is centered on dye-sensitized solar cells, but here the focus is on the photosensitizers and on the photoinduced electron injection processes. The solar light-harvesting efficiency of various dyes is investigated, and the authors discuss the choice of ligands used, with regard to their effects on light-harvesting efficiency and recombination events.

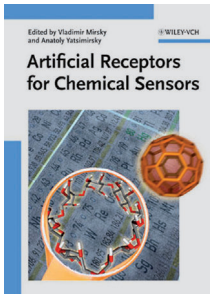
Water splitting is not the only way to convert solar energy into chemical energy, and other chapters deal with promising processes such as methane-to-methanol conversion, which is discussed by Hashiguchi and co-authors, who review the various coordination metal complexes involved as catalysts in this important process. The electrochemical and photoelectrochemical conversion of carbon dioxide to alcohol is discussed by Crabtree, who also reports in his chapter some broad conclusions about the difficulties and perspectives related to electrocatalytic (or photocatalytic) processes for the reduction of CO_2.

The "Energy Production" part of the book also includes chapters dealing with fuel cells, as the optimization of fuel cells is obviously a key point for the effective use of solar fuels. Barrière introduces a biologically-orientated approach, and discusses the use of enzymes and microbes in fuel cells, including a review of research on microbial catalysis in microbial fuel cells. The selection of materials and their processing for intermediate-temperature solid oxide fuel cells are at the center of the chapter by Atkinson and co-authors, who also report on approaches to reducing the costs of materials for the production of fuel cells. The important topic of proton exchange membranes in fuel cells research is covered by Devanathan, who also discusses the degradation of such membranes, and Chia and Lee report work on direct ethanol fuel cells. Lastly, Oyaizu describes a molecular approach to the catalytic performance of fuel cells.

The "Energy Storage" section begins with an excellent chapter by Wells and colleagues, who compare key technologies for hydrogen production from various points of view, including costs, current use, and theoretical potential. Future prospects for a hydrogen energy economy are also presented. The potential of lithium ion battery electrolytes is reviewed by Lucht and co-authors, and materials aspects connected with the properties of supercapacitors, in connection with the principle of energy storage in supercapacitors, are extensively discussed in the chapter by Zhang and colleagues. These authors also report on the potential of relatively new materials such as carbon nanotubes and graphene for use in supercapacitors. Finally, the possibilities offered by thermochemical water splitting are discussed by T-Raissi, and basic investigations on molecular materials for lithium ion batteries, essentially based on NMR studies, are described by Cabana and Grey.

In conclusion, this is a well-balanced book, covering most of the approaches to the problem of the production and storage of energy from renewable sources. The presentation is excellent, with most chapters well provided with references and illustrated by informative figures. Almost all chapters end with future perspectives and with summarizing conclusions, which also serve as abstracts. The book is highly recommended for all researchers in the field, and should serve to inspire new researchers to join this extremely important field.

Sebastiano Campagna
Department of Inorganic, Analytical and Physical Chemistry, University of Messina (Italy)



Artificial Receptors for Chemical Sensors
Edited by Vladimir M. Mirsky and Anatoly Yatsimirsky. Wiley-VCH, Weinheim 2011. 470 pp., hardcover, € 139.00.—ISBN 978-3527323579

Artificial Receptors for Chemical Sensors

The editors of the book are well-known for authoring monographs such as *Combinatorial Methods for Chemical and Biological Sensors* (Springer, 2009, by V. M. Mirsky) and *Principles and Methods in Supramolecular Chemistry* (John Wiley & Sons, 1999, by H.-J. Schneider and A. K. Yatsimirsky). The content of this new book lies at the interface of sensors and supramolecular chemistry, and equally addresses readers in both areas. The goal was to discuss artificial receptors with an emphasis on their practical applications as components of chemical sensors and arrays. It comprises 14 chapters, each written by exponents in their field. References up to the year 2009 are included, such that the book is one of the most up-to-date resources in an area, where already several counterparts exist. These are, however, frequently more involved with engineering aspects, for example, *Chemical Sensors—An Introduction for Scientists and Engineers* (Springer, 2007, by P. Gründler), *Analytical Techniques in the Sciences: Chemical Sensors and Biosensors* (John Wiley & Sons, 2002, edited by B. R. Eggins), and Janata's *Principles of Chemical Sensors* (Springer, 2009).

It is one of the books, which a curiosity-driven researcher would start to read from the end: Chapter 14 tabulates binding constants of artificial receptors, 58 of them, with many analytes. The table is naturally incomplete, although the back-cover summary claims otherwise. For example, it lacks stoichiometric analyte binding by simple unmodified macrocycles such as sulfonatocalixarenes and cucurbiturils. However, it presents a

rich resource for researchers in the field, looking for analytes for which sensors already exist, and ones, which could be improved upon. Chapter 8 (by Lhoták and Kundrát on fullerene–calixarene conjugates), Chapter 9 (by Schmuck and Kuschelmeister on guanidinium-based anion receptors), and Chapter 12 (by Lange et al. on conducting polymers as artificial receptors) are excellent to obtain a broad overview of these research areas.

Other chapters tend to be more tailored towards the specific research areas of the contributors. Notable exceptions are the first two chapters, which give a comprehensive introduction to the basic terminology and definitions regarding what sensing with receptors is all about: affinity and selectivity. Having used the book as a complementary resource in a graduate course on nanoscience, we can say that these two chapters, describing numerous literature examples for analytes ranging from transition metals to nucleotides, are truly suitable for graduate students in analytical or supramolecular chemistry.

Chapter 3 deals with combinatorial developments. It presents an exceptionally comprehensive compilation of literature studies, but the information becomes overwhelming, especially for beginners in the research field. Chapters 4–9 focus on the design and applications of discrete receptors, most of which are very well written, for example Chapter 5 by Kubik, which presents the latest developments on cyclopeptide receptors. The well-structured Chapter 4 by Ikeda surveys research in the area of cyclodextrins with appended fluorescent labels in water, and Chapter 6 by Yang et al. reviews boronic acid-based chemosensors. Chapter 7 is one of the highlights for the organic chemist, by Wenzel and Pham, on receptors for chiral recognition. While synthetic procedures are discussed in all cases, spectral data on the actual sensing events (such as UV/Vis, fluorescence, NMR spectra and titrations) are scarcely graphically represented, which presents a drawback. Chapters 10–13 deal with receptors based on organized (spreader-bar approach) or macromolecular structures (aptamers, conducting polymers, and molecularly imprinted polymers), which provide a nice addition from an actual application point of view. These chapters are highly heterogeneous, Chapter 10 having no subsections, not even introduction or conclusions, while Chapters 11 and 13 have too many, with short sections consisting of a single paragraph.

Some critical points need to be addressed regarding the layout of the book. One immediately picks up on structural formulae of largely different sizes and styles, with the structure of a calixarene, for example, once spanning half a page, 4 to 5 times larger than in other schemes. Some of the structures, e.g., in Chapter 14, are also visibly scanned, in lower resolution. Table 13.5 shows formulae for simple solvents such as acetone, methanol, and even water; these would not have been necessary in a book which is clearly steered towards a readership of experienced chemists.

To summarize, any reader interested in the applicability of artificial receptors will find *Artificial Receptors for Chemical Sensors* a rich source of information—from scientists working in the field of organic chemistry to those working in medical diagnostics, biotechnology, chemical technology, food, and environmental monitoring, and of course those in analytical and supramolecular chemistry. Content-wise, it is an outstanding book.

Werner Nau, Alexandra I. Lazar, Swecha Joshi
School of Engineering & Science
Jacobs University Bremen (Germany)

DOI: 10.1002/anie.201103816

