



magnetic fields on transport properties of solids, effects of magnetic impurities, and their interaction are explained. The Anderson model, Kondo effect, and RKKY interactions in solids are discussed using quantum approaches.

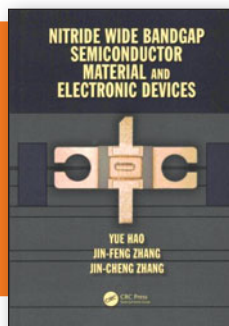
Part XIII (five chapters) is provided as a special advanced topic dedicated to strongly correlated systems, high-temperature superconductivity, artificial structures and patterned materials, and the quantum Hall effect. This part is useful for researchers working in strongly

correlated systems. Graphene, carbon nanotubes, and fullerenes are discussed with beautiful schematics. The electronic properties and band structure of graphene, as well as the effects of magnetic field on their structure and the quantum Hall effect, are treated with quantum approaches.

This is an outstanding book covering fundamental concepts and advanced theories explaining classical and quantum phenomena in solids. Solving the homework problems given at the end of each

chapter will provide students with an in-depth understanding of the concepts. This is an advanced-level book on traditional solid-state physics. I strongly recommend it to all undergraduate, master's level, and research students interested in learning solid-state physics.

**Reviewer: K. Kamala Bharathi** of the National Institute of Standards and Technology, USA, and the Department of Physics, SRM Institute of Science and Technology, Kattankulathur, India.



### Nitride Wide Bandgap Semiconductor Material and Electronic Devices

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This book illustrates how incredibly far the technology of gallium nitride-based electronic devices has progressed in the past 25 years. Gallium nitride transistors are commercially available and are preferred over their silicon counterparts for high-frequency and high-power electronics.

This volume emphasizes transistors. Optoelectronic devices, such as light-emitting diodes and laser diodes, are not covered. Chapter 1 gives an overview of the applications of gallium nitride-based devices. Chapters 2–7 discuss specific electrical properties of the nitrides, the standard procedures (atomic force microscopy, x-ray diffraction) for characterizing their structural properties, and the growth methods that have been optimized to produce high-quality thin films. Chapter 4 explains the underlying physics responsible for forming a two-dimensional electron gas at a heterojunction. The growth of specific heterostructures is covered in chapters 5 (AlGaIn/GaN) and 7 (InAlIn/GaN). Chapter 8 describes crystalline defects and residual impurities, which are important in GaN-based devices because they are unavoidable with the current technology.

This includes methods for their identification and how they vary with different process conditions, as, for example, the tendency for nitrogen polarity materials to more readily incorporate oxygen than gallium polar GaN. Chapter 9 covers the principles and performance of the most widely employed GaN-based transistor: the high-electron-mobility transistor (HEMT). Chapter 10 covers the steps for fabricating HEMTs, including etching, metal contact formation, and surface passivation. High temperatures and high electrical fields can deteriorate the performance of GaN HEMTs; chapter 11 reports on the fundamental causes and their remedies. GaN HEMTs are most frequently on devices, but enhancement mode devices have been developed, and their structures and operations are delineated in chapter 12. To reduce leakage currents, insulating layers have been added under the gate to create GaN metal oxide semiconductor (MOS) HEMTs, covered in chapter 13.

Chapter 14 discusses areas likely to see further research and advances, including the use of nitrogen polar materials (advantageous for lower contact resistances and higher operating frequencies), Al-rich

materials for ultrawide-bandgap devices with higher breakdown voltages, GaN on diamond for better heat dissipation, power electronics, terahertz frequency devices, and the use of silicon as a substrate. The authors conclude with the prediction that nitride semiconductors will be the successor to silicon. Even with all of its technological progress, only the surface has been scratched on what is possible, given their current advantages and tremendous potential for further improvements and cost reduction.

For some chapters, the authors provide passing coverage of the topic based primarily on their own work, giving minimal exposure to research results by others. Generally speaking, this is fine, as their studies are thorough, as is their depth of understanding. The majority of references cited in the book are from 2011 and earlier. Thus, even the authors' most recent studies on enhancement mode transistors and interface traps in Al<sub>2</sub>O<sub>3</sub>/AlGaIn/GaN MOS field-effect transistors are not included. Several of the most recent trends in gallium nitride electronics are covered either sparsely or not at all, including vertical power devices and GaN transistors on bulk substrates. The inclusion of homework problems would have made it more practical as a course textbook. Still, this is an appealing book for introducing state-of-the-art practices and current research on GaN transistors.

**Reviewer: J.H. Edgar** of the Department of Chemical Engineering, Kansas State University, USA.