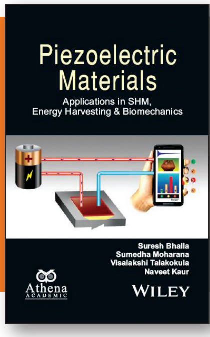


Piezoelectric Materials: Applications in SHM, Energy Harvesting & Biomechanics

Suresh Bhalla, Sumedha Moharana, Visalakshi Talakokula, and Naveet Kaur

Wiley and Athena Academic, 2017
352 pages, $125.00 (e-book $100.99)
ISBN 978-1-119-26509-2

This book, authored by four experts in piezoelectric materials, covers a good range of theoretical and applied topics from the field. It is organized into 11 chapters, and each chapter begins with a brief introduction/background to help readers understand the relevance of the subject. At the end of each chapter, concluding remarks summarize the main points presented. The chapters include an appropriate number of references to the literature, and the majority of figures are informative with good quality.

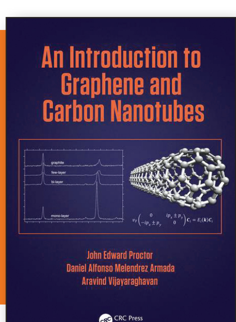
The Introduction presents basic concepts of smart materials and piezoelectric materials and their key applications in structural health monitoring (SHM), piezoelectric energy harvesting (PEH), and biomechanics. The second chapter deals with the following main themes: (1) mathematical formulation of piezoelectricity, (2) selected examples of commercially available piezo-based sensors/actuators for SHM, (3) theoretical and practical description of the electromechanical impedance (EMI) technique, and (4) considerations of one-dimensional and two-dimensional impedance models. These chapters provide a background for students potentially interested in this field but without previous training. However, students must have a good knowledge of mathematics and physics in order to fully understand chapter 2.

Chapters 3–10 are useful as reference material for those working on synthesis and characterization of piezoelectric materials and/or on piezoelectric devices in specialized fields such as biomechanics and energy harvesting. Chapters 3 and 4 address in detail the elasto-dynamic modeling of piezo-transducers for SHM with focus on those based on lead zirconate titanate (PZT). Aspects of fatigue and corrosion damage monitoring are covered in the subsequent three chapters. Only two chapters (8 and 9) are devoted to energy harvesting. They show the analytical models as well as the piezoelectric devices used for this application. The principles of integrated SHM and energy harvesting by PZT patches are also described. Chapter 10 extends discussions of SHM technologies to cover biomedical engineering, emphasizing biomechanics applications. The use of the EMI technique for monitoring the condition of bones and dental implants is presented and discussed.

Chapter 11 looks at the future of piezoelectric materials through the discussion of their emerging applications in SHM, PEH, and biomechanics/biomedical engineering. Three appendices describe the mathematical formulation of the models presented in chapters 2 and 3.

This book provides an excellent introduction to different applications of piezoelectric materials and is a useful reference for upper-level undergraduates who have a background in physics, mathematics, and engineering. It is also suitable for graduate students, engineers, physicists, and researchers interested in this topic, and could be used as a reference guide for professionals working with transducer technologies.

Reviewer: Mariana Amorim Fraga *is a full professor and researcher in the Applied Nanoscience and Plasma Technology Group at Universidade Brasil, Brazil.*



An Introduction to Graphene and Carbon Nanotubes

John Edward Proctor, Daniel Alfonso Melendrez Armada, and Aravind Vijayaraghavan

CRC Press, 2017
302 pages, $89.95 (e-book $80.96)
ISBN 9781498751797

There is continual scientific interest in graphene because of its potential applications in a variety of technologies. This book introduces the structure, properties, synthesis, and applications of graphene and carbon nanotubes (CNTs). The volume has 12 chapters and three appendices.

The first chapter introduces the structure of graphite, graphene, single-walled carbon nanotubes (SWCNTs), and multiwalled carbon nanotubes (MWCNTs). Chapter 2 describes interatomic bonds in carbon-based materials using molecular orbital theory. Hybridized atomic orbitals, σ bonds, and π bonds are used to explain bond lengths, bond energy, and geometry of C–C bonds in different materials. Chapter 3 applies tight-binding theory to explain the electronic properties of graphene. This leads to a discussion of the quantum Hall effect in graphene in chapter 4. Chapter 5 presents the electronic dispersion relation of SWCNTs, semiconducting or metallic nature of a given SWCNT, and curvature effects. Chapter 6 introduces acoustic and optical phonons in graphene and SWCNTs, and chapter 7 covers Raman spectra of graphite, diamond, graphene, and SWCNTs. The mathematical treatment of diffraction using the Laue method is discussed in chapter 8, along with a brief overview of microscopy techniques used to characterize graphene and CNTs.

https://doi.org/10.1557/mrs.2018.25 Published online by Cambridge University Press

Chapter 9 presents several synthesis methods, such as mechanical exfoliation, liquid-phase exfoliation, epitaxial growth, and variants of chemical vapor deposition. Chapter 10 focuses on thermal and mechanical properties of graphene and SWCNTs. This is followed by a discussion of chemical modification of graphene, mainly hydrogenation and fluorination of graphene, in chapter 11. Finally, chapter 12 presents applications of CNTs and graphene in electronic devices, tissue engineering, and drug delivery. Biocompatibility issues are also presented. A set of three appendices deal with Raman scattering, tight-binding theory, and x-ray diffraction.

While there is a rich body of literature on the properties of CNTs and graphene-based materials, this volume is intended to introduce the beginner to fundamental concepts. The book is well written and is at a level accessible to undergraduate students. The text is supported by illustrations, tables, and micrographs. It lacks a list of exercises, although a manual of homework problems and solutions is available from the publisher. There is a sizable list of references at the end of each chapter and an excellent bibliography at the end of the book.

The organization of the chapters is a bit haphazard. For instance, synthesis is buried between characterization and mechanical properties, which is followed by chemical modification. Moreover, there is no discussion of modeling and simulation, which have made key contributions to our understanding of these materials. The authors have also avoided significant discussion of graphene oxide, which has tremendous potential in selective separation and energy technologies. Overall, this volume serves as a good reference for the beginner interested in pursuing research in graphene and related materials.

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

Magnetic Resonance of Semiconductors and Their Nanostructures: Basic and Advanced Applications

Pavel G. Baranov, Hans Jürgen von Bardeleben, Fedor Jelezko, and Jörg Wrachtrup

Springer, 2017
524 pages, $149.00 (e-book $109.00)
ISBN 978-3-7091-1156-7

Spectroscopy of magnetic resonance has become an essential tool for scientists and engineers working in material growth and characterization, film deposition, defect detection, identifying donors and acceptors, and spin manipulation, as well as in medical and health-related fields. With the fast development of nanomaterials research in the past two decades, a book dedicated to research on magnetic resonance of nanomaterials such as this one is of interest to the scientific community.

This book consists of six chapters. The first two chapters lay out the theoretical framework of magnetic resonances, and the following chapters illustrate examples with experimental data and thorough technical discussions for readers to understand. The book provides fundamentals in theory to understand magnetic resonances (magnetic dipoles, magnetic resonance conditions, Bloch equations, g-factor, free induction decay, spin-echo); a comprehensive listing of experimental methods of electron paramagnetic resonance (EPR) spectroscopy; numerous examples of traditional EPR on intrinsic defects (vacancy, interstitial and antisite defects) of semiconductors (diamond, silicon, SiC, GaN, GaAs, and GaP); and more recent high-frequency EPR on wide-bandgap bulk, microscale, and nanoscale semiconductors (AgCl, AgBr, SiC, AlN, GaN, ZnO, InAs/GaAs, diamond).

The last chapter includes a brief discussion on the application of optically detected magnetic resonance (hence enhanced sensitivity in detecting spins) in single spin detection in diamond and SiC nanostructures or single organic molecules. This has gained increasing attention recently because they have possible applications in spintronics and quantum information processing.

What is unique about the book is that chapters 4–6 are developed around specific material systems and are straightforward, especially if the reader works in a particular material system (e.g., diamond or SiC) or a particular application of spectroscopy (e.g., electron nuclear double resonance or optically detected magnetic resonance).

Everyone in related fields (beginners and experts, experimentalists and theorists, and scientists and engineers) can benefit from this book. It includes just enough equations without spending too much time on details. Plenty of helpful figures and tables are provided throughout the book. Many up-to-date references are listed at the end of each chapter if readers want to dig into more detail. This would be a necessary exercise for beginners in order to fully understand the subject matters in the last three chapters. There are no homework problems as this is not really a textbook.

I highly recommend this book. Researchers who have just started working in the field would benefit from reading the whole book, and experienced researchers who want to know the most recent progress in the magnetic resonance spectroscopy of nanostructures could focus on one or two chapters (e.g., chapters 4 and 5).

Reviewer: Gen Long *is an assistant professor in physics at St. John's University, USA.*

https://doi.org/10.1557/mrs.2018.25 Published online by Cambridge University Press