliminate downstream separations. Such membrane reactors have found applications to fermentation and enzyme-catalyzed reactions and much of the current membrane research is exploring applications to large volume chemical and petrochemical processes. A general discussion of membrane reactor types, configurations, and applications is given in Chapter 8. Most of the reactions that have been explored to date are catalytic dehydrogenations like ethylbenzene to styrene and propane to propene, and these are discussed in detail. Chapter 9 deals with materials considerations. Porous structure, permeance and selectivity, and thermomechanical and chemical failure of membrane materials are discussed, along with module assembly and sealing techniques. Chapters 10 and 11 develop the engineering aspects of membrane reactors. A detailed treatment of the relevant mathematical models is given in Chapter 10. Membrane reactors have more degrees of freedom than conventional reactors so that there will be considerable scope for modeling and optimization once such reactors are put into practice. These engineering issues are treated well, but there is a lot of repetitious material between the different chapters. The final Chapter 12 takes a brief look at economics and at some technical issues like packing density that have a strong economic impact.

Because of the multidisciplinary nature of membrane technology, it is impossible for a single-author book to do justice to all aspects of the field. This volume is strong on the applied and engineering aspects, and although lacking in the fundamentals, it will be useful to researchers and practitioners in the field.

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Thermodynamics, Second Edition. By N. A. Gokcen (Albany, Oregon) and R. G. Reddy (University of Alabama). Plenum Press: New York, 1966. xv + 400 pp. $59.50. ISBN 0-306-45380-0.

As stated in its preface, this book is a text for students and specialists in materials science, metallurgical engineering, chemical engineering, chemistry, and electrochemistry. Indeed the book covers all the basic thermodynamic concepts common to these various groups. After beginning with an informative discussion of the mathematics of thermodynamics, the book describes the three laws of thermodynamics, the thermodynamic functions, phase equilibria, fugacity and activity, solutions of electrolytes and non-electrolytes, partial molar quantities, phase diagrams, and galvanic cells. Special topics include surface tension and the thermodynamics of electric, magnetic, and gravitational fields. Physical chemists and chemical engineers will be pleased to find that there is a nice discussion of activity coefficients in solutions of mixed electrolytes.

Ordinarily statistical models must be sought in books on statistical thermodynamics, but Gokcen and Reddy include the statistical treatment of regular solutions and substitutional alloys. One finds other useful ideas not always encountered in thermodynamics texts, including the method of Caratheodory for the second law, the Gibbs−Konovalow theorems for the vapor pressure of solutions, Pourbaix diagrams for corrosion of metals, Richard's rule for heats of fusion, the Kopp−Neumann rule for heat capacities of compounds, and the Temkin rule for activities in molten salts.

At the end of each chapter, there are a number of problems for solution, and on the inside back cover, there is a pocket with a floppy disk covering chemical equilibrium calculations for various inorganic compounds. The footnotes and general references are up to date, which in the case of thermodynamics, means the last 25 years.

I discovered only two minor editorial faults: The last page (p 386) appeared to be missing, while p 141 cited reference 30, which was missing from the list of general references on p 340. These peculiarities, however, did not measurably diminish the usefulness of the book.

After considering the vast scope covered by the text of Gokcen and Reddy, one might well wonder where we should go from here. One could suggest that the next generation of thermodynamics texts should include a description of critical phenomena. The rules for determining the divergence of the thermodynamic derivatives and identifying the applicable exponents were introduced by R. B. Griffiths and J. C. Wheeler (*Phys. Rev. A* **1970**, *2*, 1047). The only new mathematics required would be a table of Jacobian determinants.

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