Gallium Nitride Gan Physics Devices And Technology Devices Circuits And Systems

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Gallium Nitride Processing for Electronics, Sensors and Spintronics - Stephen J. Pearton 2006-02-24
Semiconductor spintronics is expected to lead to a new generation of transistors, lasers and integrated magnetic sensors that can be used to create ultra-low power, high speed memory, logic and photonic devices. Useful spintronic devices will need materials with practical magnetic ordering temperatures and current research points to gallium and aluminium nitride magnetic superconductors as having great potential. This book details current research into the properties of III-nitride semiconductors and their usefulness in novel devices such as spin-polarized light emitters, spin field effect transistors, integrated sensors and high temperature electronics. Written by three leading researchers in nitride semiconductors, the book provides an excellent introduction to gallium nitride technology and will be of interest to all reseachers and industrial practitioners wishing to keep up to date with developments that may lead to the next generation of transistors, lasers and integrated magnetic sensors.
GaN Power Devices and Applications - Alex Lidow 2021-10
GaN Power Devices and Applications, provides an update on gallium nitride (GaN) technology and applications by leading experts. It includes detailed descriptions of the latest examples of GaN's usage in power supplies, lidar systems, motor drives, and space applications.
Thermal Management of Gallium Nitride Electronics - Marko Tadjer 2022-07-15
Thermal Management of Gallium Nitride Electronics outlines the technical approaches undertaken by leaders in the community, the challenges they have faced, and the resulting advances in the field. This book serves as a one-stop reference for compound semiconductor device researchers tasked with solving this engineering challenge for future material systems based on ultra-wide bandgap semiconductors. A number of perspectives are included, such as the growth methods of nanocrystalline diamond, the materials integration of polycrystalline diamond through wafer bonding, and the new physics of thermal transport across heterogeneous interfaces. Over the past 10 years, the book's authors have performed pioneering experiments in the integration of nanocrystalline diamond capping layers into the fabrication process of compound semiconductor devices. Significant research efforts of integrating diamond and GaN have been reported by a number of groups since then, thus resulting in active thermal management options that do not necessarily lead to performance derating to avoid self-heating during radio frequency or power switching operation of these devices. Self-heating refers to the increased channel temperature caused by increased energy transfer from electrons to the lattice at high power. This book chronicles those breakthroughs. Includes the fundamentals of thermal management of wide-bandgap semiconductors, with historical context, a review of common heating issues, thermal transport physics, and characterization methods Reviews the latest strategies to overcome heating issues through materials modeling, growth and device design strategies Touches on emerging, real-world applications for thermal management strategies in power electronics
Gallium Nitride-enabled High Frequency and High Efficiency Power Conversion - Gaudenzio Meneghesso 2018-05-12
This book demonstrates to readers why Gallium Nitride (GaN) transistors have a superior performance as compared to the already mature Silicon technology. The new GaN-based transistors here described enable both high frequency and high efficiency power conversion, leading to smaller and more efficient power systems. Coverage includes i) GaN substrates and device physics; ii) innovative GaN -transistors structure (lateral and vertical); iii) reliability and robustness of GaN-power transistors; iv) impact of parasitic on GaN based power conversion, v) new power converter architectures and vi) GaN in switched mode power conversion. Provides single-source reference to Gallium Nitride (GaN)-based technologies, from the material level to circuit level, both for power conversions architectures and switched mode power amplifiers; Demonstrates how GaN is a superior technology for switching devices, enabling both high frequency, high efficiency and lower cost power conversion; Enables design of smaller, cheaper and more efficient power supplies.
Nitride Semiconductors and Devices - Hadis Morkoç 1999-09-28
This timely monograph addresses an important class of semiconductors and devices that constitute the underlying technology for blue lasers. It succinctly treats structural, electrical and optical properties of nitrides and the substrates on which they are deposited, band structures of nitrides, optical processes, deposition and fabrication technologies, light-emitting diodes, and lasers. It also includes many tables and figures detailing the properties and performance of nitride semiconductors and devices.
Gallium Nitride (GaN) - Farid Medjdoub 2017-12-19
Addresses a Growing Need for High-Power and High-Frequency Transistors Gallium Nitride (GaN): Physics, Devices, and Technology offers a balanced perspective on the state of the art in gallium nitride technology. A semiconductor commonly used in bright light-emitting diodes, GaN can serve as a great alternative to existing devices used in microelectronics. It has a wide band gap and high electron mobility that gives it special properties for applications in optoelectronic, high-power, and high-frequency devices, and because of its high off-state breakdown strength combined with excellent on-state channel conductivity, GaN is an ideal candidate for switching power transistors. Explores Recent Progress in High-Frequency GaN Technology Written by a panel of academic and industry experts from around the globe, this book reviews the advantages of GaN-based material systems suitable for high-frequency, high-power applications. It provides an overview of the semiconductor environment, outlines the fundamental device physics of GaN, and describes GaN materials and device structures that are needed for the next stage of microelectronics and optoelectronics. The book details the development of radio frequency (RF) semiconductor devices and circuits, considers the current challenges that the industry now faces, and examines future trends. In addition, the authors: Propose a design in which multiple LED stacks can be connected in a series using interband tunnel junction (TJ) interconnects Examine GaN technology while in its early stages of high-volume deployment in commercial and military products Consider the potential use of both sunlight and hydrogen as promising and prominent energy sources for this technology Introduce two unique methods, PEC oxidation and vapor cooling condensation methods, for the deposition of high-quality oxide layers A single-source reference for students and professionals, Gallium Nitride (GaN): Physics, Devices, and Technology provides an overall assessment of the semiconductor environment, discusses the potential use of GaN-based technology for RF semiconductor devices, and highlights the current and emerging applications of GaN.
Gallium Nitride & Related Wide Bandgap Materials & Devices - Roy Szweda 1997-01-01
Spiral Bound. The first edition of GaN & Related Wide Bandgap Materials & Devices provides a detailed insight into the global developments in GaN, SiC and other opto and electronics materials over the next 5 years and the implication for both suppliers and users of GaN technology.This new profile has been compiled by the publisher of III-Vs Review and has been designed to supply answers to your business decision making and corporate strategy questions by providing detailed market information including: - Market figures and forecasts to 2001. End user application and device market analysis. Geographical demand and supply - North America, Japan, Europe and Rest of World. Analysis of key industry trends:

GaN versus SiC for LEDS and lasers, electronic and optoelectronic devices, white lamp replacements, MOVPE and MBE technologies

Gallium Nitride and Related Wide Bandgap Materials and Devices - R. Szweda 2000-07-07

The second edition of Gallium Nitride & Related Wide Bandgap Materials and Devices provides a detailed insight into the global developments in GaN, SiC and other optoelectronic materials. This report also examines the implication for both suppliers and users of GaN technology. For a PDF version of the report please call Tina Enright on +44 (0) 1865 843008 for price details.

Aspencore Guide to Gallium Nitride - Maurizio Di Paolo Emilio 2021-01-20

As silicon reaches its theoretical performance limits for power electronics, industry is shifting toward wide-bandgap materials like Gallium Nitride (GaN), whose properties provide clear benefits in power converters for consumer and industrial electronics. In over 150 pages covering the technology, its applications, markets and future potential, this book delves into GaN technology and its importance for power electronics professionals engaged with its implementation in power devices. The properties of GaN, such as low leakage current, significantly reduced power losses, higher power density and the ability to tolerate higher operating temperatures, all from a device smaller than its silicon-only equivalent, provide design advantages allowing previously unimaginable application performance. As an alternative to silicon, GaN can provide clear benefits in power converters for consumer and industrial electronics; chargers for wireless devices, including 5G; driver circuits for motor control; and power switches in automotive and space applications.The book also explores why GaN-based devices hold the key to addressing the energy efficiency agenda, a key strategic initiative in increasingly power-reliant industries such as data centers, electric vehicles, and renewable energy systems. Highly efficient residential and commercial energy storage systems using GaN technology will enable distribution, local storage, and on-demand access to renewable energy. Continued progress in the battery market will lead to declining battery costs and the development of smaller batteries that pair with GaN technology-based converters and inverters. Thermal management is critical in power electronics, and high efficiency in higher-power systems is always a focus. With GaN, a 50% reduction in losses can be achieved, reducing the costs and area required to manage heat. The book delves into GaN's electrical characteristics and how these can be exploited in power devices. There are also chapters that cross into the key applications for GaN devices for several markets such as space, automotive, audio, motor control and data centers. Each chapter provides a comprehensive overview of the subject matter for anyone who wants to stay on the leading edge of power electronics.

Gallium Nitride Power Devices - Hongyu Yu 2017-07-06

GaN is considered the most promising material candidate in next-generation power device applications, owing to its unique material properties, for example, bandgap, high breakdown field, and high electron mobility. Therefore, GaN power device technologies are listed as the top priority to be developed in many countries, including the United States, the European Union, Japan, and China. This book presents a comprehensive overview of GaN power device technologies, for example, material growth, property analysis, device structure design, fabrication process, reliability, failure analysis, and packaging. It provides useful information to both students and researchers in academic and related industries working on GaN power devices. GaN wafer growth technology is from Enkris Semiconductor, currently one of the leading players in commercial GaN wafers. Chapters 3 and 7, on the GaN transistor fabrication process and GaN vertical power devices, are edited by Dr. Zhihong Liu, who has been working on GaN devices for more than ten years. Chapters 2 and 5, on the characteristics of polarization effects and the original demonstration of AlGaN/GaN heterojunction field-effect transistors, are written by researchers from Southwest Jiaotong University. Chapters 6, 8, and 9, on surface passivation, reliability, and package technologies, are edited by a group of researchers from the Southern University of Science and Technology of China.

Iii-nitride Materials, Devices And Nano-structures - Feng Zhe Chuan 2017-04-20

Group III-Nitrides semiconductor materials, including GaN, InN, AlN, InGaN, AlGaN and AlInGaN, i.e. (Al, In, Ga)N, are excellent semiconductors, covering the spectral range from deep ultraviolet (DUV) to UV, visible and infrared, with unique properties very suitable for modern electronic and optoelectronic applications. Remarkable breakthroughs have been achieved in recent years for research and development (R&D) in these materials and devices, such as high-power and high brightness UV-blue-green-white light emitting diodes (LEDs), UV-blue-green laser diodes (LDs), photo-detectors and various optoelectronics and electronics devices and applications. The Nobel Prize in Physics 2014 was awarded jointly to Isamu Akasaki, Hiroshi Amano and Shuji Nakamura "for the invention of efficient blue light-emitting diodes which has enabled bright and energy-saving white light sources". Red and green diodes had been invented since 1960s-70s but without blue LED. Despite considerable efforts, the blue LED had remained a challenge for a long time. The success and inventions on GaN-based LEDs were revolutionary and benefiting for mankind. III-Nitrides-based industry has formed and acquired rapid developments over the world. Incandescent light bulbs lit the 20th century and the 21st century will be lit by LED lamps. Before this book, the editor has edited two books, III-Nitride Semiconductor Materials (2006) and III-Nitride Devices and Nanoengineering (2008), both published by ICP/WSP, in the fields of III-Nitride. The developments of these materials and devices are moving rapidly. Many data or knowledge, some even just published only recently, have been modified and needed to be upgraded. This new book, III-Nitride Materials, Devices and Nano-Structures as the third instalment, will cover the rapid new developments and achievements in the III-Nitride fields, particularly those made since 2009. Contents:General:Comprehensive Theoretical and Experimental Studies on III-Nitrides, Doping, Nano-Structures and LEDs (Jinmin Li, Zhiqiang Liu, Xiaoyan Yi and Junxi Wang)Waste Energy Harvesting Using III-Nitride Materials (E Ghafari, E Witkoske, Y Liu, C Zhang, X Jiang, A Bukowski, B Kucukgok, M Lundstrom; I T Ferguson and N Lu)III-Nitride Nanostructures for Intersubband Optoelectronics (C B Lim, A Ajay, J Lähnemann, D A Browne and E Monroy)GaN-Based Photodetectors (Ke Jiang, Xiaojuan Sun, Hang Song and Dabing Li)III-Nitride Materials:Single Crystal AlN: Growth by Modified Physical Vapor Transport and Properties (Honglei Wu and Ruisheng Zheng)Towards Understanding and Control of Nanoscale Phase Segregation in Indium-Gallium-Nitride Alloys (Yohannes Abate, Viktoriia E Babicheva, Vladislav S Yakovlev and Nikolaus Dietz)Investigating Structural and Optical Characteritics of III-Nitride Semiconductor Materials (Yi Liang, Xiaodong Jiang, Devki N Talwar, Liangyu Wan, Gu Xu and Zhe Chuan Feng)III-Nitride Devices and Nano-Structures:III-Nitride Nano-Structures and Improving the Luminescence Efficiency for Quantum Well LEDs (Peng Chen)Fabrication and Characterization of Green Resonant-Cavity Light-Emitting Diodes Prepared by Wafer Transfer Technologies (Shih-Yung Huang and Ray-Hua Horng)Nanotexturing Effects in GaN/InGaN Multi-Quantum-Wells LED Planar Structures (S J Xu)Group III-Nitride Nanostructures for Light-Emitting Devices and Beyond (Je-Hyung Kim, Young-Ho Ko and Yong-Hoon Cho) Readership: Scientists; material growers and evaluators; device design, processing engineers; postgraduate and graduate students in electrical & electronic engineering and materials engineering.

Vertical GaN and SiC Power Devices - Kazuhiro Mochizuki 2018-04-30

This unique new resource provides a comparative introduction to vertical Gallium Nitride (GaN) and Silicon Carbide (SiC) power devices using real commercial device data, computer, and physical models. This book uses commercial examples from recent years and presents the design features of various GaN and SiC power components and devices. Vertical verses lateral power semiconductor devices are explored, including those based on wide bandgap materials. The abstract concepts of solid state physics as they relate to solid state devices are explained with particular emphasis on power solid state devices. Details about the effects of photon recycling are presented, including an explanation of the phenomenon of the family tree of photon-recycling. This book offers in-depth coverage of bulk crystal growth of GaN, including hydride vapor-phase epitaxial (HVPE) growth, high-pressure nitrogen solution growth, sodium-flux growth, ammonothermal growth, and sublimation growth of SiC. The fabrication process, including ion implantation, diffusion, oxidation, metallization, and passivation is explained. The book provides details about metal-semiconductor contact, unipolar power diodes, and metal-insulator-semiconductor (MIS) capacitors. Bipolar power diodes, power switching devices, and edge terminations are also covered in this resource.

Porous Silicon Carbide and Gallium Nitride - Randall M. Feenstra 2008-04-15

Porous Silicon Carbide and Gallium Nitride: Epitaxy, Catalysis, and Biotechnology Applications presents the state-of-the-art in knowledge and applications of porous semiconductor materials having a wide band gap. This comprehensive reference begins with an overview of porous wide-band-gap technology, and describes the underlying scientific basis for

each application area. Additional chapters cover preparation, characterization, and topography; processing porous SiC; medical applications; magnetic ion behavior, and many more

Mobile Point-of-Care Monitors and Diagnostic Device Design - Walter Karlen 2018-09-03

Efficient mobile systems that allow for vital sign monitoring and disease diagnosis at the point of care can help combat issues such as rising healthcare costs, treatment delays in remote and resource-poor areas, and the global shortage of skilled medical personnel. Covering everything from sensors, systems, and software to integration, usability, and regulatory challenges, Mobile Point-of-Care Monitors and Diagnostic Device Design offers valuable insight into state-of-the-art technologies, research, and methods for designing personal diagnostic and ambulatory healthcare devices. Presenting the combined expertise of contributors from various fields, this multidisciplinary text: Gives an overview of the latest mobile health and point-of-care technologies Discusses portable diagnostics devices and sensors, including mobile-phone-based health systems Explores lab-on-chip systems as well as energy-efficient solutions for mobile point-of-care monitors Addresses computer vision and signal processing for real-time diagnostics Considers interface design for lay healthcare providers and home users Mobile Point-of-Care Monitors and Diagnostic Device Design provides important background information about the design process of mobile health and point-of-care devices, using practical examples to illustrate key aspects related to instrumentation, information processing, and implementation.

Disruptive Wide Bandgap Semiconductors, Related Technologies, and Their Applications - Yogesh Kumar Sharma 2018-09-12

SiC and GaN devices have been around for some time. The first dedicated international conference on SiC and related devices, "ICSCRM," was held in Washington, DC, in 1987. But only recently, the commercialization of SiC and GaN devices has happened. Due to its material properties, Si as a semiconductor has limitations in high-temperature, high-voltage, and high-frequency regimes. With the help of SiC and GaN devices, it is possible to realize more efficient power systems. Devices manufactured from SiC and GaN have already been impacting different areas with their ability to outperform Si devices. Some of the examples are the telecommunications, automotive/locomotive, power, and renewable energy industries. To achieve the carbon emission targets set by different countries, it is inevitable to use these new technologies. This book attempts to cover all the important facets related to wide bandgap semiconductor technology, including new challenges posed by it. This book is intended for graduate students, researchers, engineers, and technology experts who have been working in the exciting fields of SiC and GaN power devices.

Nitride Semiconductors and Devices - Morkoç Hadis 2008-09

Under the umbrella of nitride semiconductors and devices, the book treats semiconductor fundamentals, technology, nanotechnology with clarity and depth not found elsewhere. The book is a combination of graduate level text book with all the necessary basis and derivations involving semiconductor and device physics and engineering, an extensive reference book for GaN and related material and ZnO, and a handbook for the same, all in one. Properties and processes with sufficient basis for thermal, optical (3, 2, 1, 0-dimensional systems), electrical (at low and high electric field, low and high magnetic field for 3- and 2-dimensional systems full with measurement techniques), magnetism and magnetic properties (in dilute magnetic ion doped varieties), spin based device concepts and associated measurement methods, semiconductor deposition methods, inclusive of hydride VPE, ogranometallic CVD, MBE, liquid/high pressure growth with fundamentals, extended defects and their electrical nature, point defects, and extensive discussion of doping, text book-like treatment of LEDs (including lighting and competing technologies), Lasers (including recording), FETs and HBTs (including novel treatment of fundamentals and hot phonon processes affecting the velocity), detectors and unique issues surrounding solar blind detection. The depth and scope of the book and the easily understandable treatment of subject matter are certain to lift any a-priori cloud present.

Entrepreneurship in Power Semiconductor Devices, Power Electronics, and Electric Machines and Drive Systems - Krishnan Ramu 2020-12-07

Entrepreneurship in Power Semiconductor Devices, Power Electronics, and Electric Machines and Drive Systems introduces the basics of entrepreneurship and a methodology for the study of entrepreneurship in electrical engineering and other engineering fields. Entrepreneurship is considered here in three fields of electrical engineering, viz. power semiconductor devices, power electronics and electric machines and drive systems, and their current practice. It prepares the reader by providing a review of the subject matter in the three fields, their current status in research and development with analysis aspect as needed, thus allowing readers to gain self-sufficiency while reading the book. Each field's emerging applications, current market and future market forecasts are introduced to understand the basis and need for emerging startups. Practical learning is introduced in: (i) power semiconductor devices entrepreneurship through the prism of 20 startups in detail, (ii) power electronics entrepreneurship through 28 startup companies arranged under various application fields and (iii) electric machines and drive systems entrepreneurship through 15 startups in electromagnetic and 1 in electrostatic machines and drive systems. The book: (i) demystifies entrepreneurship in a practical way to equip engineers and students with entrepreneurship as an option for their professional growth, pursuit and success; (ii) provides engineering managers and corporate-level executives a detailed view of entrepreneurship activities in the considered three fields that may potentially impact their businesses, (iii) provides entrepreneurship education in an electrical engineering environment and with direct connection and correlation to their fields of study and (iv) endows a methodology that can be effectively employed not only in the three illustrated fields of electrical engineering but in other fields as well. This book is for electrical engineering students and professionals. For use in undergraduate and graduate courses in electrical engineering, the book contains discussion questions, exercise problems, team and class projects, all from a practical point of view, to train students and assist professionals for future entrepreneurship endeavors.

GaN Transistors for Efficient Power Conversion - Alex Lidow 2019-09-11

An up-to-date, practical guide on upgrading from silicon to GaN, and how to use GaN transistors in power conversion systems design This updated, third edition of a popular book on GaN transistors for efficient power conversion has been substantially expanded to keep students and practicing power conversion engineers ahead of the learning curve in GaN technology advancements. Acknowledging that GaN transistors are not one-to-one replacements for the current MOSFET technology, this book serves as a practical guide for understanding basic GaN transistor construction, characteristics, and applications. Included are discussions on the fundamental physics of these power semiconductors, layout, and other circuit design considerations, as well as specific application examples demonstrating design techniques when employing GaN devices. GaN Transistors for Efficient Power Conversion, 3rd Edition brings key updates to the chapters of Driving GaN Transistors; Modeling, Simulation, and Measurement of GaN Transistors; DC-DC Power Conversion; Envelope Tracking; and Highly Resonant Wireless Energy Transfer. It also offers new chapters on Thermal Management, Multilevel Converters, and Lidar, and revises many others throughout. Written by leaders in the power semiconductor field and industry pioneers in GaN power transistor technology and applications Updated with 35% new material, including three new chapters on Thermal Management, Multilevel Converters, Wireless Power, and Lidar Features practical guidance on formulating specific circuit designs when constructing power conversion systems using GaN transistors A valuable resource for professional engineers, systems designers, and electrical engineering students who need to fully understand the state-of-the-art GaN Transistors for Efficient Power Conversion, 3rd Edition is an essential learning tool and reference guide that enables power conversion engineers to design energy-efficient, smaller, and more cost-effective products using GaN transistors.

Gallium Nitride and Silicon Carbide Power Devices - B Jayant Baliga 2016-12-12

During the last 30 years, significant progress has been made to improve our understanding of gallium nitride and silicon carbide device structures, resulting in experimental demonstration of their enhanced performances for power electronic systems. Gallium nitride power devices made by the growth of the material on silicon substrates have gained a lot of interest. Power device products made from these materials have become available during the last five years from many companies. This comprehensive book discusses the physics of operation and design of gallium nitride and silicon carbide power devices. It can be used as a reference by practicing engineers in the power electronics industry and as a textbook for a power device or power electronics course in universities. Request Inspection Copy

Technologies for Smart Sensors and Sensor Fusion - Kevin Yallup 2017-12-19

Exciting new developments are enabling sensors to go beyond the realm of simple sensing of movement or capture of images to deliver information such as location in a built environment, the sense of touch, and the presence of chemicals. These sensors unlock the potential for

smarter systems, allowing machines to interact with the world around them in more intelligent and sophisticated ways. Featuring contributions from authors working at the leading edge of sensor technology, Technologies for Smart Sensors and Sensor Fusion showcases the latest advancements in sensors with biotechnology, medical science, chemical detection, environmental monitoring, automotive, and industrial applications. This valuable reference describes the increasingly varied number of sensors that can be integrated into arrays, and examines the growing availability and computational power of communication devices that support the algorithms needed to reduce the raw sensor data from multiple sensors and convert it into the information needed by the sensor array to enable rapid transmission of the results to the required point. Using both SI and US units, the text: Provides a fundamental and analytical understanding of the underlying technology for smart sensors Discusses groundbreaking software and sensor systems as well as key issues surrounding sensor fusion Exemplifies the richness and diversity of development work in the world of smart sensors and sensor fusion Offering fresh insight into the sensors of the future, Technologies for Smart Sensors and Sensor Fusion not only exposes readers to trends but also inspires innovation in smart sensor and sensor system development.

Nitride Semiconductor Technology - Fabrizio Roccaforte 2020-07-17

The book "Nitride Semiconductor Technology" provides an overview of nitride semiconductors and their uses in optoelectronics and power electronics devices. It explains the physical properties of those materials as well as their growth methods. Their applications in high electron mobility transistors, vertical power devices, LEDs, laser diodes, and vertical-cavity surface-emitting lasers are discussed in detail. The book further examines reliability issues in these materials and puts forward perspectives of integrating them with 2D materials for novel high-frequency and high-power devices. In summary, it covers nitride semiconductor technology from materials to devices and provides the basis for further research.

Nitride Semiconductor Light-Emitting Diodes (LEDs) - Jian-Jang Huang 2017-10-24

Nitride Semiconductor Light-Emitting Diodes (LEDs): Materials, Technologies, and Applications, Second Edition reviews the fabrication, performance and applications of the technology, encompassing the state-of-the-art material and device development, along with considerations regarding nitride-based LED design. This updated edition is based on the latest research and advances, including two new chapters on LEDs for large displays and laser lighting. Chapters cover molecular beam epitaxy (MBE) growth of nitride semiconductors, modern metalorganic chemical vapor deposition (MOCVD) techniques, the growth of nitride-based materials, and gallium nitride (GaN)-on-sapphire and GaN-on-silicon technologies for LEDs. Nanostructured, non-polar and semi-polar nitride-based LEDs, as well as phosphor-coated nitride LEDs, are also discussed. The book also addresses the performance of nitride LEDs, including photonic crystal LEDs, surface plasmon enhanced LEDs, color tuneable LEDs, and LEDs based on quantum wells and quantum dots. Further chapters discuss the development of LED encapsulation technology and fundamental efficiency droop issues in gallium indium nitride (GaInN) LEDs. It is a technical resource for academics, physicists, materials scientists, electrical engineers, and those working in the lighting, consumer electronics, automotive, aviation, and communications sectors. Features new chapters on laser lighting, addressing the latest advances on this topic Reviews fabrication, performance, and applications of this technology that encompass the state-of-the-art material and device development Covers the performance of nitride LEDs, including photonic crystal LEDs, surface plasmon enhanced LEDs, color tuneable LEDs, and LEDs based on quantum wells and quantum dots Highlights applications of nitride LEDs, including liquid crystal display (LCD) backlighting, infra-red emitters, and automotive lighting Provides a comprehensive discussion of gallium nitride on both silicon and sapphire substrates

Handbook of GaN Semiconductor Materials and Devices - Wengang (Wayne) Bi 2017-10-20

This book addresses material growth, device fabrication, device application, and commercialization of energy-efficient white light-emitting diodes (LEDs), laser diodes, and power electronics devices. It begins with an overview on basics of semiconductor materials, physics, growth and characterization techniques, followed by detailed discussion of advantages, drawbacks, design issues, processing, applications, and key challenges for state of the art GaN-based devices. It includes state of the art material synthesis techniques with an overview on growth technologies for emerging bulk or free standing GaN and AlN substrates and their applications in electronics, detection, sensing, optoelectronics and photonics. Wengang (Wayne) Bi is Distinguished Chair Professor and Associate Dean in the College of Information and Electrical Engineering at Hebei University of Technology in Tianjin, China. Hao-chung (Henry) Kuo is Distinguished Professor and Associate Director of the Photonics Center at National Chiao-Tung University, Hsin-Tsu, Taiwan, China. Pei-Cheng Ku is an associate professor in the Department of Electrical Engineering & Computer Science at the University of Michigan, Ann Arbor, USA. Bo Shen is the Cheung Kong Professor at Peking University in China.

Nitride Semiconductors and Devices - Hadis Morkoç 2013-03-08

This timely monograph addresses an important class of semiconductors and devices that constitute the underlying technology for blue lasers. It succinctly treats structural, electrical and optical properties of nitrides and the substrates on which they are deposited, band structures of nitrides, optical processes, deposition and fabrication technologies, light-emitting diodes, and lasers. It also includes many tables and figures detailing the properties and performance of nitride semiconductors and devices.

Testing for Small-Delay Defects in Nanoscale CMOS Integrated Circuits - Sandeep K. Goel 2017-12-19

Advances in design methods and process technologies have resulted in a continuous increase in the complexity of integrated circuits (ICs). However, the increased complexity and nanometer-size features of modern ICs make them susceptible to manufacturing defects, as well as performance and quality issues. Testing for Small-Delay Defects in Nanoscale CMOS Integrated Circuits covers common problems in areas such as process variations, power supply noise, crosstalk, resistive opens/bridges, and design-for-manufacturing (DfM)-related rule violations. The book also addresses testing for small-delay defects (SDDs), which can cause immediate timing failures on both critical and non-critical paths in the circuit. Overviews semiconductor industry test challenges and the need for SDD testing, including basic concepts and introductory material Describes algorithmic solutions incorporated in commercial tools from Mentor Graphics Reviews SDD testing based on "alternative methods" that explores new metrics, top-off ATPG, and circuit topology-based solutions Highlights the advantages and disadvantages of a diverse set of metrics, and identifies scope for improvement Written from the triple viewpoint of university researchers, EDA tool developers, and chip designers and tool users, this book is the first of its kind to address all aspects of SDD testing from such a diverse perspective. The book is designed as a one-stop reference for current industrial practices, research challenges in the domain of SDD testing, and recent developments in SDD solutions.

Technology of Gallium Nitride Crystal Growth - Dirk Ehrentraut 2010-06-24

This book discusses the important technological aspects of the growth of GaN single crystals by HVPE, MOCVD, ammonothermal and flux methods for the purpose of free-standing GaN wafer production.

GaN Transistors for Efficient Power Conversion - Alex Lidow 2014-09-15

Gallium nitride (GaN) is an emerging technology that promises to displace silicon MOSFETs in the next generation of power transistors. As silicon approaches its performance limits, GaN devices offer superior conductivity and switching characteristics, allowing designers to greatly reduce system power losses, size, weight, and cost. This timely second edition has been substantially expanded to keep students and practicing power conversion engineers ahead of the learning curve in GaN technology advancements. Acknowledging that GaN transistors are not one-to-one replacements for the current MOSFET technology, this book serves as a practical guide for understanding basic GaN transistor construction, characteristics, and applications. Included are discussions on the fundamental physics of these power semiconductors, layout and other circuit design considerations, as well as specific application examples demonstrating design techniques when employing GaN devices. With higher-frequency switching capabilities, GaN devices offer the chance to increase efficiency in existing applications such as DC–DC conversion, while opening possibilities for new applications including wireless power transfer and envelope tracking. This book is an essential learning tool and reference guide to enable power conversion engineers to design energy-efficient, smaller and more cost-effective products using GaN transistors. Key features: Written by leaders in the power semiconductor field and industry pioneers in GaN power transistor technology and applications. Contains useful discussions on device–circuit interactions, which are highly valuable since the new and high performance GaN power transistors require thoughtfully designed drive/control circuits in order to fully achieve their performance potential. Features practical guidance on formulating specific circuit designs when constructing power conversion systems using GaN transistors – see companion website for further details. A valuable learning resource for professional engineers and

systems designers needing to fully understand new devices as well as electrical engineering students.

Monolithic Integration in E-Mode GaN Technology - Maik Peter Kaufmann 2022-10-26

This book is a comprehensive, all-in-one source on design of monolithic GaN power ICs. It is written in handbook style with systematic guidelines and includes implementation examples. It covers the full range from technology fundamentals to implementation details including design techniques specific for GaN technology. It provides a detailed loss analysis based on comparative measurements between silicon and GaN based converters to provide an understanding of the relations between design choices and results which can be transferred to other power converter systems.

III-Nitride Semiconductors and their Modern Devices - Bernard Gil 2013-08-22

This book is dedicated to GaN and its alloys AlGaInN (III-V nitrides), semiconductors with intrinsic properties well suited for visible and UV light emission and electronic devices working at high temperature, high frequency, and harsh environments. There has been a rapid growth in the industrial activity relating to GaN, with GaN now ranking at the second position (after Si) among all semiconductors. This is mainly thanks to LEDs, but also to the emergence of lasers and high power and high frequency electronics. GaN-related research activities are also diversifying, ranging from advanced optical sources and single electron devices to physical, chemical, and biological sensors, optical detectors, and energy converters. All recent developments of nitrides and of their technology are gathered here in a single volume, with chapters written by world leaders in the field. This third book of the series edited by B. Gil is complementary to the preceding two, and is expected to offer a modern vision of nitrides and of their devices to a large audience of readers.

Gallium Nitride Electronics - Rüdiger Quay 2008-04-05

This book is based on nearly a decade of materials and electronics research at the leading research institution on the nitride topic in Europe. It is a comprehensive monograph and tutorial that will be of interest to graduate students of electrical engineering, communication engineering, and physics; to materials, device, and circuit engineers in research and industry; to all scientists with a general interest in advanced electronics.

Metallic Spintronic Devices - Xiaobin Wang 2017-12-19

Metallic Spintronic Devices provides a balanced view of the present state of the art of metallic spintronic devices, addressing both mainstream and emerging applications from magnetic tunneling junction sensors and spin torque oscillators to spin torque memory and logic. Featuring contributions from well-known and respected industrial and academic experts, this cutting-edge work not only presents the latest research and developments but also: Describes spintronic applications in current and future magnetic recording devices Discusses spin-transfer torque magnetoresistive random-access memory (STT-MRAM) device architectures and modeling Explores prospects of STT-MRAM scaling, such as detailed multilevel cell structure analysis Investigates spintronic device write and read optimization in light of spintronic memristive effects Considers spintronic research directions based on yttrium iron garnet thin films, including spin pumping, magnetic proximity, spin hall, and spin Seebeck effects Proposes unique solutions for low-power spintronic device applications where memory is closely integrated with logic Metallic Spintronic Devices aims to equip anyone who is serious about metallic spintronic devices with up-to-date design, modeling, and processing knowledge. It can be used either by an expert in the field or a graduate student in course curriculum.

Modeling Gallium-nitride Based High Electron Mobility Transistors - Ujwal Radhakrishna 2016

Gallium-Nitride-based high electron mobility transistor (HEMTs) technology is increasingly finding space in high voltage (HV) and high frequency (HF) circuit application domains. The superior breakdown electric field, high electron mobility, and high temperature performance of GaN HEMTs are the key factors for its use as HV switches in converters and active components of RF-power amplifiers. Designing circuits in both application regimes requires accurate compact device models that are grounded in physics and can describe the non-linear terminal characteristics. Currently available compact models for HEMTs are empirical and hence are lacking in physical description of the device, which becomes a handicap in understanding key device-circuit interactions and in accurate estimation of device behavior in circuits. This thesis seeks to develop a physics-based compact model for GaN HEMTs from first principles which can be used as a design tool for technology optimization to identify device-performance bottlenecks on one hand and as a tool for circuit design to investigate the impact of behavioral nuances of the device on circuit performance, on the other. Part of this thesis consists of demonstrations of the capabilities of the model to accurately predict device characteristics such as terminal DC- and pulsed-currents, charges, small-signal S-parameters, large-signal switching characteristics, load-pull, source-pull and power-sweep, inter-modulation-distortion and noise-figure of both HV- and RF-devices. The thesis also aims to tie device-physics concepts of carrier transport and charge distribution in GaN HEMTs to circuit-design through circuit-level evaluation. In the HV-application regime benchmarking is conducted against switching characteristics of a GaN DC-DC converter to understand the impact of device capacitances, field plates, temperature and charge-trapping on switching slew rates. In the RF-application regime validation is done against the large-signal characteristics of GaN-power amplifiers to study the output-power, efficiency and compression characteristics as function of class-of-operation. Noise-figure of low-noise amplifiers is tested to estimate the contributions of device-level noise sources, and validation against switching frequency and phase-noise characteristics of voltage-controlled oscillators is done to evaluate the noise performance of GaN HEMT technology. Evaluation of model-accuracy in determining the conversion-efficiency of RF-converters and linearity metrics of saturated non-linear amplifiers is carried out. The key contribution of this work is to provide a tool in the form of a physics-based compact model to device-technology-engineers and circuit-designers, who can use it to evaluate the potential strengths and weaknesses of the emerging GaN technology.

GaN-Based Materials and Devices - M S Shur 2004-05-07

The unique materials properties of GaN-based semiconductors have stimulated a great deal of interest in research and development regarding nitride materials growth and optoelectronic and nitride-based electronic devices. High electron mobility and saturation velocity, high sheet carrier concentration at heterojunction interfaces, high breakdown field, and low thermal impedance of GaN-based films grown over SiC or bulk AlN substrates make nitride-based electronic devices very promising. The chemical inertness of nitrides is another key property. This volume, written by experts on different aspects of nitride technology, addresses the entire spectrum of issues related to nitride materials and devices, and it will be useful for technologists, scientists, engineers, and graduate students who are working on wide bandgap materials and devices. The book can also be used as a supplementary text for graduate courses on wide bandgap semiconductor technology. Contents:Materials:Materials Properties of Nitrides. Summary (S L Rumyantsev et al.)Kinetics, Microstructure and Strain in GaN Thin Films Grown Via Pendeo-Epitaxy (A M Roskowski et al.)Cracking of GaN Films (E V Etzkorn & D R Clarke)Transport and Noise Properties:Quasi-Ballistic and Overshoot Transport in Group III-Nitrides (K W Kim et al.)High Field Transport in AlN (R Collazo et al.)Generation-Recombination Noise in GaN-Based Devices (S L Rumyantsev et al.)Devices:Insulated Gate III-N Heterostructure Field-Effect Transistors (G Simin et al.)High Voltage AlGaN/GaN Heterojunction Transistors (L S McCarthy et al.)Etched Aperture GaN Cavet Through Photoelectrochemical Wet Etching (Y Gao et al.)and other papers Readership: Undergraduates, graduate students, academics, researchers and practitioners in semiconductor science and materials engineering. Keywords:Nitrides;Power Switches;Substrates;Device Fabrication;TransistorsKey Features:Unique feature: extensive coverage of issues ranging from materials growth and characterization to devices

Gallium Nitride Materials and Devices VII - Jen-Inn Chyi 2012

Includes Proceedings Vol. 7821

Technology of Gallium Nitride Crystal Growth - Dirk Ehrentraut 2010-06-14

This book discusses the important technological aspects of the growth of GaN single crystals by HVPE, MOCVD, ammonothermal and flux methods for the purpose of free-standing GaN wafer production.

Power GaN Devices - Matteo Meneghini 2018-04-22

This book presents the first comprehensive overview of the properties and fabrication methods of GaN-based power transistors, with contributions from the most active research groups in the field. It describes how gallium nitride has emerged as an excellent material for the fabrication of power transistors; thanks to the high energy gap, high breakdown field, and saturation velocity of GaN, these devices can reach breakdown voltages beyond the kV range, and very high switching frequencies, thus being suitable for application in power conversion systems. Based on GaN, switching-mode power converters with efficiency in excess of 99 % have been already demonstrated, thus clearing the way for massive adoption of GaN transistors in the power conversion market. This is expected to have important advantages at both the environmental and economic level,

since power conversion losses account for 10 % of global electricity consumption. The first part of the book describes the properties and advantages of gallium nitride compared to conventional semiconductor materials. The second part of the book describes the techniques used for device fabrication, and the methods for GaN-on-Silicon mass production. Specific attention is paid to the three most advanced device structures: lateral transistors, vertical power devices, and nanowire-based HEMTs. Other relevant topics covered by the book are the strategies for normally-off operation, and the problems related to device reliability. The last chapter reviews the switching characteristics of GaN HEMTs based on a systems level approach. This book is a unique reference for people working in the materials, device and power electronics fields; it provides interdisciplinary information on material growth, device fabrication, reliability issues and circuit-level switching investigation.

Wide Bandgap Semiconductor Power Devices - B. Jayant Baliga 2018-10-17

Wide Bandgap Semiconductor Power Devices: Materials, Physics, Design and Applications provides readers with a single resource on why these devices are superior to existing silicon devices. The book lays the groundwork for an understanding of an array of applications and anticipated benefits in energy savings. Authored by the Founder of the Power Semiconductor Research Center at North Carolina State University (and creator of the IGBT device), Dr. B. Jayant Baliga is one of the highest regarded experts in the field. He thus leads this team who comprehensively review the materials, device physics, design considerations and relevant applications discussed. Comprehensively covers power electronic devices, including materials (both gallium nitride and silicon carbide), physics, design considerations, and the most promising applications Addresses the key challenges towards the realization of wide bandgap power electronic devices, including materials defects, performance and reliability Provides the benefits of wide bandgap semiconductors, including opportunities for cost reduction and social impact

III-Nitride Devices and Nanoengineering -

Medical Imaging - Troy Farncombe 2017-12-19

The book has two intentions. First, it assembles the latest research in the field of medical imaging technology in one place. Detailed descriptions of current state-of-the-art medical imaging systems (comprised of x-ray CT, MRI, ultrasound, and nuclear medicine) and data processing techniques are discussed. Information is provided that will give interested engineers and scientists a solid foundation from which to build with additional resources. Secondly, it exposes the reader to myriad applications that medical imaging technology has enabled.

Handbook for III-V High Electron Mobility Transistor Technologies - D. Nirmal 2019-05-14

This book focusses on III-V high electron mobility transistors (HEMTs) including basic physics, material used, fabrications details, modeling, simulation, and other important aspects. It initiates by describing principle of operation, material systems and material technologies followed by description of the structure, I-V characteristics, modeling of DC and RF parameters of AlGaN/GaN HEMTs. The book also provides information about source/drain engineering, gate engineering and channel engineering techniques used to improve the DC-RF and breakdown performance of HEMTs. Finally, the book also highlights the importance of metal oxide semiconductor high electron mobility transistors (MOS-HEMT). Key Features Combines III-As/P/N HEMTs with reliability and current status in single volume Includes AC/DC modelling and (sub)millimeter wave devices with reliability analysis Covers all theoretical and experimental aspects of HEMTs Discusses AlGaN/GaN transistors Presents DC, RF and breakdown characteristics of HEMTs on various material systems using graphs and plots