A Bug's Life

Industrial Biotransformations. By *Andreas Liese, Karsten Seelbach* and *Christian Wandrey.* Wiley-VCH, Weinheim 2000. 423 pp., hardcover DM 198.00 (ca. 101 €).—ISBN 3-527-30094-5

How important are transformations with biological catalysts in modern industrial chemistry? Is their use limited to special types of reactions, or are biocatalysts a versatile tool whose real potential is still unrecognized by most synthetic chemists, a Sleeping Beauty waiting to be awakened? The authors of the book *Industrial Transformations* have set out to answer these questions, and to show the extent to which biocatalysts are already being used in industry. Biotransformations are to be understood as processes in which well-defined compounds are transformed into products, in one step or a small number of steps, by using catalysts of biological origin. With the aim of describing all relevant biological transformations that are in industrial use, the authors have compiled an impressive amount of data, which is presented in this book.

The use of enzymes or whole microorganisms as biocatalysts for the manufacture of chemicals has a long tradition, as is shown at the beginning of the book in a short historical outline under the title "History of Biotransformations—Dreams and Realities". This chapter describes the most important advances that have occurred in the area of industrial biocatalysis. The development of industrial transformations is an interdisciplinary field of work, and to understand it thoroughly one needs insight into all the contributing disciplines. Therefore, in the chapters entitled "Enzyme Classification" and "Basics of Bioreaction Engineering", the authors present the basic principles of enzyme classification, biochemistry, elementary reaction kinetics, and reactor design. With that basic knowledge even the nonspecialist can move forward to learning about the essentials of the processes described. It is true that the chapters do not treat all aspects down to the last detail, but that would necessitate a larger book than was intended.

The main value of the book lies in the section on "Processes", which describes various biotransformations used in industry. The authors have gathered information about the most important reaction parameters for each process. As well as the reaction conditions, they give data about yields, plant capacities, and catalysts used. In accordance with the maxim "one formula tells more than a thousand words", the description of each transformation is accompanied by a formula scheme. Alternative synthetic routes are shown in graphical form, as also is the place of the biotransformation within the context of the whole synthesis. Wherever possible a flow diagram of the process is included. This is followed by information about the uses of the product, and a list of the most important literature references relating to the process. It is, of course, well known that manufacturers are, with good reason, reluctant to publish key details of their processes. That is certainly why this compilation does not always give data on all the parameters for a process. For the same reason, some of the numerical data cited should only be regarded as giving an indication of the order of magnitude of the actual values. Subject to that proviso, the authors have succeeded in giving a good, clearly understandable description of a large number of industrial biotransformations. Also, at the end of the book, there are four indexes listing the contents according to different criteria, enabling the reader to quickly find items of interest.

The authors invite readers to supply information about biotransformations that are not mentioned in this first edition of the work, so that the coverage can be extended. For that purpose a form has been included at the end so that process data can be given. One hopes that, as well as including additional data from those sources, the next edition of the work will correct a number of annoying mistakes, such as the grouping of the bacterium *Zymomonas mobilis* within the domain of eukaryotes (p. 65), and some inaccurate or confusing statements which detract from the otherwise positive impression given by the book. Also, unfortunately, some structural formulas are incorrect (e.g., on p. 241), and occasionally the descriptions of compounds are wrong or misleading (e.g., p. 176). The authors have deliberately concentrated on biotransformations, and do not deal with fermentation processes. However, that area too includes industrial processes for the manufacture of important products. One can only hope that in the near future there will be a work of reference on fermentation processes, along similar lines to the present book.

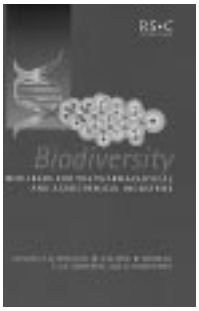
To summarize, *Industrial Biotransformations* describes, in a clear and understandable way, a wide variety of processes which illustrate that biological catalysts already make an important contribution to industrial synthetic chemistry. Although the book definitely

has some flaws and its contents are not presented in textbook style, it is still qualified for giving students an overview of this fascinating area of industrial and academic research. Chemists will learn from it that biological systems can offer elegant solutions to problems of synthesis, and biologists will be made aware of the potential that microorganisms and enzymes hold for applications in chemistry.

Michael Breuer
BASF AG
Ludwigshafen (Germany)

Biodiversity. New Leads for the Pharmaceutical and Agrochemical Industry. Edited by *Stephen K. Wrigley, Martin A. Hayes, Robert Thomas, Ewan J. T. Chrystal* and *Neville Nicholson*. Royal Society of Chemistry, Cambridge 2000. vi + 314 pp., hardcover £ 59.50.—ISBN 0-85404-830-8

Natural products, as a result of the structural diversity that has resulted from evolution and natural selection, have a firmly established place in contributing to the search for pharmaceutical and agrochemical lead structures, despite the increasing competition from synthetic combinatorial chemistry and libraries of compounds. Current research on active agents is directed towards making optimal use of this structural diversity, which is closely linked to biodiversity. With that in mind, the title of this book, based on a conference organized by the Royal Society of Chemistry in 1999, raises the expectation of interesting material. It collects together 21 contributions providing insights into many different facets of natural products research. These are presented in a clear arrangement of topics in six chapters, starting with a general part (history, diversity, and discovery), which is followed by more specialized articles on microbial, marine, and plant natural products, biosynthesis, and chemical synthesis of natural products. The book is well edited, with a good layout, apart from a few small lapses. The articles are competently written and relevant, mostly with a good mix of review style and detailed description; there are only a few instances of excessive compilations of primary data or confusing tables.



A number of well respected authors provide a retrospective survey of the best known natural products (commercial products or research compounds) and report on the present state of knowledge about these, including for example microbial products (A. L. Demain) and antineoplastic compounds (G. M. Gragg et al.). These articles are of value as a way of finding detailed information on these topics, or as a reference source, or (and this appears to be the main purpose) to illustrate the importance of natural products research. The article by A. E. Wright addressing the problem of how to extract active agents from marine organisms cost-effectively, which must be solved to allow intensive research on these substances, will be of great interest, at least to experts in the field. However, only J. Ruddock, in his article on the role of natural products in animal health, succeeds in linking the historical aspects with interesting speculations about the future, including the commercial viewpoint.

The contributions by authors with an industrial background provide some stimulating ideas. Thus, S. Brewer compares the roles of natural and synthetic compounds in the search for active agents, and reaches the firm conclusion that natural products are superior as "pathfinders" in pharmacology and medicinal chemistry. In contrast, D. Baker and co-authors, in an interesting case study comparing natural products and test compounds from the combinatorial route, conclude that natural products had a less important role in high-throughput tests; unfortunately, however, they give no information about the comparative success rates in the subsequent chain of value creation. J. M. Clough contributes a very instructive account of the history of the fungicide Strobilurin.

Nevertheless, these articles, and also those that deal competently, although at a very specialized level, with the area of biosynthesis, are far removed from the subject of biodiversity promised by the book's title. Some important questions and aspects of biodiversity (including, for example, its definition, qualitative and quantitative description, the analysis of biological sources and interpretation of the results in terms of structural diversity, rights of ownership and the Rio Convention on Biological Diversity) are not treated in sufficient depth. Marshall and Hillman contribute a first insight into the importance of molecular biology for understanding biodiversity, although this relies heavily on experience from plants grown as crops. In a very readable article, Reddell and Gordon discuss the potential value of ecological observations in the search for biochemically active natural products; however, this approach does not answer the problem of achieving a real improvement in efficiency in identifying active compounds. Nevertheless, it is a productive strategy, and is already much more widely used in the scientific community than the authors suggest.

How does biodiversity become translated into new active agents? Or, more generally, what is the current state of natural products research, what trends are evident, and what are the future prospects and opportunities? The expertly written articles will certainly provide stimulating ideas for readers already active in the area, but they offer no clear directions for new work, nor anything that is surprising or novel. Readers who are new to the field and are looking for a way to become involved will find some of the contributions useful and worthwhile.

Thomas Henkel
Bayer AG, Pharma Forschung
Wuppertal (Germany)

Principles of Molecular Mechanics. By *Katsunosuke Machida.* John Wiley & Sons Ltd., Chichester 1999. x + 318 pp., hardcover £ 96.95.—ISBN 0-471-35727-8

Enormous progress in computer hardware and computational chemistry software in the 1980s and 1990s has allowed the application of quantum chemical (QC) methods to larger and larger

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systems, and it was even believed that molecular mechanics (MM) would not be sooner or later applied. At the beginning of the new century it is, however, clear that MM will play an important role not only in chemistry and physics but also in biodisciplines. Biomacromolecules as well as various solvents cannot be described quantum-chemically, and simpler descriptions (e.g., using a continuum model for the solvent) have been shown to be not accurate enough. MM (or, in other words, the use of empirical potentials) has proved to be very useful. Very attractive possibilities for a new application of MM methods come from the introduction of QC/MM methods which take advantage of both theoretical models. Accurate description by QC methods is used for the innermost system, while the outer part (solvent or peripheral regions of biomacromolecules) is described by MM methods.

MM methods can be viewed from various angles, with the emphasis on either their applications or the theoretical background. In this book Katsunosuke Machida presents the mathematical and physical background of molecular mechanics calculations. Readers interested in the application of MM methods are referred to monographs and reviews cited at the end of Chapters 1 and 2.

The book is divided into 9 chapters together with an Appendix and an Addendum, and contains altogether 327 literature references. The titles of the chapters are self-explanatory: Introduction, Molecular Force Fields, Equilibrium Structure of Molecules, Normal Coordinate Analysis, Rotation and Anharmonic Vibrations of Molecules, Thermodynamic Functions, Electric Properties of Molecules, Simulation of Vibrational Spectra, Molecular Mechanics of Crystals. The mathematics behind MM methods is described in an intelligible manner, and everybody who has used the MM methods as a "black box" and trusted the outputs will now become aware of the strong and weak points of the method. It is not necessary to read the book from the first to the last page, and individual chapters are more or less independent, which is a great advantage in my opinion.

Katsunosuke Machida has written a good and useful book which is recommended to everybody who needs to know more about the principles of widely used MM methods. The book or its parts can be used in first year chemistry courses as well as in courses on computational chemistry and biochemistry.

Pavel Hobza
J. Heyrovský Institute of Physical Chemistry, Academy of Sciences
Prague (Czech Republic)

Metal Oxide Chemistry and Synthesis. From Solution to Solid State. By *Jean-Pierre Jolivet.* John Wiley & Sons Ltd., Chichester 2000. 321 pp., hardcover £ 95.00.—ISBN 0-471-97056-5

This book was written in collaboration with Marc Henry of the University of Strasbourg and Jacques Livage, Jolivet's colleague at the University of Pierre and Marie Curie in Paris. Published in 1994 as the third edition of *De la Solution à l'Oxyde*, it has been translated from the French by Eric Bescher of the University of California, Los Angeles.

Metal oxides occupy a special place in technology and history. Arguably, metal oxides were mankind's first synthetic materials: fired clay ceramics (heat-transformed mixtures of aluminum and silicon oxides) are ubiquitous at archeological sites in the form of potsherds. In modern life metal oxides are still used in decorative and useful ceramics, as well as in catalysts, magnetic recording materials, zeolites for ion exchange and molecular sieves, phosphors, and solid-state electronic devices. The lure of high-temperature superconductors has recently increased research into these oxides. Small metal oxide particles have special uses; to quote from the book:

"'Nanomaterials' also generate interest because of the specific properties linked to the nanometer size of the particles. Some unusual optical and electrical properties are due to a phenomenon known as quantum confinement. The large surface/volume ratio also leads to the use of some of these materials in catalysis. The excellent sintering characteristics of fine powders are useful in the fabrication of ceramics and composites. The dispersion of small particles in various solvents allows the fabrication of thin films and antireflection coatings, or improvements in the optical performance of mirrors."

Jolivet's book is an introduction to the aqueous behavior of metal oxides and is aimed at engineers and researchers. The emphasis is on solution behavior, colloids, and surfaces rather than electrochemistry, catalysts, or semiconductors, but the concepts and equations introduced are broadly applicable. According to the preface the two main objectives of the book are "to describe the logic behind the formation of oxides from solutions," and "to introduce the basics of the physics and chemistry of oxide surfaces, which are at the core of the behavior of small particles in suspension." The book succeeds in these goals.

About two-thirds of the book (comprising Part I) is concerned with the aqueous solution behavior of metal ions and metal oxides. The differences in behavior of metals in water as pH is varied can be bewildering. Some metal ions remain in solution over the whole accessible pH range, some precipitate at high but not low pH values, some precipitate at low but not high pH values, some are amphoteric, and some aggregate into oligomers or polyoxo species over certain pH ranges. At the heart of Jolivet's book is an appendix which helps make sense of these various behaviors. The key is how well the metal ion communicates its charge to the surrounding atoms. A "partial charges" model of compounds is developed to roughly predict solution behavior. This model is a function of the electronegativities of the elements in question. The various concepts of electronegativity are clearly explained and the advantages and disadvantages of the model chosen are noted. In particular the partial charges model used is insensitive to geometry or concentration, so only qualitative information is obtained. This is no substitute for thermodynamic data, but is of course better than no information at all, and the author's claim that the model

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rationalizes the chemistry of cations in solution is given support through examples. Aqueous phenomena including solvation, complexation, oxolation and olation, nucleation, growth, crystallization, aging, and precipitation are examined in Part I. Polyoxocations and polyoxoanions are discussed briefly.

The remaining third of the book (Part II) covers the surface chemistry of oxides. This includes surface charge and acidity, models of the surface–solution interface, the stability of colloidal dispersions, and adsorption. This part includes results of the author's research with Elisabeth Tronc concerning iron oxides. In fact, as might be expected because of their technological importance, iron oxides are discussed throughout the book.

The literature is covered up to about 1993. This limitation is of little consequence for the primary objective of the book, which is to introduce the basics to readers new to the field. But on reading the section on polyoxometalates it became clear that much has happened in that field in the past seven years. This is in large part a consequence of the availability of CCD detectors for routine X-ray crystallography. For example, the largest discrete polyoxomolybdate (as opposed to true polymers) discussed in the book contains 36 Mo atoms and is described as "very large". But this is dwarfed by recent structures emanating from Achim Mueller's group in Bielefeld, one containing up to 176 Mo atoms in a torus-shaped anion (the "big ring"), another with 132 Mo atoms (the "big ball") in an icosohedral arrangement. In the polytungstate category Knut Wassermann, working with Michael Pope here at Georgetown University, made a disk-shaped anion containing 148 W atoms. These structures are typically several nanometers in diameter and have masses equal to those of small proteins.

The increase in size of characterized discrete polyoxoanions is an exciting trend, and it is not yet clear what the limit is to this growth. As these structures get larger, the discrete anion more closely resembles a bulk oxide surface. At some point they may be a bridge between the two parts of *Metal Oxide Chemistry and Synthesis.*

Jolivet's book contains copious references, diagrams, illustrations, and graphs complementing the text, which is generally well-organized, clear, and readable. The table of contents is extensive. The index is useful but could be expanded. There are a small number of typographical errors as might be expected for a first edition of a translation; these appear to be minor and do not detract much from the book. (One example: PZC, or point of zero charge, is sometimes referred to as PCN which is apparently the French equivalent.) The discussion is well balanced between theory and examples. This is an informative and valuable contribution to the literature of metal oxides.

Michael H. Dickman
Department of Chemistry
Georgetown University
Washington, DC (USA)

Microreactors. By *Wolfgang Ehrfeld, Volker Hessel* and *Holger Löwe.* Wiley-VCH, Weinheim 2000. xii + 288 pp., hardcover DM 148.00 (ca. 126 €).—ISBN 3-527-29590-9

This is a useful book for anyone interested in learning some of the current techniques used in the fabrication and application of microreactors. Microreactor technology is an exciting new area in chemical engineering, and the text provides a good first step in informing the reader about selected developments in the field. Overall, the book gives many good examples of engineered micro devices that have already been made. Unfortunately, however, these examples are presented as photographs of the finished product, and do not provide much engineering data (e.g., step-by-step manufacturing instructions and detailed dimensions) for someone else to replicate the microdevices. In addition, there is no discussion anywhere in the book of the difficulties encountered in the fabrication or use of these devices. Furthermore, the examples are derived only from a very small number of research groups, mostly the authors themselves, which tends to limit the scope. For example, the book does not cover the more developed field of microelectromechanical systems (MEMs), where similar or related challenges of fabrication and application to flow systems are also being faced.

The authors make the following general comment about micro devices on page 6: "…benefits concerning chemical engineering is the main driver for microreactor investigations, while chemistry, in terms of reaction mechanisms and kinetics, remains widely unchanged". This statement can be misleading to a newcomer to the field. As reactor dimensions are reduced, surface effects become prominent, and this can significantly influence reaction kinetics, especially in catalysis. For example, trace additives and promoters that are often used with heterogeneous catalysts can be selectively adsorbed on reactor walls, so that they do not become or remain incorporated in the catalytic material. Consequently, the intrinsic reaction kinetics in microreactors can be quite different from those in larger scale (i.e., traditional) systems where catalysts are prepared with minimum vessel wall effects. In other words, the issues of scale-up and scale-down are overlooked by the authors.

Chapter 1 makes a persuasive case for continuing research and development on microreactors. Unfortunately, as noted before, there is no discussion of some of the difficulties encountered in the fabrication and use of microreactors. Consequently, the reader is set on an exciting new course, but with no help regarding potential pitfalls.

Chapter 2 summarizes a variety of methods used in the fabrication of microreactors. Again, the list covers methods primarily used by the authors, giving the false impression that very little research is conducted elsewhere on the fabrication of microdevices.

Chapter 3 is devoted to mixing phenomena in microreactors. The authors describe various mixing configurations, again as a final design, with no discussion of the difficulties and limitations encountered in the fabrication and use of the devices. Fundamental issues involved in mixing are only discussed superficially. For example, the molecular diffusion concept is introduced, but there is no discussion of scale-up based on the Knudsen number considerations in small channels. Also the effects of

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surface tension forces that are crucial to liquid flows and mixing, and which apply especially to microdevices, are totally ignored.

Chapters 4 and 5 address hardware developments concerned with heat exchange and mass exchange, respectively. Again, many good hardware ideas are presented with experimental data, but there is little discussion about the fundamental transport phenomena in small channel flows as applicable to the devices described.

Chapter 6 discusses the application of microdevices for liquid-phase reactions and electrochemical reactions. As with other chapters, final reactor designs are presented with only a limited discussion of the methods used to prepare them, and without much guidance to the reader on how to proceed.

Chapter 7 describes a number of case studies on the application of microreactor systems to gas-phase reactions (mostly catalytic). Like the earlier chapters, this chapter provides brief discussions of the catalysts used, the conditions explored, and results on conversion and selectivity. Readers will probably need to go to the original papers cited by the authors to obtain the necessary reaction rate data. For example, no mention is made of the reaction times (i.e., contact time or residence time) in the examples discussed.

Chapter 8 attempts to address microreactor issues related to gas–liquid contacting, with some relevant examples. Again, the examples are presented "as is", without much analysis of the underlying multiphase flow or the reasons for the design chosen. However, in the concluding section the authors clearly acknowledge the need for the development of reactor models.

Chapters 9 and 10 briefly discuss applications of microreactors to the generation of synthesis gas and to catalyst screening, respectively. Chapter 9 should probably have been a part of Chapter 7, because there is no apparent reason to present them separately, as both chapters deal with heterogeneous catalysis. Again, the descriptions of the microreactors, the reactions, and the conditions used are very short, leaving the reader with more questions. Chapter 10 on catalyst screening is particularly brief (only 5 pages), and falls short of interested readers' expectations in this area.

Lastly, Chapter 11 contains a brief discussion of the potential use of microdevices in large-scale chemical production. Again, this chapter emphasizes only the advantages offered by microdevices, and leaves much room regarding the challenges to be overcome for the wide implementation of microtechnologies.

However, in spite of the shortcomings noted above, this should be a good reference book for anyone interested in learning about some of the gadgets being made for microreactor engineering. The lack of fundamental, unifying principles that would rationalize the designs presented, and thereby help the reader to enter the field painlessly, render the book of rather limited utility. On the other hand, considering the fact that microreactor engineering is an emerging field, it would perhaps be unrealistic at this time to expect a thorough treatment of the fundamental principles in such a book. We will undoubtedly see such books in the future, spurred, in part, by publications such as this one. I hope that this book, and the books that will follow, will eventually set the stage for the development of standardized "unit devices", similar to the "unit operations" concept formulated in the early days of chemical engineering. The development of unit devices will enable their easy coupling and use in a wide variety of applications, very much like building computers today from standard components.

Selim Senkan
UCLA Chemical Engineering
Los Angeles, California (USA)

Combinatorial Chemistry. A Practical Approach. Edited by *Hicham Fenniri*. Oxford University Press, Oxford 2000. xxxii + 476 pp., paperback £ 39.50, hardcover £ 75.00.—ISBN 0-19-963754-7, 0-19-963757-1

A considerable number of new monographs on combinatorial chemistry have appeared during the last two years (e.g., see *Angew. Chem.* **2001**, *113*, 261–263); *Angew. Chem. Int. Ed. Engl.* **2001**, *40*, 255–257), and *Combinatorial Chemistry—A Practical Approach* is a further addition to those. It is immediately clear from the title that this is not a textbook in the narrow sense. Here the editor, H. Fenniri, has put the emphasis on the preparative aspects of compound libraries: synthesis, screening, and evaluation, as can be seen from the impressive number of detailed synthetic protocols (109 altogether). The book provides a concise description of the basic methods of combinatorial chemistry, supported by practical examples. In the 16 chapters, leading experts in the field of combinatorial chemistry present various aspects of the subject that are related to their own areas of work. The chapters deal with every important aspect of recent work on liquid-phase and solid-phase chemistry, including the synthesis of compound libraries by both manual and automated methods, the analytical techniques used to identify individual compounds, and the application of the results to the development of pharmaceutical agents, catalysts, receptors, and materials.

Chapters 1–6 deal with fundamental principles of solid-state chemistry, and describe different types of polymeric supports. In Chapter 1, Á. Furka and co-authors describe the essentials of "mix and split" synthetic techniques and the associated synthetic strategies for evaluating the compound libraries thus obtained, in some cases using optical, chemical, or radiofrequency encoding, with relevant examples. In Chapter 2, K. S. Lam and G. Liu take up the theme in more detail; they discuss the "one bead, one compound" principle, and describe syntheses of various peptide libraries and the use of functional screening assays. Then in Chapter 3 R. A. Houghten and co-authors give a detailed description of two deconvolution methods for identifying individual active agents. They describe the different screening methods that are used, such as ELISA (enzyme-linked immunosorbent assay), and give a useful insight into the relationship between the synthesis of a compound library and the associated analysis. K. C. Nicolaou and X.-Y. Xiao discuss nonchemical encoding methods, such as the barcode method and radiofrequency encoding, using the IRORI-MicroKan technique, and describe ex-

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amples of applications to the synthesis of various natural products.

In addition to the preparative aspects of the synthesis, screening, and evaluation of compound libararies, the book also contains a survey of solid-phase reactions carried out during 1998 and 1999. This information is presented by W. D. Bennett in Chapter 7 (118 pp.). It is arranged chronologically under reaction types and named reactions, a method that seems a rather unfortunate choice. Bennett's compilation can be compared with those by Dörwald and Bannwarth/Felder (both reviewed in the *Angew. Chem.* and *Angew. Chem. Int. Ed. Engl.* pages cited above), which not only have a better graphical arrangement, but are also much more informative in giving details about the individual reactions. In Fenniri's book it takes some time to get used to the tabular form used and the graphical representation. Also small errors have sometimes occurred in transferring data from the original literature: for example, azides are not diazonium ions (p. 240), and the Heck reaction is not a nucleophilic aromatic substitution (p. 209). Despite these criticisms, this chapter affords quick and easy access to information about recently performed solid-phase reactions, avoiding the need for an extensive literature search. However, in view of the flow of new publications that continue to appear every week, it must be borne in mind that only a selection of the possible reactions are listed here, and therefore it is also essential to scan the current literature.

That is followed in Chapter 8 by a concise survey of all the common analytical methods that are used to monitor reactions in the liquid and solid phases and to identify products (FT-IR spectroscopy, gel-phase NMR spectroscopy, solid phase magic angle spinning NMR spectroscopy, FIA mass spectrometry, etc.). In Chapter 9, I. Ugi and A. Dömling deal with multicomponent reactions of isocyanides. Examples of Ugi, Strecker, and Bucherer reactions are described, and are discussed in relation to synthetic protocols, thus providing a concise overview of the topic. Chapters 10–13 are devoted to liquid phase combinatorial methods, both manual and automated. In particular, D. L. Boger and J. Goldberg give a brief survey of the main advantages and shortcomings of the methods, with examples. Chapter 11 provides a comprehensive review of the use of fluorinated solvents and reagents, and of the role of fluorine in encoding and in reactions for organic combinatorial syntheses. Chapter 14 introduces discussions of combinatorial catalysis from different viewpoints. Thus, E. Reddington and co-authors describe the use of combinatorial electrochemistry for the development and optimization of electrode materials.

S. Kobayashi discusses the synthesis of a catalyst in the solid phase, and describes an example leading to a catalyst that is used in the synthesis of libraries based on tetrahydroquinoline and other structures. Lastly, in Chapter 16, M. L. Snapper and A. H. Hoveyda discuss the use of combinatorial chemistry for the development and optimization of chiral ligands for catalytic applications. In particular, they give an excellent and instructive account of the discovery of a suitable metal salt and a chiral ligand for the Strecker reaction and for selective ring opening of epoxides.

The book is mainly intended for readers experienced in combinatorial chemistry, as is evident from the extremely short introduction to the subject, in which it is assumed that the reader already has some knowledge of the theoretical concepts and basic synthetic strategies. The texts of the individual chapters (typically about 20 pages long) are self-contained, well structured, and easily readable. Although they have been written by different author groups, they follow a fairly consistent layout and, thanks also to the many cross-references (a commendable feature), they produce a good overall impression. The carefully prepared index provides a rapid and direct means of finding specific topics. Another pleasing feature is the inclusion of a list of suppliers of chemicals and apparatus, although the choice of these is rather arbitrary.

In summary, through the careful selection of important examples from academia and industry, the book provides an effective starting point for solving a wide range of problems, and also offers many new ideas and much practical advice. Apart from a few errors it compares satisfactorily with other similar works, such as that by Bannwarth and Felder. However, beginners in combinatorial chemistry would probably be better served by other works.

Frank Avemaria, Stefan Bräse
Institut für Organische Chemie
Technische Hochschule Aachen
(Germany)

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