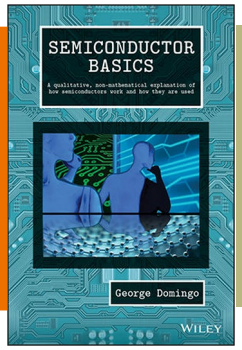

Semiconductor Basics: A Qualitative, Non-mathematical Explanation of How Semiconductors Work and How They Are Used

George Domingo

Wiley, 2020
320 pages, $95 (eBook $76)
ISBN: 9781119702306

Starting from the very first discoveries that led to today's semiconductor revolution, this book is a good resource for anyone interested in building a foundation in semiconductors. The book is structured into 15 chapters with qualitative explanations of the subject of interest followed by some mathematical formulations in the appendix at the end of most of the chapters for those who are interested in deeper reading. Chapter 1 chronologically presents the scientific advances, both theoretical and experimental, that led to Niels Bohr's planetary model of the atom. It touches upon the important facts and brief stories about the inventors in a narrative format. Chapter 2 introduces the concept of three major types of materials—conductors, insulators, and semiconductors—and explains the idea of band formation in solid materials with analogies and simple examples. Major semiconductor materials, their properties, and the theory of doping are the topics of interest in chapter 3. The concept of the Fermi level in *n*- and *p*-type semiconductors is explained with the help of energy band diagrams in the appendix of chapter 3.

Chapter 4 discusses one of the applications—that is, the theory and principle of operation of infrared detectors. The beautiful images and simple explanations of intrinsic, extrinsic, and compound semiconductors are more than enough to create an interest in the topic in anyone's mind. Chapter 5 portrays different types of semiconductor diodes. Starting from *p*–*n* junction fundamentals, it then proceeds to the details of various biases of semiconductor diodes. The principles of operation of Schottky and Zener diodes are well-explained with the help of pictures and analogies. For a deeper understanding, more detailed explanations of some concepts are provided in the appendix of chapter 5. Chapter 6 introduces the fundamental concepts of resistance, capacitance, and inductance before proceeding to the discussion of practical circuits of *p*–*n* junction devices. Applications of *p*–*n* junction diodes such as solar cells, rectifiers, clipping and clamping circuits, current protection circuits, and voltage doubler circuits are briefly outlined with the help of circuit diagrams in chapter 7.

Chapter 8 examines a very important component in modern electronic circuits: transistors. The chapter begins by explaining the concept of transistors with the help of a simple fluidics analogy followed by the theory and operation of the first type of transistor, the bipolar junction transistor. The structure, modes of operation, and characteristic performance curves are well explained with the help of diagrams. Two types of field-effect transistors (FETs)—junction FETs and metal oxide semiconductor FETs—are also described in detail with different fabrication/operation conditions.

Chapter 9 explains three different types of transistor biasing used to retain the characteristics of transistors during device operations whereby stable circuit performance is attained. Starting from the more complex emitter feedback bias, the design and operations of the emitter, collector, and fixed base biasing of transistors are discussed in separate sections. The selection of operating values, voltages, and currents of the transistor based on the characteristic curves and the conditions of functional and stable operation are explained with the help of circuit diagrams and flow diagrams. A brief introduction to operational amplifiers, including the concept of differential amplifiers, is also provided. Chapter 10 briefly explains the different stages involved in the fabrication of integrated circuits, including the methods of preparation of a silicon boule, its further processing into wafers, and, finally, the photolithographic technique of fabricating the integrated circuits into these wafers. The chapter also outlines the transistor processing techniques and the method of testing the integrated circuit wafers for any defects or imperfections. Resources such as YouTube links are included, which can help the reader with an easy visualization of the narrated theory.

Chapter 11 starts with the basics of Boolean algebra and logic circuits, and then presents the actual circuit implementations of logic circuits using the semiconductor devices. Furthermore, circuit diagrams and truth tables elaborate upon the applications of logic circuits in performing digital arithmetic calculations such as addition, subtraction, multiplication, and division. Chapter 12 describes large electronic system components such as multiplexers and demultiplexers, registers, and different types of memories in devices such as computers and cell phones. Chapter 13 is devoted to the field of optoelectronics. The effects of light on semiconductors and *p*–*n* junction devices are elaborated in applications such as photodiodes, lasers, and light-emitting diodes. Different types of lasers are explained in detail and the important applications are summarized.

Chapter 14 provides an inside view of the operation of computers and microprocessors based on semiconductor devices. The design and operation of liquid-crystal displays (LCDs) are also included in this chapter, as one of the main components of LCDs is a semiconductor device, thin-film transistor.

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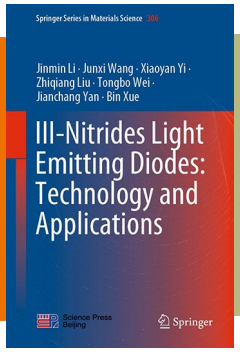
Chapter 15 describes semiconductor technology in a nutshell, including the past, challenges with current silicon-based technology, and futuristic research areas. The book concludes by outlining some of the innovations in silicon technology.

As the title of the book implies, this is a qualitative volume on semiconductor theory and applications with numerous analogies, real-world examples, some inspiring history, and extra resources. The well-written book succeeds in explaining the major concepts with less mathematical complexities and can be a good resource at the undergraduate level, and can also be an asset to anyone interested in having a comprehensive overview of the electronics field.

***Reviewer: Jyothirmayee Aravind S.S.**, Wright State University, USA.*



III-Nitrides Light Emitting Diodes: Technology and Applications

Jinmin Li, Junxi Wang, Xiaoyan Yi, Zhiqiang Liu, Tongbo Wei, Jianchang Yan, Bin Xue

Springer, 2020, 285 pages
$149.99 (eBook $109)
ISBN: 9789811579486

Different semiconductor materials have been investigated and employed in the manufacturing of light-emitting diodes (LEDs). Among them, this book focuses on III-nitride materials. In its 12 chapters, the book addresses topics including basic principles and concepts of LED technology, properties and growth of III-nitride materials, chip fabrication, packaging, and important applications of LED devices. It is illustrated with numerous informative figures and tables. In addition, the fundamental equations and calculations are clearly explained. There is also a comprehensive list of references at the end of each chapter. These characteristics make the book easy to understand.

Although the book is not divided into sections, I consider that the chapters from 2 to 12 could be grouped into four parts: (i) LED and III-nitride materials: principles, properties and growth (chapters 2–4); (ii) multiple quantum-well materials and quantum efficiency enhancement technology (chapters 5–7); (iii) fabrication, packaging, and reliability analysis of III-nitride LED chips (chapters 8–10); and (iv) LED applications and novel nitride LED technology (chapters 11 and 12).

The first chapter not only is a good introduction to the history and evolution of LED devices, but it also presents an overview of the LED materials and highlights the recent advances of III-nitride LED technology. Chapter 2 presents the basic principles of LEDs, such as luminescence, radiative and nonradiative recombination, quantum efficiency, electrical characteristics, and realization methods of white LEDs. In the subsequent chapter, the authors address the properties of III-nitride LED materials, including crystal structure and band structure, polarization effects, doping, and a summary of the analysis techniques used to investigate the structure, morphology, chemical composition, and photoelectric properties of these materials. Chapter 4, the longest chapter of the book, presents epitaxial growth of III-nitride LED materials. This chapter covers basic models of epitaxy, substrates, and the following growth methods: liquid phase epitaxy, molecular beam epitaxy, metal–organic chemical vapor deposition (MOCVD), and hydride vapor phase epitaxy. It also discusses the two-step growth method for MOCVD nitride materials and the influence of growth conditions on epitaxial layer quality of III-nitride materials. Finally, the last section of this chapter deals with the technology for epitaxial growth of high-quality gallium nitride (GaN) on silicon carbide (SiC) substrates.

The InGaN/GaN multiple-quantum-well materials, their properties, and their effects on blue and green LEDs are discussed in chapter 5, which also provides an overview on semi-polar and non-polar LEDs. Chapter 6 is devoted to AlGaN-based multiple-quantum-well materials and UV LEDs. The electrical and optical properties of AlGaN materials are presented as well as techniques for their epitaxial growth and doping. This chapter ends with an introduction to the design and fabrication of AlGaN-based UV LEDs. Chapter 7 summarizes the III-nitride LED quantum efficiency improvement technology. The five topics related to improvement technology addressed in the chapter are structures of LEDs, internal quantum efficiency, light extraction efficiency, current injection efficiency, and the droop effect.

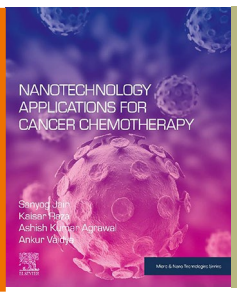
This book has a great deal to offer those who are interested in or want to know more about fabrication, packaging, and reliability of III-nitride LED chips. Chapter 8 presents in detail the following fabrication processes and technologies for III-nitride LEDs: photolithography, etching, metallization, electroplating technology, and bonding technology. Chapter 9 covers all key topics related to LED packaging, such as materials, design, processes, technologies, and latest trends. The failure modes, failure analysis, LED aging tests, aging mechanisms, and LED system reliability are discussed in chapter 10.

I especially liked the last two chapters focused on LED technology and applications. Chapter 11 contains many interesting LED applications including displays, plant breeding, and medical

treatments for neonatal jaundice, hemorrhoids, wound healing, oral ulcer inflammation, joint pain, and medical treatment for beauty. Chapter 12 details the novel nitride LED technology by presenting some examples, such as GaN-based nanorod LEDs, quantum dot LEDs, surface plasmon enhanced GaN-based LEDs, and GaN-based polarizing LEDs.

I believe that this book is quite useful for students and professionals interested in or working on III-nitride LEDs. Although the book has no exercises, it could be a good textbook for undergraduate and graduate courses in electrical engineering, microelectronics, physics, and materials science with a focus on different aspects involving LED technology.

***Reviewer: Mariana Amorim Fraga**, visiting professor at the Universidade Federal de São Paulo, Brazil.*



Nanotechnology Applications for Cancer Chemotherapy

Sanyog Jain, Kaisar Raza, Ashish Kumar Agrawal, Ankur Vaidya

Elsevier, 2020, 702 pages
$200 (eBook $200)
ISBN: 9780128178461

This book covers a broad range of topics in nanotechnology and cancer chemotherapy. The style of writing is clear and concise, and the material is well presented. This book is an excellent introduction for postgraduate students and researchers in the field of pharmaceutics and cancer management. There are other books on similar topics, but this is one of the most comprehensive in its wide and thorough coverage, with in-depth discussions of basics and applications ranging from fundamental aspects of oncology, progression of the disease, and cancer microenvironment to drug delivery and nanocarrier-based therapeutic inventions for cancer management. The contents of the book are up-to-date, and it provides researchers with comprehensive knowledge supported by useful schematic diagrams, tables, illustrated figures, and adequate numbers of references for each chapter. It is written from a combined perspective of nanotechnology, pharmaceutics, and medicinal points of view and includes 29 main chapters. Each chapter starts with a brief introduction of the topics to be covered and concludes with further reading and references.

Chapter 1 begins with a discussion of the basic pathology and etiology of tumors and introduces an overview of the composition of tumors, genetics of cancers, and tumor microenvironment. The next four chapters discuss the factors and techniques that affect enhanced permeability and retention, how nanoparticulate systems can accumulate only in the tumor sites, pH-sensitive nanocarriers for drug delivery to tumor sites, drug release properties, toxicity, conventional chemotherapy treatments like hyperthermia, and cancer diagnosis by using magnetic nanoparticles and by applying the magnetic resonance imaging technique on the magnetite and maghemite nanoparticles. Chapters 6 and 7 focus on the chemotherapeutics, the different types of ligands used for tumor targeting, the progression and the therapeutic targeting of tumor sites, and the normal physiological conditions required to balance the level of the activator and inhibitor molecules that cause an increase in blood vessel growth and lead to abnormal conditions or disease. Chapter 8 covers the different fundamental aspects of the immune and biological therapy of cancer. Chapters 9 and 10 detail the different types of chemical linkers, targeting of tumors using cleavable and noncleavable linkers, the mechanisms of cellular uptake, and cancer targeting by the cell-penetrating proteins. Chapter 11 presents a brief introduction to the synthesis and stabilization of nanoparticles by different dry and wet chemical methods in solutions and their application in cancer diagnosis and chemotherapy. Chapters 12 and 13 provide details of the development of photodynamic cancer therapy and drug delivery systems based on small interfering RNA (siRNA) in different cancers. Chapter 14 deals with the different types of highly active short single-strained nucleic acids used for cancer therapy, like target-specific aptamers and their applications for early cancer detection. Chapters 15 and 16 provide information on cancer stem cells in improving therapeutics, nanomaterials in targeting cancer, stem cells for cancer therapy, and targeting breast cancer. Chapters 17, 18, and 19 cover the different classes of lung cancers, colorectal cancer, and hepatic cancer. Chapter 20 discusses the different types and strategies to evade solid tumors. Chapters 21 and 22 cover pancreatic cancer, its early diagnosis, and the targeting to the central nervous system for brain tumors. Chapters 23–25 discuss metastatic cancer and bone-resorption therapy, prostate cancer and its specific enzymes, and the different types of leukemia. Chapters 26–28 introduce brief discussions of tumor imaging and their applications in tumor-targeting and drug delivery and cell culture to mimicking the tumor microenvironment *in vitro* and *in vivo* of animal models. In chapter 29, the authors end the book by discussing the regulatory aspects, clinical development, and market potential of the nanosystems.

In conclusion, the authors have succeeded in discussing different issues of cancer chemotherapy to explain cancer microenvironments. This approach will allow the book to be useful for many years and not become dated as many textbooks do even before they are

published. Overall, this book will serve as an important addition to the libraries of those interested in cancer management. I can recommend this book without hesitation to all interested in pharmaceutics and medicine, and particularly to those entering the field of cancer management.

Reviewer: Walid M. Daoush *is a professor of nanomaterials at Helwan University, Egypt.*

2022

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