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BOOK REVIEWS

Activated Carbon Adsorption. By Roop Chand Bansal and Meenakshi Goyal (Panjab University, Chandigarh, India). CRC Press (an imprint of Taylor and Francis Group): Boca Raton, FL. 2005. xxii + 498 pp. $189.95. ISBN 0-8247-5344-5.

This book is both very informative and fairly comprehensive on the subject of adsorption by activated carbon. Written for the chemist and/or engineer, it serves as a broad and well-documented study of activated carbon. The organization of the book makes it an excellent resource for individuals who are involved with the scientific and engineering study of activated carbons, or with one or more of their various applications. Coming nearly two decades after *Active Carbon* (Bansal, Donnet, and Stoeckli, Marcel Dekker, 1988), this book benefits from the insight that comes from an additional two decades of active research by one of the authors. The book is rich in references, and the authors have the technical maturity to offer excellent critical reviews of the research dealing with the characterization and application of activated carbons for adsorption.

The first chapter is very clear and concise in its description of the current understanding of the physical and chemical nature of activated carbon. The various characterization techniques are described in enough detail to capture the importance of the measurements and techniques, and enough references are given so that further details can be obtained by the interested reader. There is an especially good section dealing with the effects of the carbon−oxygen surface groups. The discussion includes experimental techniques for determining such groups and coverage of their influence in the process by which various types of adsorbates are adsorbed. This chapter also includes a good discussion of techniques to modify the carbon surface. This first chapter is especially well done—a "must read" for graduate students and researchers new to the study of activated carbons.

The second chapter is a fairly succinct introduction to the various physiochemical models of the equilibrium and energetics of the adsorption processes. It includes discussion of the various adsorption models, beginning with those developed by Langmuir, BET, etc., and continues with a description of capillary condensation, hysteresis, and volume filling of micropores. The authors discuss the high points of the derivations of the various adsorption isotherm models and describe how the models are linearized to obtain the required parameters and used to characterize the activated carbon surface area and morphology. There are numerous examples of experimental data obtained from the adsorption of gases and vapors on activated carbon to demonstrate how well the models fit the data. There is also a brief discussion of the types of isotherms observed and the IUPAC classification scheme of isotherms and hysteresis.

The third chapter is devoted to adsorption on activated carbons from solutions. The vast majority of industrial applications of activated carbon are in the purification, detoxification, and decoloration of liquids such as water, wine, and oils, with especially significant usage in drinking water purification. The authors describe the classification of adsorption from solutions and deal with adsorption from both dilute solutions and solutions with higher concentrations of solute. They also briefly discuss the various factors that influence the adsorption from binary liquid solutions.

A series of chapters on activated carbons and their applications follows. The first is a discussion of carbon molecular sieves, carbons that are highly microporous but do not adsorb larger molecules above a particular size in an appreciable amount. The authors describe how these special activated carbons are prepared and the various characterization techniques. As is true throughout the book, there are several cited experiments and examples with recent data. The chapter concludes with a discussion of the separation of oxygen and nitrogen using these sieves.

The next chapter is an overview of several different applications of activated carbon adsorption and includes descriptions of the many unit operations associated with food and beverage processing, decoloration of oils and sugar, etc. It also covers some applications with inorganic adsorbates and processes such as gold recovery and purification of electrolytic baths.

In each of the remaining three chapters, the authors give excellent summaries of studies of the use of activated carbon in environmental applications. They serve as fairly complete surveys of state-of-the-art applications and are supported by excellent compilations of the latest research in these areas. The first of these covers the removal of inorganics from water; the second, the removal of organics from water; and the final, the removal of hazardous vapors and gases.

The book does fulfill the authors' desire to offer the necessary background on the adsorption of activated carbon and serve as a guide and survey of the numerous studies of activated carbon. Complete with important references, it does an excellent job of providing the latest perspectives in research concerning carbon surfaces and their adsorption processes and, as such, should be a valuable resource for those individuals involved with the study and application of activated carbon, including surface scientists, chemists, engineers, and technologists.

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Nuclear Spin Relaxation in Liquids: Theory, Experiments, and Applications. By Jozef Kowalewski and Lena Mäler (Stockholm University, Sweden). from the Series in Chemical Physics. Edited by J. H. Moore and N. D. Spencer. CRC Press/Taylor & Francis Group: Boca Raton, FL. 2006. xii + 426 pp. $129.95. ISBN 0-7503-0964-4.

In recent years the emphasis on characterizing materials as completely as possible with NMR spectroscopy has led to the appearance of books on spin relaxation, particularly of spin-

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1/2 nuclei like ^{13}C and ^{1}H in liquids and solutions. The book by Kowalewski and Mäler is the latest book to arrive. It is a laudable attempt to introduce chemists to this corner of the NMR world.

Three areas of theory, experiment, and applications are addressed in this monograph. The introductory chapters demonstrate that the authors intend to present more than just formulas with which to reduce relaxation data. They start from the quantum mechanics of spin systems to develop an understanding of the density operator. They give a clear presentation of stochastic processes, followed by an exposition of relaxation theory, including Redfield theory. Relaxation by the dipole−dipole coupling is discussed extensively, since it is often the dominant mode of relaxation for spin-1/2 nuclei. Cross-relaxation and the nuclear Overhauser effect are tackled in detail. The connection of spin relaxation to molecular dynamics is given by specific examples of how one analyzes the relaxation behavior. The focus on anisotropy of motion adds a dimension to the explanations that is often not found in other similar books. The applications throughout the book are often chosen from biochemistry, although there are examples of relaxation in "small" organic molecules.

Relaxation of quadrupolar nuclei is discussed, but only briefly. The authors focus on the relaxation of spin-1 nuclei, but they seem intent on describing the effects of coupling to quadrupolar nuclei on the relaxation behavior of spin 1/2. Similarly, relaxation by paramagnetic centers is discussed with particular attention to the effects on spin-1/2 nuclei.

Relaxation in phases other than liquids can be extremely complex and quite different from that in the liquid state. The authors' discussion of relaxation in these various phases, particularly the solid state, is brief and therefore incomplete. This is not surprising, since the title of the book indicates a focus on the relaxation behavior of liquids. There are, however, examples of relaxation in liquid crystalline materials, in gases, and in supercritical fluids.

I find the book very readable. I am quite sure that NMR spectroscopists and chemists who have only a passing interest in NMR esoterica will find it a particularly handy reference for the details of the spin-relaxation process in molecular liquids containing spin-1/2 nuclei.

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Isotope Effects in Chemistry and Biology. Edited by Amnon Kohen (University of Iowa) and Hans-Heinrich Limbach (Freie Universität Berlin). CRC Press/Taylor and Francis Group: Boca Raton, FL. 2006. xiv + 1074 pp. $229.95. ISBN 0-9247-2449-6.

Kohen and Limbach have produced a massive text that broadly covers the subject of isotope effects in 42 chapters written by experts in the field. Collectively, the chapters demonstrate the very close connection between experiment and theory that is the hallmark of research on isotope effects. The book follows a logical progression of subjects beginning with a fitting perspective by Bigeleisen on the foundations of isotope effects, followed by chapters that elaborate further on theoretical considerations, isotope separation, and isotope enrichment. The chapters in the remainder of the book cover advanced computational research, applications of isotope effects, and spectroscopic studies for a wide range of chemical and biochemical systems.

The chapters on applications are appropriately rich in topics that concern hydrogen bonding, related proton transfers, and enzymatic reaction mechanisms and are interspersed with strong sections covering atmospheric isotope effects and spectroscopy. Noteworthy recurring themes in numerous chapters are the importance of anharmonic treatments of vibrational motions and the contributions of nuclear tunneling to isotope effects. These themes, and the focus on hydrogen bonds, may give a false impression that the book overemphasizes deuterium isotope effects; the book is so large, however, that there is ample coverage of heavy-atom isotope effects, including reviews of chlorine and oxygen isotope effects, as well as intriguing accounts of effects on reaction rates from exotic isotopes such as ^{11}C and muonium.

Among the engaging aspects of many chapters are the insights and admonitions freely offered by the authors. Some examples include guidelines on the use of electronic structure calculations for isotope-effect studies (Wolfsberg), the "cautionary notes on mutations at hydrogen-bonding sites in enzymes" (Schowen), advocacy for mass-spectrometric calibration scales based on absolute isotopic abundances (Roth, Létolle, Stevens, and Robert), warnings about the "intrinsically statistical character of the medium" in theoretical treatments of liquid-phase reaction rates (Truhlar), and an advisory on potentially small catalytic contributions from dynamics effects in enzymic reactions (Schwartz). Further examples are cautions against mistaking interpretations of measured isotope effects for experimental findings (Warshel, Olsson, and Villà-Freixa) and advice about using the substrate dependence of isotope effects to augment rather than replace conventional initial rate studies of enzymic kinetic mechanisms (Karsten and Cook).

All of the chapters begin with a helpful table of contents, and most have introductory sections that provide excellent background for the subsequent advanced material. If not for the high price, this book would make a good primary or supplemental text for multiple graduate courses covering subjects such as vibrational spectroscopy, enzyme mechanisms, reaction rate theory, or isotope separation and enrichment. Overall, Kohen and Limbach have produced a worthy and much needed successor to the series of books—Melander (1960), Collins and Bowman (1970), Cleland, O'Leary, and Northrop (1977), Melander and Saunders (1980), Cook (1991)—that have been so important to isotope-effect researchers and their students.

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The Jahn−Teller Effect. By Isaac B. Bersuker (University of Texas at Austin). Cambridge University Press: Cambridge. 2006. xvi + 616 pp. $185.00. ISBN 0-521-82212-2.

This is the third book that Bersuker has written on the Jahn−Teller effect (JTE); his previous contributions were published

in 1984 and 1989. Before reviewing the book itself, I would like to address two questions: Why are these books written by the same person, and what is the importance of the JTE for the research community in chemistry and physics?

The answer to the first question is a "no-brainer": Bersuker is one of the most widely recognized authorities in the field of the JTE. He has been working in this field for more than 40 years, tirelessly contributing to our understanding of physical, chemical, and biological phenomena. In addition, he has written about several fundamental results in the theory of the JTE, one of the most important being the tunneling in molecules with orbital degeneracy. As for the second question, as stated in the preface, the JTE is a fascinating phenomenon in modern physics and chemistry, and interest in this subject is steadily rising. Remarkable attention to the vibronic interaction in materials science emerged after the discovery of high-temperature superconductivity in the late 1980s and continued with the discovery of buckyballs (fullerenes) and buckytubes, colossal magnetoresistance, and, lately, materials with strong magnetoelectric effect. All these discoveries are tightly connected to the JTE, which strongly influences structural, spectroscopic, and reactivity properties of all kinds of molecular systems and solids. New ideas and new materials require new discussions. Thus, this book is especially important, in particular because all the above-mentioned discoveries are still "hot" in modern research with many fundamentally important and unanswered questions.

In comparing this book with others on the JTE, it appears to be the broadest in subject, covering the most important elements of the fundamental theory of vibronic interactions in molecules and crystals and its applications in physics, chemistry, and biology. It is thoroughly referenced (~2000 cited papers) and well illustrated with over 200 illustrations. Scrupulously detailed subject and formula indices confirm the author's vast experience in this field.

After an interesting and intriguing introduction, the author describes the fundamentals of the Jahn−Teller, pseudo-Jahn−Teller, and Renner−Teller effects in polyatomic molecules and structural units. This is done very skillfully, clearly, and in detail. The reader has no doubts about getting first-hand information. In addition to the traditional JT problems, considerable attention is paid to the new vibronic systems such as icosahedral (buckyballs), multicenter (coordination and mixed-valence compounds, biological molecules), and linear molecular systems (the Renner−Teller effect). One of the "hottest" topics is related to conical intersections and the topological phase problem (Berry-phase), another amazing example of the influence of the JTE on modern science.

The analysis of applications of the Jahn−Teller concept starts with a comprehensive discussion of its manifestations in various kinds of spectroscopy (optical, IR, Raman, magnetic resonance, nuclear magnectic resonance, ultrasonic attenuation, etc.). Chapter 7, which covers analysis of quantum-chemical computations, reactivity and chemical activation, molecular pseudorotations, geometry and spectra of different classes of compounds, etc., can be viewed as the "most chemical" one, although the book is interdisciplinary overall. The last portion of this chapter concerns clusters and mixed-valence systems, of which mostly their local properties are explored. Here an interesting discussion of the role of the JTE in biological systems, especially in metalloenzymes, is also given.

The book ends with a discussion of the JTE manifestations in local and cooperative properties of solids, a topic that is related to the rapidly developing microscopic theory of structural phase transitions and the large gap cooperative pseudo-Jahn−Teller effect leading to ferroelectric phase transitions. Once again, subjects that are absolutely new to books on the JTE, like problems related to high-temperature superconductivity and colossal magnetoresistance, are considered. This book should convince the reader that the role of the JTE in modern science is very deep and fundamental (see, for example, the reference in the Preface to the Nobel Prize Lecture by Bednorz and Muller (1993)).

Overall, this book is a great contribution to the JTE field and a very serious contribution, I think, to science in general. It reflects the character of its author who has an encyclopedic view of physical and chemical problems, is interested in both fundamental concepts and new ideas, and is aggressively focused on new unsolved problems.

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Molecular Machines. Topics in Current Chemistry, 262. Edited by T. Ross Kelly (Boston College). Springer: Berlin, Heidelberg, New York. 2005. xii + 236 pp. $229.00. ISBN 3-540-28501-6.

Does anybody still need to be convinced that basic research is necessary and will always, eventually, lead to the great advancement of science and engineering? Well, here's a perfect example! After the wish for a "molecular machine" was formulated by Richard Feynman and others in the late 1950s, this concept was eventually embraced by chemists as being feasible during the 1980s, once the paradigms and experimental concepts and techniques of "supramolecular chemistry" that were developing during the second half of the 1970s became available. The early examples, however, were concerned with the "proof of principle" and less so with particular applications that the public and our political leaders would like to see, such as nano-medicinal work or highly dense, efficient storage and processing.

Today, after 30 years of research, there has been an intense evolution, and we can expect extraordinary applications of molecular machines to emerge. By now, several "branches" of the evolutionary tree of molecular machines exist, as the contents of this book impressively demonstrate. At the same time, each team of authors describes how the development of their specific field has progressed during the years, from the early beginning to the latest breakthrough. The work presented by the six research teams differs in the supramolecular strategies applied, the "fuel" employed for the driving of the molecular machines (photophysical, photochemical, and chemical systems, as well as systems exploiting the thermal continuum), and, most importantly, the proposed utilization of the various molecular machines.

In the first chapter, Balzani and his team define the state-of-the-art in their contribution "Artificial Molecular Motors and Machines: Design Principles and Prototype Systems". Sauvage and co-workers follow with the chapter "Transition Metal-Complexed Catenanes and Rotaxanes in Motion: Towards

Molecular Machines". In Chapter 3, Magnera and Michl explicate the construction and potential application of "Altitudinal Surface-Mounted Molecular Rotors", and Stoddart and his team dedicate their contribution to strategies "Towards a Rational Design of Molecular Switches and Sensors from their Basic Building Blocks" in Chapter 4. In the final two chapters, Kay and Leigh elaborate on the design and underlying physical principles of "Hydrogen Bond-Assembled Synthetic Molecular Motors and Machines", and Karlen and Garcia-Garibay open the fascinating microcosmos of crystalline molecular machines, including molecular gyroscopes and molecular compasses, in their contribution "Amphidynamic Crystals: Structural Blueprints for Molecular Machines". In my opinion, this book provides deep insight into this fascinating, challenging, and increasingly important field.

Are you interested in molecular machines and looking for a comprehensive book to learn the important physical paradigms and synthetic strategies? Do you teach molecular machines in a chemistry or engineering course at a college and would like to include the usual and some unusual experimental techniques in your course? Are you an expert in molecular machines and would like to keep up with recent developments? Would you like to know why the work on molecular machines is challenging the classic definition of chemical engineering? The answer to all four questions is the same: Here is the book for you!

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Enzyme-Catalyzed Synthesis of Polymers. Advances in Polymer Science, 194. Edited by Shiro Kobayashi (Kyoto Institute of Technology, Japan), Helmut Ritter (Heinrich Heine University, Dusseldorf, Germany), and David Kaplan (Tufts University, Medford, MA). Springer: Berlin, Heidelberg, New York. 2006. xii + 256 pp. $239.00. ISBN 3-540-29212-8.

The last two decades have seen an emergence in the use of enzymes as catalysts for polymer synthesis. As a result of the unique synthetic machinery of biocatalysts, new polymers have been developed and "old" polymers have been generated using novel synthetic strategies. This book contains seven chapters that cover in great detail the use of enzymes to synthesize a range of polymers. It also makes use of a large number of examples to summarize the salient features of the enzymatic reactions and resulting polymeric properties. For this reason, this book will be of interest to both expert and nonexpert readers.

The book begins with three chapters on oxidative polymerization, primarily those employing highly diverse peroxidases. These chapters provide a very good overview of the field, including the underappreciated use of enzymes to generate biologically active oligomeric derivatives of natural products. In addition, significant attention is given to the peroxidase-catalyzed oxidation of simple phenols into functional phenolic polymers for use as replacement technology to conventional phenol-formaldehydes, electrically conductive polyanilines, and phenolic-based nanocomposites. The research is up-to-date and thoroughly covered. However, the authors miss an opportunity to expand on material that would be of more specific interest to readers. For example, dip-pen nanolithography coupled with peroxidase-catalyzed polyaniline synthesis is discussed as a novel route to nanowire synthesis. Two figures are provided, yet only one short paragraph is included to describe the relevant studies. This leaves the reader interested but unfulfilled about the generality of this potentially exciting confluence of nanotechnology with biocatalysis.

Polycondensation reactions catalyzed primarily by lipases, proteases, and glycosidases are discussed next. The field of ring-opening polymerization to give A−B type polymers is nicely reviewed as is the use of enzymes to synthesize A−B and AA−BB type polymers from alcoholic and acidic precursors. Nevertheless, little mechanistic insight is provided, and the reader is likely to be left with little information on the fundamental limitations of the enzymatic approach and how to overcome them. Chapter 6 completes the section of the book on condensation polymerization with an extensive overview of polysaccharide synthesis. This chapter starts with a broad discussion of enzymatic catalysis, which would have been better placed in the Introduction. The final chapter is a summary of a relatively new application of enzymes in the synthesis of polymers, namely, enzyme-catalyzed initiation of vinyl polymerization. While the chapter is brief, it is the most mechanistically rich of the book and provides a fitting conclusion to it.

In summary, this book will be useful to scientists and engineers that have an interest in learning about enzymes and their use as catalysts in polymer synthesis. However, because there is little fundamental depth in most of the chapters, the book essentially serves as a compendium of individual enzyme-catalyzed polymerization reactions that are highlighted and placed into specific context by the three editors, at least one of whom is involved as an author in all but one chapter. Therefore, the reader will be able to use this book as a starting point to understand the synthesis of enzymatic polymers better but will need to seek more information from additional sources to form a more complete picture.

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Layered Double Hydroxides. Structure & Bonding, 119. Edited by Xue Duan and David G. Evans (Beijing University of Chemical Technology). Series. Edited by D. M. P. Mingos. Springer: Berlin, Heidelberg, New York. 2006. xii + 234 pp. $219. ISBN 3-540-28279-3.

Layered Double Hydroxides (LDH) is a collection of five papers on the structure, synthesis, intercalation mechanisms, and current applications of LDHs, focusing on LDH composites. LDHs are layered materials based on the mineral brucite ($Mg(OH)_2$). Fractional substitution by a 3+ metal results in positively charged layers, which are electronically balanced by interlayer anions. The understanding of the structure and composition of LDHs has come a long way since Feitknecht's "doppelschichtstrukturen" structure in the 1940s. Evans and Slade's excellent opening chapter on the structural aspects of LDHs is a valuable resource for students entering the field, and the comprehensiveness of the material makes this an essential

reference for anyone doing research in LDHs. Both experimental and theoretical studies of nearly every aspect of the LDH structure are discussed, including the range of metal cations and interlayer anions, M^{3+}/M^{2+} ratios, LDH polytypes, arrangement of the "interlayer" anions and water molecules, molecular modeling and molecular dynamics simulations, and the long- and short-range order in both the layers and interlayer galleries. Of especial value is the treatment of the more detailed aspects of the LDH structure that are still unresolved.

One advantage of LDHs over traditional clays is the ease with which they can be synthesized in the lab. The review of synthetic methods is closely related to the LDH structure, and Chapters 1 and 2 make up half of the content of this volume. The focus of the latter is on the suitability of the different methods for component cations and anions and the effect of synthetic method on the purity, crystallinity, and surface area of the product. The primary synthetic methods are covered, including coprecipitation, anion exchange, rehydration, and hydrothermal methods, as well as less common methods.

The intercalation mechanism is one of the least studied aspects of LDH chemistry. O'Hare and co-workers have recently developed an experimental reactor that allows for a noninvasive energy-dispersive X-ray diffraction (EDXRD) analysis of the reaction using synchrotron radiation. The high-intensity polychromatic X-ray beam permits the diffraction pattern for all species present in a reaction to be recorded. This method allows for a noninvasive, in-situ study of the intercalation reaction that is covered in this chapter. Synthesis reactions for $LiAl_2(OH)_6X{\cdot}mH_2O$ have been studied extensively as well as intercalation and deintercalation reactions of LiAl-LDHs. Also covered in this review are staging during anion exchange, selective intercalation, and the intercalation of biomolecules and agrochemicals into LiAl-LDHs. The research to date has focused on LiAl and CaAl LDHs, as reactions of the more common MgAl-LDHs proceed too rapidly to be measured with the current technology.

The variability of composition of the metal cations and intergallery anions results in the ability to fine-tune the properties of LDHs. Li and Duan cover a wide range of applications, including catalysis, ion-exchange/adsorption, pharmaceutics, photochemistry, and electrochemistry as well as less-known applications in magnetic memory, biosensors, and concrete infrastructure. Many of these applications overlap, and the discussion can be difficult to follow. Some applications, such as flame-retardant materials, sensors, and membranes, are not included.

The discussion of LDH−polymer composites is a good illustration of the transition from the general to a specific application. The properties of both the LDH and the polymer can be enhanced in LDH−polymer composite materials. Taviot-Guého and Leroux report on the changes in crystallinity, dimension, and morphology of the LDH as well as enhanced stability, barrier properties, mechanical strength, control of the molecular weight, and processability of the polymers. Strategies for incorporating polymers into LDHs, including matching the charge density of the LDH to the packing of the monomer and the conditions for the intercalation and polymerization reactions, are discussed.

In conclusion, this is a valuable resource for researchers and students in the field of LDHs and should be of general interest to those in the field of layered and porous materials. While the information on applications may become dated, the literature through 2004 is thoroughly reviewed and some 2005 references are included. The price of $219.00 compares reasonably to those of other volumes of its class.

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