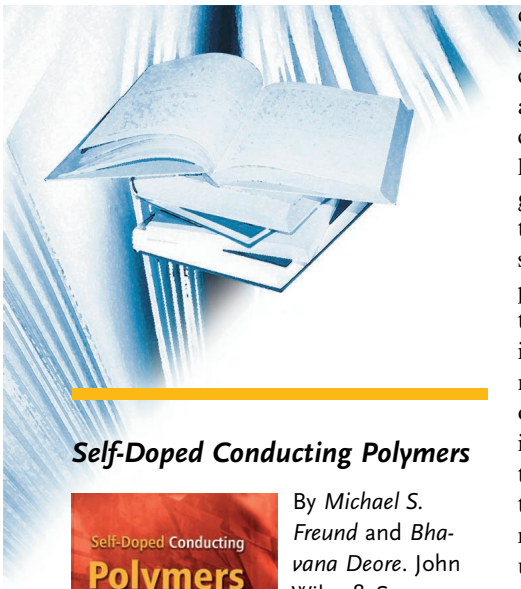
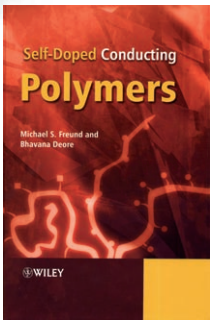


Self-Doped Conducting Polymers



By *Michael S. Freund* and *Bhavana Deore*. John Wiley & Sons, Chichester 2007. 333 pp., hardcover $ 135.00.—ISBN 978-0-470-2969-5

Since the discovery and characterization of conducting polymers, an achievement that is closely associated with the work of the Nobel Prize laureates Heeger, MacDiarmid, and Shirakawa, these systems have become an important theme of materials research. That is mainly because their unconventional properties have led to many practical applications, in areas that range from optoelectronics to artificial muscle. Thus, it is not surprising that, in addition to an enormous number of original publications, more than 60 books devoted to the subject have appeared.

The book reviewed here is concerned with a special aspect of the subject: the properties and synthesis of self-doped conducting polymers. This rather narrowly defined field is receiving intensive research efforts, as is shown by the fact that over 900 publications are cited.

The term "self-doped conducting polymers" is, in principle, misleading, as it implies that these materials are already doped because of their intrinsic structure. That is not the case. Conducting polymers of this type must, like all such systems, be transformed from the neutral state into a charged state (i.e., doped) by oxidation or reduction. The special structural feature of self-doped conducting polymers is that a considerable fraction of the monomer units in a conjugated polymer chain contain covalently bonded ionizable functional groups. In the case of p-doping (oxidation), for example, these groups become stable immobile anions that screen the positively charged polymer backbone, thus maintaining the electrical neutrality of the polymer film, while, simultaneously with the charging process, cations (e.g., protons) move out of the film into the electrolyte solution. Thus, from the viewpoint of an electrochemist, the term "self-ionized conjugated polymers" would be a better, and unambiguous, description of the structural properties of these materials. However, now a look at the contents of the book.

With five chapters and 326 pages, including the index and literature references, this is a book of readable and digestible size. As usual in works of this kind, it begins with a description of the essential properties of conducting polymers, followed by the special characteristics of self-doped polymers. Next come two chapters on self-doped polyanilines, including a section devoted specifically to derivatives with boronic acid as a substituent group, which is a special research topic of these two authors. The next chapter deals with the analogous polythiophenes, and lastly the authors discuss self-doped pyrrole, carbazole, phenylene, phenylenevinylene, and indole derivatives.

All these chapters follow a closely similar structure, beginning with synthesis, which is followed by descriptions of the electrochemical, spectroscopic, and other properties. Applications that have been described in the literature are discussed and explained in detail. An important aspect of the applications is that many self-doped polymers, in contrast to conventional conducting polymers, are soluble, which makes them much easier to process. Furthermore, it is often claimed in the literature that, because the cations are small, the charging and discharging processes occur much faster than in conventional conducting polymers, which makes these systems more suitable for applications.

To summarize, the book offers the reader a very detailed introduction to this highly topical area. An especially pleasing feature of the references is that the titles of the papers are given, which helps one to choose items of interest for further reading. However, it is a little disappointing that the authors have limited themselves very narrowly to simply reporting on the cited literature, without expanding on points that are not covered clearly in the publications, or developing their own views. The overall impression is that the authors have devoted much care and thoroughness to the compilation of a very comprehensive review article, but have only been marginally concerned with presenting a critical and analytical view (see the introduction). Nevertheless, the book can be recommended for materials scientists and chemists as a guide into the literature for further detailed study.

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Enzymatic Reaction Mechanisms

By *Perry A. Frey* and *Adrian D. Hegeman*. Oxford University Press, Oxford 2007. 848 pp., hardcover £ 60.00.—ISBN 978-0-19-512258-9

The title of this book is a compliment to Chris Walsh's original *Enzymatic Reaction Mechanisms* (ERM), published in 1979, which has been the backbone of myriad courses in chemical enzymology, and is still in print today. Walsh put together the first comprehensive single-volume text on the subject, creatively applying the established mechanistic classification of organic reactions to the broad sweep of enzyme chemistry, with the explicit intention of providing "a simple chemical framework for the study and analysis of enzyme-catalyzed reactions". If vast numbers of organic

reactions could be classified into a small number of distinct mechanistic classes, then the organic reactions catalyzed by enzymes should be similarly susceptible. And so, naturally, they are: except that the encounters and constraints involved in the reactions of a pair of substrates brought together in an enzyme active site are somewhat more complicated.

The Walsh ERM is, of course, out of date in many ways, although not in its basic approach. The field has grown enormously since the late 1970s, and its growth points have changed. So too has the need for a successor volume, to the point when it seemed that such broad coverage in a single volume by a single author was no longer a practical proposition. (Truly comprehensive coverage of this multifaceted area has long been impossible.) So Perry Frey and Adrian Hegeman (who is Frey's co-worker at Wisconsin, thereby getting as close to a single-author treatment as we can hope for) have taken on a major challenge, knowing that the bar is high, and aware as they were writing—between 2002 and 2005—that "each chapter became outdated within a few weeks of being written". They have done a fine job.

This is necessarily a substantial volume, but not inordinately so. It actually has fewer pages than that of Walsh, but the pages are larger and the font smaller, so that each page offers some 30% more information. The organization is logical, and not unfamiliar. Chapters 1–5 cover "principles, theory and concepts", although the bulk of the material that these headings suggest is actually covered in the first two substantial chapters, each with over 60 pages. Chapters 3 and 4 deal at similar length with coenzymes (many more are known now than appeared in the classical treatments of the 1970s), and Chapter 5 deals specifically with enzyme inhibition. The rest of the book describes enzyme reactions by type, in order of increasing kinetic complexity: starting with irreversible reactions involving a single substrate and ending (Chapter 18) with what is effectively an introduction to complex enzyme systems—multienzyme complexes, modular enzymes such as the polyketide synthases and non-ribosomal polypeptide synthetases, the ribosome, and energy transduction. The coverage and its depth inevitably reflect the individual authors' interests, but these are broad and the treatment is correspondingly authoritative.

The chapters on reaction types start with a brief overview of the basic chemistry involved, followed by compressed, but often quite detailed, case studies of individual enzymes (in total over 100 enzymes are covered), with relevant leading references (on average more than 100 per chapter). Structure and mechanism are inseparable facets of enzyme chemistry, and each case study comes complete with a representation of the protein structure (inevitably on a small scale), often with a substrate analogue or inhibitor bound to it, a stereochemical ball-and-stick diagram of the active site region, and a molecular representation. The small scale of the structural representations means that these can be no more than indicative, but in each case the reader is referred through the four-character PDB code to the original in the Brookhaven Protein Data Bank. Enzyme Classification (EC) numbers are also given, thereby providing easy access to searchable enzyme databases. A useful introduction to these, and to relevant internet resources in general, follows the authors' preface.

Searching through a substantial book for information can seem hard work compared with on-line and on-computer searching, but this book is organized to make the task as easy as possible, with detailed chapter subheadings in the list of contents and an extensive 22-page index. I have lived with the Frey and Hegeman ERM for a couple of months, while writing another more specialized one in a related area. I have learned a great deal, as also will any interested reader. Most important is the conclusion that this well-written and clearly presented volume has become the unchallenged first point of reference for general questions or topics in chemical enzymology.

A few caveats: no book is perfect, and certainly not a volume of this size.

My first review copy had pages missing or mis-bound, so check your copy when it arrives. I came across a host of trivial errors—misprints, typos, or just spelling mistakes (even one on the cover), figures wrongly numbered, and so on. These can be distracting and even irritating, though they do not detract seriously from the value of this excellent piece of work. Such a single-volume text in a major field, which reflects the experience and coherent thinking of a single author, becomes rarer—and correspondingly more valuable—as fields grow and become more complex. Perhaps when this particular field has matured further, with the super-families all identified and fully characterized, the genomics and proteomics all sorted out, and new generalizations tested and accepted, the task will become simpler again. Meanwhile, this volume will do very nicely. It can be recommended to students at all levels who are learning, teaching, or working in organic, biological, or medicinal chemistry, and in biochemistry, pharmacology, and related subjects, and is a must-have for their libraries.

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