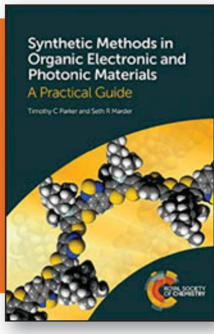


Synthetic Methods in Organic Electronic and Photonic Materials: A Practical Guide

Timothy C. Parker and Seth R. Marder

Royal Society of Chemistry, 2015
296 pages, $110.00
ISBN 978-1-84973-986-3

This book describes synthetic methods for organic chromophores used in optoelectronic applications. It emphasizes the design and synthesis of (electron donor)-(π-bridge)-(electron acceptor) systems, including improving processing and thermo-optical stability.

Chapter 1 includes a history of organic electronics and photonics, including light-emitting diodes, field-effect transistors, nonlinear optics, electro-optics, and photovoltaics. Chapter 2 discusses chromophore design. The authors correlate the optical gap, ionization energy, and electron affinity with descriptors, including Hammett-type parameters, aromaticity indices, and frontier orbital energies. They give strategies for improving processability, followed by a discussion of the relation of intermolecular interactions and charge-transport properties.

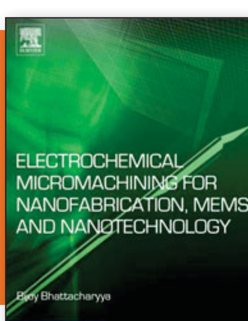
The remainder of the book discusses methods to synthesize the designed chromophores. All of the chapters explain underlying reaction mechanisms and give numerous examples. Chapter 3 includes methods for donor materials synthesis, specifically thiophenes and aryl amines. There is extensive discussion of the safe use of lithium reagents for preparation of various thiophenes. There is also discussion of Grignard reagents, alkylation reactions, thiophene rings, and heteroannulation synthesis.

Chapter 4 deals with the creation of π-conjugated bridges between aromatic intermediates. The reactions discussed include halogenation, Vilsmeier formylation, use of phosphorus reagents, and the Horner–Wadsworth–Emmons reaction. Chapter 5 describes organometallic coupling chemistry. The basic reactions of ligand exchange, oxidative addition, reductive elimination, migratory insertion, and β-hydride elimination are covered, followed by a discussion of the Stille, Kumada, Negishi, Sonogashira, and Heck coupling reactions.

Chapter 6 discusses synthesis of acceptors. There is a discussion of Knoevenagel condensation as well as the chemistry of polymethine dyes, including hemicyanines, merocyanines, and cyanines. Other types of acceptors presented are tetracyanoethylenes, heterocycles, thiadiazoles, pyrazines, diketopyrrolopyrroles, isoindigos, and imides. Chapter 7 focuses on main-chain π-conjugated polymers. There is a good discussion on how to prepare high number average molecular-weight polymers. Synthesis of poly(phenylene vinylene) polymers using the Wittig, Knoevenagel, and Heck methods are described. Formation of aryl-aryl polymers by Stille, Suzuki, and Kumada methods and direct arylation polymerization are also discussed.

This book is a very useful introduction to synthesis methods for optoelectronic materials that are also applicable to electronic materials. There are over 600 references, including all critical books and reviews, along with 19 tables and 137 schemes/figures that support the text well. There is an appendix describing related synthesis of functional materials and a good discussion of lab safety. A materials scientist or advanced student with a background in organic chemistry will be able to enter the organic optoelectronics research field after studying this book.

***Reviewer: Thomas M. Cooper** of the Air Force Research Laboratory, USA.*



Electrochemical MicroMachining for Nanofabrication, MEMS and Nanotechnology

Bijoy Bhattacharyya

Elsevier, 2015
296 pages, $170.00
ISBN 978-0-323-32737-4

This book falls into Elsevier's Micro & Nano Technologies Series. As a teacher who taught a course on microsensors and actuators for over 10 years, I always saw the need for having a book on electrochemical micromachining (EMM) techniques containing good illustrations. Classical books cover this topic in a few pages without emphasizing the principles. Electrochemical machining (ECM) is a topic that requires greater emphasis as a potential method by which devices can be fabricated. It provides continuous production schemes with ease. This book is an excellent addition to the nanotechnology literature.

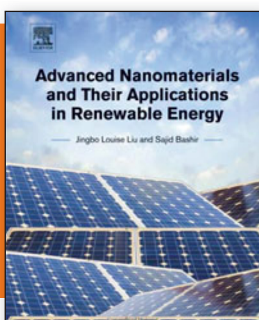
In chapter 1, the author brings out the differences between conventional processing and nanofabrication. He also describes the different elements of microelectromechanical systems and microsystems. Micromachining processes are well illustrated and explained. The advantages and limitations of ECM and EMM are presented to orient the reader to top-down and bottom-up approaches in nanofabrication processes. Chapter 2 is directed toward electrochemical macro- to micromachining. It brings out the versatility of ECM techniques and introduces the reader to fundamentals of electrochemistry. The pathways of a general electrode reaction and electrode processes are explained using Faraday's Laws of electrolysis, Nernst's equation, and Pourbaix diagrams.

Chapter 3 discusses the principle of materials removal in EMM. Appropriately, the author introduces the basic equivalent electrical circuit for a single electrode by using the metal-electrolyte interface as a capacitor. This is followed by a good picture of the inter-electrode gap, and its response to pulse cycle is discussed elegantly. Subsequent discussion of the material removal rate model illustrates the removal of micromachined products through the Butler–Volmer equation.

Chapters 4–12 discuss several technological aspects of ECM, such as types of ECM (chapter 4); ECM setup (chapter 5); design and development of micro tools (chapter 6); influencing factors of EMM (chapter 7); improvements of machining accuracy (chapter 8); advantages, limitations, and applications of EMM (chapter 9); microdevice fabrication (chapter 10); electrochemical microsystem technology (chapter 11); and advancements in EMM of micro- and nanofabrication (chapter 12). The concluding chapter discusses nano features on metals and semiconductors for nanotechnological applications (chapter 13). There is an 11-page index that makes it easy to navigate topics.

The author orients the reader in a logical and systematic manner to power supply requirements, electrolyte feed, optimum factor levels, and process details with impressive illustrations. One drawback of the book is in formatting: the equations in some chapters are numbered, while in others they are not. The book will be very useful to professionals as well as nonprofessionals who are interested in electrochemical micromachining. I strongly recommend this book for scientists, engineers, and those who wish to teach this subject.

***Reviewer: K.S.V. Santhanam** is a professor in the School of Chemistry and Materials Science at the Rochester Institute of Technology, USA.*



Advanced Nanomaterials and Their Applications in Renewable Energy

Jingbo Louise Liu and Sajid Bashir

Elsevier, 2015
436 pages, print and e-book $144.50
ISBN 9780128015285

This e-book linking nanotechnology to renewable energy applications is composed of 436 pages divided into nine chapters. The beginning includes a preface and a glossary of acronyms. Most of the chapters have been written by the main authors, with chapter 7 co-authored by Yeng-Pin Chen. Chapter 6 is exclusively authored by Daqiang Yuan. The book concludes with a summary/post-log.

The first chapter discusses generalities of nanomaterials in terms of their properties and applications. A brief historical perspective of nanotechnology is also provided, followed by a discussion on dimensionality of nanomaterials. The second chapter deals with what I consider the most important aspect: their synthesis via top-down (ball-milling and lithography processes) and bottom-up (sol-gel synthesis) approaches. Since synthesis itself is unable to define the nanoscale character of the materials, the third chapter therefore describes nanocharacterization methods. This chapter also describes indispensable techniques such as transmission electron microscopy (TEM), atomic force microscopy, x-ray diffraction, optical spectroscopy techniques, and x-ray photoelectron spectroscopy.

Chapters 4 and 5 deal with energy production. The fourth chapter briefly overviews important concepts in fuel cells, energy storage, and carbon capture and storage. It also imparts a lot of background knowledge on photovoltaic cells. Toward the end of the chapter, a special section is dedicated to nanocatalyst preparation and nanocharacterization. The fifth chapter on fuel cells examines proton-exchange-membrane fuel cells and the role of Pt-carbon nanotube cathodes in their performance.

Chapters 6 and 7 deal with energy storage and capture via porous materials such as metal–organic frameworks (MOFs). Chapter 6 delves into storage of gases such as CH_4, CO_2, and H_2 in covalent organic frameworks. Chapter 7 provides the implications of fossil fuels used for producing electricity in transportation and industry. It further provides statistics of CO_2 emission in various developed and developing countries. Methods of CO_2 capture and the use of MOFs for the same are examined.

Chapter 8 covers the toxicity of nanomaterials. Nanomaterials, even though a growing field of research and development, have their shortcomings. Environmental implications such as exposure to nanomaterials, their toxicology, and toxicity evaluation are discussed. The reader is made aware of the implications of nanomaterials in everyday life. The ninth chapter is the post-log, bringing forward points that were not discussed in detail in previous chapters.

A positive aspect of this book is the large number of TEM images that have been used to demonstrate the shape, size, morphology, and crystallization of the nanomaterials. This book gives the reader a good overview of nanomaterials in energy-related applications. However, the e-book version of the index could be made more reader friendly by adding sub-subsections and making them available at the click of a button. It would also be helpful to the reader if page numbers were provided in the index.

***Reviewer: Protima Rauwel** of the Institute of Physics, University of Tartu, Estonia.*