Handbook of Thiophene-Based Materials

The discovery that the conductivity of conjugated organic polymers can be controlled through oxidation or reduction has led to materials combining the electronic and optical properties of traditional inorganic materials with the weight, flexibility, and processability of plastics. As a result, these materials are of considerable fundamental and technological interest, with a variety of applications, including their use in sensors, electrochromic devices, light-emitting diodes, photovoltaic devices, and field-effect transistors. The impact of these materials was widely recognized with the awarding of the 2000 Nobel Prize in chemistry to Alan Heeger, Alan MacDiarmid, and Hideki Shirakawa for the discovery and development of conjugated polymers.

As expected for a field now in its fourth decade, a large number of reviews, monographs, and books have been published on the subject, including the long-standing *Handbook of Conjugated Polymers* (CRC Press, 2007), now in its third edition. However, with the expansive growth of the field, it is becoming more difficult to cover its full scope in a single book, and thus a number of volumes have elected to focus on either a specific application or, as in this case, one important class of conjugated materials. Thiophene-based materials have been the focus of at least two previous books, the most recent of which is the *Handbook of Oligo- and Polythiophenes* (Wiley-VCH, 1999), and thus an updated summary of these important materials in this currently reviewed handbook is overdue. As a consequence of their environmental stability and ease of synthetic modification, polythiophenes are considered to be one of the most versatile classes of conjugated polymers. As a result, oligo- and polythiophenes typically exhibit the greatest amount of synthetic diversity, perhaps the most widespread application, and thus are still broad topics to cover in a single book. To help make the material more digestible, the handbook has been broken into two near-equal volumes, with Volume 1 focusing on synthesis and theory. Volume 2 then continues with a focus on properties and applications, and includes an index for both volumes.

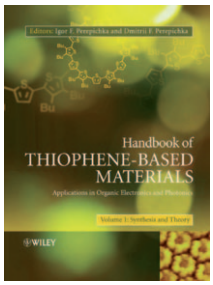
The bulk of Volume 1 is made up of the first two chapters, in which the volume's first third consists of a comprehensive review of oligothiophene-based materials by Bäuerle and co-workers. This chapter encompasses all aspects of oligothiophenes, not only as final materials but also as repeat units of corresponding polymers and building blocks for more complex systems. While this serves as an excellent introduction to the breadth and diversity of thiophene-based materials, dividing the enclosed material into two, or possibly three, chapters would have broken up such a large amount of material better and allowed the reader to more quickly find subsections of interest.

Chapter 2 then continues with a review of regioregular polythiophenes by McCullough and co-workers. Althought McCullough has written several reviews on this subject, the chapter here stands out in that it focuses less on a survey of regioregular materials and more on mechanistic aspects of regioregular polymerizations, as well as in-depth characterization of the resulting materials. Following these two initial chapters, the volume continues with several short chapters on more specialized synthetic topics: fused oligothiophenes (Skabara), thiophene-*S*,*S*-dioxides (Barbarella and Melucci), transition-metal-containing thiophene materials (Wolf), and selenophene materials (Otsubo and Takimiya).

Volume 1 concludes with two chapters covering theory and computational studies. The first is a contribution by Kertesz and co-workers that focuses on the band gap of polymeric materials. The chapter provides a good discussion of both aromatic versus quinonoid character and the attempts to produce low-band-gap materials through the copolymerization of intrinsic aromatic and quinonoid units. The strength of this discussion, however, does make one wish that a corresponding synthetic chapter on low-band-gap materials had also been included, although some of these systems are covered in Chapters 1 and 3. The final chapter by Zade and Bendikov covers a bit of the same ground as Kertesz, but focuses more on oligothiophene materials and is broader in scope.

Volume 2 opens with five chapters covering various material properties including electrochemistry (Blanchard, Cravino, and Levillain), electronic and photonic properties (Hotta and coworkers—2 chapters), liquid crystallinity (Akagi), and self-assembly (Santato, Cicoira, and Rosei). Following these initial chapters is a bridging chapter on PEDOT, one of the most commercially important polythiophenes. This chapter, contributed by Reuter, Kirchmeyer, and Elschner, begins with the preparation, properties, and processing of PEDOT and then transitions into its common applications.

The remaining eight chapters then cover various applications, with the two largest chapters covering OFETs (Facchetti) and LEDs (the Perepichkas). Other topics covered include capacitors (Belanger), FETs (McCulloch and Heeney), photovoltaics (Gevorgyan and Krebs), electrochromics (Sotzing and co-workers), photochromism (Ubaghs, Sud, and Branda), and sensors (Ho and Leclerc). While these chapters survey the applications of thiophene-based materials, a number can



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only be considered an introduction and refer the reader to more expansive reviews.

Overall, this book is a well-referenced introduction to the broad field of thiophene-based materials and their applications. As such, it is a worthy addition to the collection of both those looking to enter the field and the seasoned researcher of conjugated polymers.

Seth C. Rasmussen
Department of Chemistry and Biochemistry
North Dakota State University (USA)

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