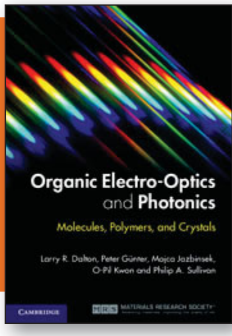


Organic Electro-Optics and Photonics: Molecules, Polymers, and Crystals

Larry R. Dalton, Peter Günter, Mojca Jazbinsek, O-Pil Kwon, and Philip A. Sullivan

Materials Research Society and Cambridge University Press, 2015, 300 pages, $79.99 (e-book $64.00), ISBN 978-0-521-44965-6

In the interest of transparency, MRS is a co-publisher of this title. However, this review was requested and reviewed by an independent Book Review Board.

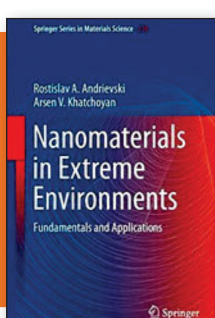
This book provides insight into organic electro-optic materials, from fundamental physics to practical applications. The authors focus on the importance of "photonic integration" as the next step in the long-term development of these materials for computing, telecommunications, and related technologies. This book gives guidance on structure–property relationships needed to improve device performance. It emphasizes second-order nonlinear optical effects in organic materials and their applications.

Chapter 1 provides a history and introduction to nonlinear optical phenomena. Chapter 2 presents the basic theory of the nonlinear optical response, including the nonlinear wave equation and second- and third-order nonlinearities. Chapter 3 focuses on electro-optic phenomena. Topics discussed include the electro-optic effect, frequency and wavelength dependence, and electro-optic modulation. Chapter 4 gives the theory of nonlinear optics from a molecular perspective and experimental techniques for measuring nonlinearities. This chapter also discusses approaches to the design and synthesis of organic electro-optic chromophores. Chapter 5 discusses self-assembled acentric materials, including Langmuir–Blodgett, solution-deposited, and vapor-deposited films. Chapter 6 covers crystalline materials, including crystal-growth methods. There is a discussion of the most promising organic electro-optic crystals.

Chapter 7 focuses on poled polymer systems and discusses optical loss and thermal and photochemical stability. There is a detailed discussion of device fabrication, including silicon photonic, plasmonic, and photonic-crystal hybrid devices. Chapter 8 reviews the device parameters and materials requirements for applications, including telecommunications, computing, and plasmonic devices. Chapter 9 covers electro-optic waveguides, switches, and modulators. There is a description of stripline and resonant electro-optic device structures. There are detailed closed-form solutions of light propagation in slab waveguides and one-dimensional photonic crystals. Chapter 10 focuses on other second-order nonlinear optical effects, including frequency doubling, optical rectification, and difference-frequency generation. Chapter 11 deals with the photorefractive effect and materials, giving detailed theoretical models and methods for measurement of photo-induced refractive index changes. Chapter 12 provides conclusions and projections for the future, forecasting that all-organic devices will evolve into devices integrating organic materials into silicon architectures.

The book reflects the authors' multidecade experience in organic nonlinear optical materials and has very useful comparisons of organic and inorganic materials and the impact of competing technologies. The strengths and weaknesses of organic nonlinear optical materials are presented, where performance is rapidly improved by new materials development, but commercialization is limited by cost and engineering improvements of competing inorganic materials. There are close to 800 references, and extensive materials and figure-of-merit tables are provided. This book is useful as a reference book for researchers and graduate students interested in all aspects of organic nonlinear optics.

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



Nanomaterials in Extreme Environments: Fundamentals and Applications

Rostislav A. Andrievski and Arsen V. Khatchoyan

Springer, 2016
107 pages, $99.00 (e-book $69.99)
ISBN 978-3-319-25329-9

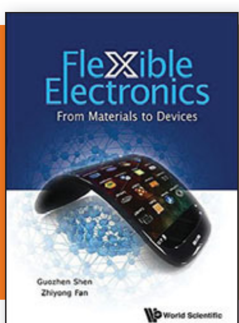
This slim volume is an extensive review of the current understanding of the response of nanostructured materials to extreme operating conditions, such as high temperature, flux of high-energy neutrons, high pressure, mechanical stress, and oxidizing environments. The emphasis is on metallic materials, especially Cu alloys. Graphene-based materials, fullerenes, polymeric materials, nanoglasses, and glass ceramics are not covered.

The book has six chapters, including an introduction and a brief conclusion. The introduction documents the growth of scientific interest in nanostructured materials and stresses the need to study the behavior of nanomaterials under extreme conditions. This chapter also presents Herbert Gleiter's classification of nanomaterials into 12 groups based on the shapes of the nanoscale features and chemical composition of the components of the nanostructure. Chapter 2 deals with the high-temperature environment and the thermodynamics and kinetics of grain growth. The authors identify the lack of reliable thermodynamic data as a key limitation in this field. The discussion brings out the interplay of structural relaxation, redistribution of excess free volume, diffusion, and recrystallization in multicomponent nanostructures at elevated temperature. Chapter 3 focuses on the effects of ion and neutron irradiation on the structure and properties of nanomaterials. The authors effectively highlight recent studies on the radiation tolerance of nanocrystalline oxides and rapid grain growth under irradiation. The material addresses both fission and fusion reactor applications.

Chapter 4 reviews the effects of severe plastic deformation and cyclic loading on nanostructure formation and phase transformation. This chapter also explores the challenge of achieving high density while retaining nanostructural features during processing under extreme loads and high temperatures. Chapter 5 discusses the effects of corrosion on nanomaterials. The behavior of a variety of alloys and high melting point compounds in liquid media and high-temperature oxidizing environments is reviewed. The concluding chapter identifies areas for further research. Each chapter ends with a section on applications and a long list of references. The book has more than 50 plots, micrographs, and schematic diagrams.

The book would have benefited from more careful copy editing of the English language. Moreover, although a list of acronyms is provided at the front of the book, the excessive use of acronyms makes the text difficult to read. However, the integration of theoretical approaches and simulation results with experimental data offers fresh insights into the behavior of nanomaterials. Overall, this book will serve as a useful reference for researchers interested in nanomaterials driven to extremes.

Reviewer: Ram Devanathan *is Technical Group Manager of Reactor Materials and Mechanical Design, Pacific Northwest National Laboratory, USA.*



Flexible Electronics:
From Materials to Devices
Guozhen Shen and Zhiyong Fan, Editors
World Scientific, 2016
476 pages, $178.00 (e-book $142.00)
ISBN 978-981-4651-98-1

This book gives an excellent introduction to flexible electronics, which refers to the science and technology of using flexible materials for manufacturing electronic circuits and optoelectronic devices. Flexible electronics enables wrapping devices into desired shapes and allows compact and efficient layouts to be created. It is considered the next generation of microelectronics, very promising for practical applications in wearable products. The authors present a comprehensive review of the field, aiming to understand this advanced science and engineering paradigm, which has enormous potential.

The book comprises 10 chapters, which provide a detailed introduction of flexible electronics with typical materials and devices. Chapter 1 presents an overview of flexible electronics based on carbon nanotubes. Chapter 2 introduces various nanomaterial-based flexible sensors. Chapter 3 reviews the synthesis, properties, and applications of graphene in flexible electronics. Chapter 4 goes into high-performance flexible electronic circuits by integrating nanowires such as IV, II–VI, and III–V semiconducting nanowires. Chapter 5 focuses on electronic and optoelectronic devices based on graphene for high-frequency electronics and THz technology.

Chapter 6 is concerned with the design of nanostructures for flexible energy conversion and storage, including photovoltaic cells, lithium-ion batteries, and supercapacitors. Chapter 7 deals with next-generation flexible solar cells, such as dye-sensitized, organic, and perovskite solar cells. Chapter 8 illustrates flexible solar cells, with an emphasis on inorganic, organic, and organic–inorganic solar cells. Chapter 9 covers recent advances in fiber supercapacitors based on various nanostructures. Chapter 10 discusses flexible electronic devices based on electrospun microfibers and nanofibers with stretchable behaviors. References are listed at the end of the chapters, and multiple indexes are provided at the end of the book.

This book provides a detailed and comprehensive introduction to flexible electronics based on advanced materials. Most of the materials that are extensively studied today are discussed, such as carbon nanotubes, graphene, typical semiconductors (e.g., Si, Ge, GaAs, ZnO, TiO_2, and InGaZnO) and organics. From there, flexible thin-film transistors, memories, electronic circuits, light-emitting diodes, photodetectors, solar cells, supercapacitors, lithium-ion batteries, and sensors can be fabricated by elaborately designed techniques, most of which are discussed in detail. The book is neither too advanced nor too simple, and is useful as a reference source of materials and devices. The comprehensive summary and review of the published results in the field are remarkably helpful and vital for further developments.

I recommend this book to all interested in flexible electronics, particularly those engaged in the field. It is written at a level appropriate to researchers with a chemistry, physics, electronics, optical, materials, or device background. It is also a good book for advanced undergraduate and graduate students.

Reviewer: Jianguo Lu *of Zhejiang University, China.*