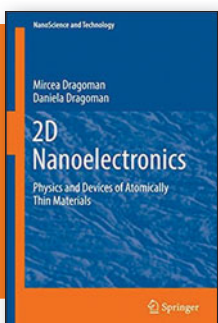
Chapter 13 gives a good outlook for the future in TEM and STEM. The main objectives are to increase beam brightness and decrease aberrations of the lenses used to converge the electron beam. This chapter also describes current attempts for correction of chromatic aberration being developed and presents a bright future for elemental mapping and analytical microscopy with even higher resolution, both spatially and in energy.

Part III (chapters 15–31) describes the theory of imaging with electro-magnetic lenses, the application of Fourier optics to electromagnetic lenses, contrast transfer function, lens aberration, and image processing methods, as well as diffraction theory for a plane wave (TEM) and in convergent-beam electron diffraction. With these theoretical chapters located at the end of the book, the author is able to focus on the concepts important to imaging at the nanoscale in Parts I and II.

The included figures, both electron microscopy photographs as well as schematics, are useful to understand the material covered. The references in each chapter are up to date. The problems included in the book are helpful for students, although I would have liked to have seen more problems in each chapter. The theoretical background is appropriate for graduate students in physical science.

I strongly recommend this book as a resource for electron microscopists with a basic knowledge of TEM and STEM who are interested in advanced imaging and diffraction techniques. The book is up to date on recent developments in electron microscopy.

Reviewer: Lourdes Salamanca-Riba *is a professor in the Department of Materials Science and Engineering, University of Maryland, USA.*



2D Nanoelectronics: Physics and Devices of Atomically Thin Materials

Mircea Dragoman and Daniela Dragoman

Springer, 2017
199 pages, $149.99 (e-book $109.00)
ISBN 978-3-319-48435-8

This is an excellent book on devices based on graphene and other two-dimensional (2D) materials, such as MoS_2, including their physics and applications. The book contains three chapters covering the fabrication and characterization of 2D materials, transistors, and other nanodevices and acts as a user guide for researchers working with atomically thin materials in applied physics.

Chapter 1 consists of four parts discussing physics and applications of graphene-based nanostructures and their applications in optoelectronics and sensors. The chapter starts with bondings between atomic orbitals, interaction between carbon atoms, their allowed energy states, and the density of charge carriers derived using a quantum mechanical approach. Functionality of graphene-based field-effect transistors (FETs), diodes, detectors and receivers, sensors, and photonic devices are discussed. Allowed energy states, density of states, carrier density, mobility, and other physics parameters in these nanodevices are derived by employing the tight-binding approximation, Drude model, and Dirac spinor method. Gate voltage-dependent current–voltage (I–V) characteristics of graphene FETs are well explained. Conduction mechanisms, current density equations, and I–V characteristics of various types of graphene-based diodes are also covered.

Chapter 2 deals with various growth process mechanisms of 2D materials, such as chemical vapor deposition, physical vapor deposition, bottom-up approach, and top-down method. Growth of transition metal dichalcogenides (TMDs), semimetal chalcogenides, and 2D alloys are covered. Typical mechanical properties and optical properties are tabulated with the help of literature. Band diagrams of several TMDs, thickness-dependent band structures, band structures of bilayer-monolayer TMDs, vertical heterostructures, photoexcited heterostructures, and van der Waals heterostructures are discussed.

Electronic devices such as transistors, diodes, and optoelectronic devices based on atomically thin materials are covered in chapter 3. Schottky barriers at monolayers, unwanted tunnel currents, mobility, and other electrical properties in different device structures are briefly described. Highly bendable MoS_2 FETs, dual-gate MoS_2 FETs, radio-frequency MoS_2 transistors, and self-aligned FETs and their I–V characteristics with typical working conditions are described. Electronic injection and band diagrams of graphene-based heterostructures, MoS_2/WSe_2, black phosphorous/$SnSe_2$, and nonvolatile memory based on MoS_2/graphene heterostructures are discussed. Absorption spectrum of MoS_2 monolayers and exciton binding energy of some TMDs are briefly described. Graphene/MoS_2 photodetectors and their quantum efficiency, expression for gain, and the functionality of such photo-devices are clarified. In_2Se_3 and WSe_2-based photodetectors and the world's thinnest lens made with a MoS_2 layer are also mentioned.

This is an outstanding book covering a range of nanodevices based on 2D materials. Fundamental properties and fabrication methods of recent 2D materials are well covered. It is targeted toward researchers rather than students. There are no solved problems or homework problems. Up-to-date references are given at the end of each chapter. The written material is augmented with many excellent figures, diagrams, illustrations, and images. I strongly recommend this book to researchers interested in device fabrication based on 2D materials.

Reviewer: K. Kamala Bharathi *is an assistant professor at the SRM Institute of Science and Technology, India.*