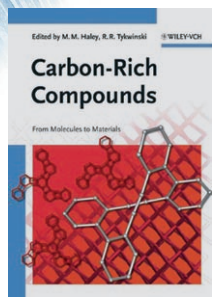
Carbon-Rich Compounds



From Molecules to Materials. Edited by *Michael Haley* and *Rik R. Tykwinski*. Wiley-VCH, Weinheim 2006. 643 pp., hardcover € 159.00.—ISBN 978-3-527-31224-2

Hydrocarbon chemistry has shown itself to be remarkably resistant to fashion trends. In the 1960s and 1970s the fascination of many researchers was focused on saturated—often polycyclic—systems, or on aromatic and antiaromatic annulenes, whereas today, not least as a result of the discovery of the fullerenes, it is on compounds with maximum unsaturation, including aromatic compounds, alkynes, and combinations of these two classes. In this area too there is now an enormous variety of structures and forms, and that is reflected impressively in this monograph. In contrast to the studies of 40 years ago, the questions being asked nowadays are more often, and more intensively, focused on potential practical applications of such systems, and therefore the book's subtitle is appropriate.

It is difficult to give a clear definition of "carbon-rich" compounds. One of the editors (Michael Haley) describes any hydrocarbon with a C/H atomic ratio of 1:1 or higher as carbon-rich. A different, and structurally more informative, classification appears in the chapter by Peter R. Schreiner, in which he discusses all the various computational methods that are used to predict the structures and reactive properties of carbon-rich compounds. Schreiner differentiates on the basis of the degree of hybridization. He makes a distinction between sp^3 systems (polycyclic alkanes, diamantanoids such as polyadamantyls, and nanodiamonds) and sp and sp^2 systems, which he groups under headings such as polycyclic aromatics (PAHs), graphenes, carbon nanotubes, polyalkynes, cumulenes, graphite, and lastly fullerenes (which are not strictly "carbon-rich" systems, but are pure carbon!). The majority of the articles in the book deal with the second class of systems.

It is pleasing to find that the book begins with a historical chapter, by Johnson and Haley. This not only gives a thorough and very readable account of the development of the chemistry of aromatic compounds since the middle of the 19th Century, it also emphasizes, again and again, the extent to which we are still profiting from the achievements of the chemical pioneers. This chapter also serves as a very good introduction to the subject of the book, and also shows that many questions reach far back into the history of chemistry (how long can one extend polyacetylene strings? how far can sheets of aromatic compounds—graphite subunits—be extended?).

The rest of the chapters can be divided roughly into two categories: chapters about synthesis and chapters about applications, although there is, of course, some overlap between these.

In the synthesis-oriented chapters, Vollhardt and Miljanić write about [*N*]-phenylenes, which, thanks to the senior author's work in the last few years, are now easy to synthesize. They have become especially important as reference compounds in connection with studies of bond fixation in aromatic compounds (regarding aromatic compounds as 1,3,5-hexatrienes). Tykwinski and Campbell contribute a chapter on carbon-rich macrocycles and cyclophanes, many of which have fascinating structures and stereochemical properties, such as helical chirality. Gleiter and Werz describe carbocyclic ring systems containing two or more 1,3-butadiyne subunits; many of these compounds not only have interesting structural properties and show novel kinds of spectroscopic or chemical behavior (e.g., intraannular reactions leading to new ring systems), but also form columnar or tubular structures in the solid state, which are capable of taking up smaller species as guest molecules. Oligomeric and polymeric carbon-rich compounds are discussed by Fowler and Lauher and by Herbert Meier. A few of these compounds, which have interesting optical, electrical, and optoelectronic properties, have already found practical applications. The discussions about these linear, highly unsaturated compounds, which of course include the polyynes described in a chapter by Yam and Tao, are followed by chapters on planar molecules. Important examples of these are the graphite substructures, which are reported by Müllen and Wu. Until recently, nobody would have thought it possible to synthesize (and characterize) large-area condensed aromatic compounds that are formally made up of well over 100 benzene rings. These compounds too have now been shown to have practical applications (as liquid crystals and organic semiconductors). The next steps in this chemistry, leading to carbon sheets that are bent, and ultimately closed, follow appropriately in the next two chapters. In the first, Sygula and Rabideau describe the novel chemistry of the "buckybowls", based originally on corannulene, that have been synthesized. In the second, Kitagawa, Murata, and Komatsu describe new reactions of fullerenes, the most striking of which concerns the transport of guest molecules through an artificially created hole in the fullerene wall, which lead to a new way of synthesizing endohedral fullerenes.

The two remaining chapters show that the binary compounds mentioned above can also be made to undergo a wide variety of reactions with many different metals. Harriman and Ziessel describe electronic conduction phenomena in photoactive metallowires of various metals, in which carbon-rich linkers form the connections between the metal atoms, or even also act as switching elements. Sternfeld and Rabinovitz discuss the reduction of carbon-rich systems—annulenes, dehydroannulenes, cyclophanes of all kinds, non-planar polycyclic aromatics, fullerenes, and nanotubes—by alkali metals; the species thus formed have been characterized mainly by NMR spectroscopy.

Most of the chapters conclude with experimental details, usually synthetic laboratory procedures, which show

clearly that the book is about synthetic methods and not only about how compounds are formed. Unsaturation is one of the great themes of organic chemistry, whether one is talking about the reactivity of organic compounds or about their structures or physical properties. "Organicists" will continue to carry out research on this subject as long as organic chemistry exists as a branch of chemistry. Finally, it is important to keep in mind that not just the best, but the only possible attitude for chemists is that it does not matter whether the spirit of the times is dominated by the search for new structures or by the search for practical applications.

My only criticism of the book (which, incidentally, has a comprehensive index) is about the title. I would have called this volume "Carbon-Rich Compounds, I", because I think it goes without question that a second volume will soon be necessary in such a rapidly developing field as this.

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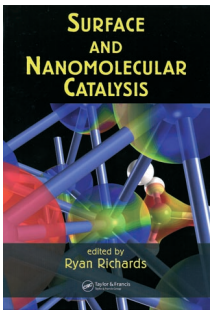
Surface and Nanomolecular Catalysis



Edited by *Ryan Richards*. CRC/Taylor & Francis 2006. 544 pp., hardcover £97.00.—ISBN 1-57444-481-6

In recent years, new instrumentation and experimental techniques that allow scientists to observe chemical reactions and determine molecular properties on the nanoscale have been developed and applied to study catalytic solids at work. This development has expanded our current view of the fundamentals of this field of science and technology, which contributes significantly to the quality of our everyday lives. Furthermore, many of the concepts of nanotechnology have to be translated not only for modeling catalysts, but also for designing and constructing real-life solids with well-defined catalytic functions on the kilogram and tonne scales. Such an endeavor requires a profound chemical knowledge. Insightful textbooks may help us by bringing together different areas and up-to-date expertise of catalysis research in a single volume.

As the title suggests, the new book *Surface and Nanomolecular Catalysis*, edited by Ryan Richards, contains a series of chapters devoted to catalyst characterization, synthesis, surface science, combinatorial catalysis, and a wide variety of catalysis applications. As mentioned by the editor in the foreword, "few terms have been more commonly used and abused in the scientific literature than *nano*". Since heterogeneous catalysts are nanomaterials that literally work, it was in my opinion not necessary to use the term "nanomolecular catalysis", since "molecular catalysis" already implies catalysis concepts on the nanoscale. This small comment aside, I have been impressed by the scientific content, overall quality, and scope of this attractively produced book, and would rate the individual chapters from good to truly excellent. The best and most refreshing contributions are Chapter 3 on "Colloidal Nanoparticles in Catalysis", Chapter 4 on "Microporous and Mesoporous Catalysis", Chapter 10 on "Understanding Catalytic Reaction Mechanisms", Chapter 12 on "Heterogeneous Photocatalysis", and Chapter 14 on "Asymmetric Catalysis by Heterogeneous Catalysts".

As often with multi-author books, the detailed level of each chapter varies significantly, and consequently it is not always clear what is the entrance level of a given chapter. For people not yet familiar with catalysis, the book is not easy to read, and a first introduction to catalysis is clearly needed. All this can be judged from the level at which the authors have chosen to write their introductions, whether it is Masters or PhD student level. In this respect, I was delighted to see that each chapter has at the end a series of questions/problems, although the level of these ranges from merely reproducing knowledge to solving an insightful case study. It is clear that the latter is my preference when using a specific chapter for teaching students. It would also have been good if each chapter had a "further reading" section; unfortunately this has only been done for Chapter 4.

Another point that I have noticed is that some chapters (more specifically those on texturology and skeletal catalysts) do not really fit within the scope of the book, and to omit these would not have made the book weaker. At a more detailed level, I have noticed that the journal abbreviations used in the different chapters are not consistent (e.g., *The Journal of Molecular Catalysis A: Chemical*), and also some figures are not well reproduced (mainly in Chapter 10). The book would also have benefited from a general appendix, especially when it is used in university courses (e.g., with regard to terms and abbreviations in Chapter 4). A final point of criticism is that the material in the chapter on characterization, although this is nicely written as a stand-alone contribution, would have been better if incorporated within the individual chapters on materials synthesis, as has already been partially done by the authors themselves. There is some overlap, for example, on the use of infrared spectroscopy and probe molecules in acid–base characterization of metal oxides and zeolites (page 12 in Chapter 1, pages 50–51 in Chapter 2, and pages 132–134 in Chapter 4).

Summarizing, this is a very interesting contribution, which gives up-to-date views on a wide variety of catalysis topics and their important contributions to different areas of technology. *Surface and Nanomolecular Catalysis* is certainly a valuable book for everyone with an interest in molecular views of heterogeneous catalysis. Furthermore, a selection of individual chapters can be used as a basis for university courses on catalysis at the Masters and PhD student level.

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