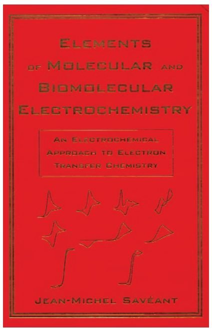
Elements of Molecular and Biomolecular Electrochemistry



An Electrochemical Approach to Electron Transfer Chemistry. By *Jean-Michel Savéant*. Wiley-VCH, Weinheim 2006. 508 pp., hardcover € 125.00.—ISBN 0-471-44573-9

Savéant is a giant of modern electrochemistry. Insightful, elegant, and groundbreaking experiments have poured from his Paris laboratory for more than three decades. Those of us working in the field have long wondered at the combination of rigorous and insightful theory with meticulous voltammetric experimentation that have resulted in kinetic and mechanistic conclusions that are often of an unrivalled precision and clarity. The more so, since electron transfer is at the heart of chemistry—synthetic as well as mechanistic—and the use of the conceptually relatively straightforward cyclic voltammetry experiment offers profound scope for the understanding, in thermodynamic and kinetics terms, of a plethora of chemical reactions and processes.

The scope of voltammetric insight can be appreciated from the following, much abbreviated, list of a few headings and subheadings from Savéant's book: "Redox catalysis", "Product distribution resulting from competition between follow-up reactions", "Coupling of electron transfer with acid-base reactions", "Reduction of carbon dioxide", "H-atom transfer versus electron + proton transfer", "The $S_{RN}1$ substitution", "Conformational changes, isomerisation and electron transfer", "Stepwise versus concerted mechanisms", "Reaction of radicals with nucleophiles", "Role of solvent …", "Enzymatic catalysis"—in short, the chemical conclusions and interpretations are at the cutting edge of the understanding of chemical reactivity, and are therefore of profound significance to all chemists, and especially those working in organic and biological chemistry.

In his book *A Brief History of Time* (1968), Stephen Hawking relates that "someone told me that each equation I included in the book would halve the sales". I fear that Savéant's book writing project may likely bankrupt him. In reality there are two books—probably with quite different readerships—intermingled in this tome, which results from the Baker Lectures given by Savéant at Cornell University in 2002. The first is a characteristically rigorous, insightful, and (to the non-electrochemist) mathematically demanding account of voltammetry. This is what we electrochemists expect of Savéant, and we delight in it. We love the stories, even though surely apocryphal, of draft papers submitted to him by his naïvely communicative students being cruelly edited, so as to eliminate the paragraphs of explanation and the algebraically essential links between the equations that were intended to illuminate the theory for lower-caste electrochemists! One can only speculate about the state of modern voltammetry had Savéant grown up with an English nanny advocating, like Mary Poppins in the musical of the same name, that "*Just a spoonful* of sugar helps the medicine go down … in a most delightful way" (my italics)!

However, the second "half-book" in the work consists of the descriptions of chemical results that emerge beautifully, clearly, and quantitatively from the voltammetry. These are extremely significant and insightful, especially and above all, for organic chemists. For example, it is shown how algebraically simple models of electron transfer can rationalize the chemically diverse kinds of behavior that follow when an electron is added to or removed from a substrate. Such models can explain, for example, whether electron transfer triggers a radical chemistry or an acid–base chemistry. They might also contribute to an understanding of enzymatic catalysis mechanisms, thereby leading to optimized biosensors. These and related issues are of central chemical importance, and I strongly urge the chemical community as a whole to pick up and read Savéant's messages—skim the voltammetry on a first read, but recognize the unique insights into molecular reactivity that it can provide. You may then be so impressed by what electrochemical methods can reveal that you will need to re-read and get know the entirety of this book of two halves.

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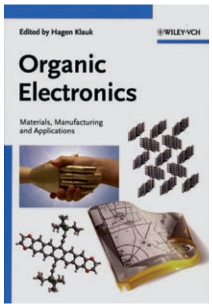
Organic Electronics



Materials, Manufacturing and Applications. Edited by *Hagen Klauk*. Wiley-VCH, Weinheim 2006. 428 pp., hardcover € 129.00.—ISBN 3-537-31264-1

Electronic circuits are fundamental to a myriad of photonic/electronic products, such as displays, computers, cell-phones, household appliances, and sensors. This technology is mainly based on silicon and Groups III–V semiconductors (and other inorganic materials) processed at high temperatures for the production of field-effect transistors. Despite concerns related to physical, technological, and economic limitations, transistor/circuit performance and integration will likely continue to increase according to Moore's law, leading to smaller, faster, and more powerful electronics. The aims of this book, *Organic Electronics*, are to focus attention and shed light on a new technology for producing electronic circuits and devices that are "organic", and possibly "fully printed". This organic-transistor-based technology is not meant to compete with the (poly)crystalline silicon-based electronics industry, but to complement it by challenging us with exciting new science and paving the way for new market opportunities.

The main text of the book consists of 17 chapters divided into four sections. These follow a brief preface in which the editor, Hagen Klauk, summarizes the book's aims and scope. The introductory section consists of Chapter 1 by G. Horowitz, which provides a general overview of semiconductor structure, fundamental differences between organic and inorganic materials, and the design and working principles of organic thin-film transistors (OTFTs). Section II is entitled "Advanced Materials for Organic Electronics", and comprises Chapters 2–7. In Chapter 2, M. Kelly focuses on pentacene, one of the most thoroughly investigated organic semiconductors for OTFTs. He summarizes the pentacene-based TFT performance achieved to date, and describes the main semiconductor deposition parameters and dielectric surface functionalization affecting charge transport characteristics. In Chapter 3, J. E. Anthony goes further, by discussing "engineered pentacenes". This chapter is rich in chemical details of the molecular design and synthesis of pentacene derivatives that exhibit unique crystal-packing motifs and enhanced solubility. Chapter 4 deals with organic semiconductors based on polythiophenes and carbazoles. B. S. Ong, Y. Wu, and Y. Li summarize their main achievements in this area, which are targeted at the stabilization of polythiophene TFT performance under ambient conditions and the design of innovative p-type semiconductors. In Chapter 5, A. Salleo and M. L. Chabinyc focus attention on critical performance parameters during TFT operation. This well-organized chapter discusses the origins of bias stress in polymer TFTs, and summarizes recent electrical stress data for polythiophenes and polyfluorenes. Chapter 6, by M. Halik, describes a different and important type of material for organic TFTs: the gate insulator. The properties of the main insulator classes (inorganics, polymers, and molecular self-assembled layers) are summarized in considerable detail, with special attention to poly(4-vinylphenol)-based TFTs. Finally, in Chapter 7, W. M. MacDonald briefly describes the optical, thermal, and mechanical properties and use of polymeric substrates on which OTFT-based circuits could be fabricated in a roll-to-roll fashion.

Section III is entitled "Manufacturing for Organic Electronics", and comprises Chapters 8–12. In Chapter 8, R. Treutlein and co-authors describe the process of vacuum metallization of plastic substrates, and the applications of the resulting films in the packaging, food, and electronic industries. Chapter 9, by M. Heuken and N. Meyer, discusses the fabrication of semiconducting films by organic vapor-phase deposition, mainly for applications in organic light-emitting-diodes and TFTs. Chapters 10 and 11 highlight methods to deposit/pattern materials (mainly conductors) for OTFTs, and give useful details about how to fabricate organic circuits and displays. These two chapters give a very good summary of the best that can be achieved at present in terms of feature size/resolution without the use of photo/e-beam lithographies. In Chapter 10, H. H. Lee, J. Rogers, and G. Blanchet describe thermal imaging and microcontact printing, whereas in Chapter 11 W. S. Wong and co-authors focus on digital lithography. In Chapter 12, on a related topic, H. Sirringhaus and co-authors first give a very useful introduction to conventional (graphic-art) printing methodologies, and then focus on inkjet-printed TFTs/circuits, especially for backplane applications.

The last section (IV) is entitled "Devices, Applications, and Products", and includes Chapters 13–17. In Chapter 13, G. H. Gelinck and co-authors describe details of the manufacture of integrated circuits, and give a useful analysis of the relationships between transistor properties and circuit performance. Chapters 14 and 15 introduce an exciting application of organic electronics: "flexible" active-matrix displays. H. E. A. Huitema and co-authors (Chapter 14) describe the Phillips philosophy and design principles for rigid/rollable OTFT-addressed displays based on electrophoretic inks. On the other hand, in Chapter 15, S. F. Nelson and L. Shou describe a different approach to displays based on organic light-emitting diodes. The last two brief, but extremely useful, chapters deal with progress on OTFTs for sensor/detection applications. In Chapter 16, T. Someya and T. Sakurai describe pressure sensors for artificial skin and photodetectors for sheet image scanners, whereas in Chapter 17, H. E. Katz and J. Huang focus on OTFT chemical sensors.

This book is well structured, and the individual chapters have been written by leading scientists in each area. The editor has coordinated the large amount of information effectively. I really appreciate the good balance between introductory and advanced topics, between scientific and technological/applications issues, and between materials and device structure/applications. I am somewhat surprised with the lack, in Section II, of a chapter devoted to efforts/issues related to n-channel semiconductors for OTFTs (necessary for organic CMOS) and, in Section IV, of an introduction/application of OTFTs to radio-frequency identification technologies. Nevertheless, this excellent book should be brought to the attention of graduate students as well as industrial and academic researchers interested in organic electronics. It will also provide stimulating ideas for open-minded chemists, physicists, material scientists, and electrical engineers seeking new opportunities in this exciting R & D area. Do not miss it!

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