Sic Power Devices And Modules Rohm Semiconductor

Disruptive Wide Bandgap Semiconductors, Related Technologies, and Their ApplicationsBoD – Books on Demand
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
With efforts to reduce the cost, size, and thermal management systems for the power electronics drivetrain in hybrid electric vehicles (HEVs) and plug-in hybrid electric vehicles (PHEVs), wide band gap semiconductors including silicon carbide (SiC) have been identified as possibly being a partial solution. Research on SiC power electronics has shown their higher efficiency compared to Si power electronics due to significantly lower conduction and switching losses. This paper focuses on the development of a high power module based on SiC JFETs and Schottky diodes. Characterization of a single device, a module developed using the same device, and finally an inverter built using the modules is presented. When tested at moderate load levels compared to the inverter rating, an efficiency of 98.2% was achieved by the initial prototype.
This book relates the recent developments in several key electrical engineering R&D labs, concentrating on power electronics switches and their use. The first sections deal with key power electronics technologies, MOSFETs and IGBTs, including series and parallel associations. The next section examines silicon carbide and its potentiality for power electronics applications and its present limitations. Then, a dedicated section presents the capacitors, key passive components in power electronics, followed by a modeling method allowing the stray inductances computation, necessary for the precise simulation of switching waveforms. Thermal behavior associated with power switches follows, and the last part proposes some interesting prospectives associated to Power Electronics integration.
MEMS devices are found in many of today’s electronic devices and systems, from air-bag sensors in cars to smart phones, embedded systems, etc. Increasingly, the reduction in dimensions has led to nanometer-scale devices, called NEMS. The plethora of applications on the commercial market speaks for itself, and especially for the highly precise manufacturing of silicon-based MEMS and NEMS. While this is a tremendous achievement, silicon as a material has some drawbacks, mainly in the area of mechanical fatigue and thermal properties. Silicon carbide (SiC), a well-known wide-bandgap semiconductor whose adoption in commercial products is experiening exponential growth, especially in the power electronics arena. While SiC MEMS have been around for decades, in this Special Issue we seek to capture both an overview of the devices that have been demonstrated to date, as well as bring new technologies and progress in the MEMS processing area to the forefront. Thus, this Special Issue seeks to showcase research papers, short communications, and review articles that focus on: (1) novel designs, fabrication, control, and modeling of SiC MEMS and NEMS based on all kinds of actuation mechanisms; and (2) new developments in applying SiC MEMS and NEMS in consumer electronics, optical communications, industry, medicine, agriculture, space, and defense.
This edited volume presents the proceedings of the AMAA 2015 conference, Berlin, Germany. The topical focus of the 2015 conference lies on smart systems for green and automated driving. The automobile of the future has to respond to two major trends, the electrification of the drivetrain, and the automation of the transportation system. These trends will not only lead to greener and safer driving but re-define the concept of the car completely, particularly if they interact with each other in a synergetic way as for autonomous parking and charging, self-driving shuttles or mobile robots. Key functionalities like environment perception are enabled by electronic components and systems, sensors and actuators, communication nodes, cognitive systems and smart systems integration. The book will be a valuable read for research experts and professionals in the automotive industry but the book may also be beneficial for graduate students.
The growth of power electronics, centering on inverters and converters as its key system topology, has accelerated recently due to the demand for efficient power conversion. This growth has also been backed up by several evolutionary changes and breakthroughs achieved in the areas of power semiconductor device physics, process technology, and design. However, as power semiconductor technology remains a highly specialized subject, the literature on further research, development, and design in related fields is not adequate. With this in view, two specialists of power semiconductors, well known for their research and contributions to the field, compiled this book as a review volume focusing on power chip and module technologies. The prime purpose is to help researchers, academia, and engineers, engaged in areas related to power devices and power electronics, better understand the evolutionary growth of major power device components, their operating principles, design aspects, application features, and trends. The book is filled with unique topics related to power semiconductors, including tips on state-of-the-art and futuristic-oriented applications. Numerous diagrams, illustrations, and graphics are included to adequately support the content and to make the book extremely attractive as a practical and user-friendly reference book for researchers, technologists, and engineers, as well as a textbook for advanced graduate-level and postgraduate students.
This book discusses a number of important topical technical and non-technical issues related to the global energy, environment and socio-economic developments for professionals and students directly and indirectly involved in the relevant fields. It shows how renewable energy offers solutions to mitigate energy demand and helps achieve a clean environment, and also addresses the lack of a clear vision in the development of technology and a policy to reach the mandatory global renewable energy targets to reduce greenhouse gas emissions and stimulate socio-economic development. The book is structured in such a way that it provides a consistent compilation of fundamental theories, a compendium of current research and development activities as well as new directions to overcome critical limitations; future technologies for power grids and their control, stability and reliability are also presented.
Halbleiter-Leistungsbauelemente sind das Kernstück der Leistungselektronik. Sie bestimmen die Leistungsfähigkeit und machen neuartige und verlustarme Schaltungen erst möglich. In dem Band wird neben den Halbleiter-Leistungsbauelementen selbst auch die Aufbau- und Verbindungstechnik behandelt: von den physikalischen Grundlagen und der Herstellungstechnologie über einzelne Bauelemente bis zu thermomechanischen Problemen, Zerstörungsmechanismen und Störungseffekten. Die 2., überarbeitete Auflage berücksichtigt technische Neuerungen und Entwicklungen.
Since the production of the first commercially available blue LED in the late 1980s, silicon carbide technology has grown into a billion-dollar industry world-wide in the area of solid-state lighting and power electronics. With this in mind we

organized this book to bring to the attention of those well versed in SiC technology some new developments in the field with a particular emphasis on particularly promising technologies such as SiC-based solar cells and optoelectronics. We have balanced this with the more traditional subjects such as power electronics and some new developments in the improvement of the MOS system for SiC MOSFETS. Given the importance of advanced microsystems and sensors based on SiC, we also included a review on 3C-SiC for both microsystem and electronic applications.

A guide to the field of wide bandgap semiconductor technology Wide Bandgap Semiconductors for Power Electronics is a comprehensive and authoritative guide to wide bandgap materials silicon carbide, gallium nitride, diamond and gallium(III) oxide. With contributions from an international panel of experts, the book offers detailed coverage to the growth of these materials, their characterization, and how they are used in a variety of power electronics devices such as transistors and diodes and in the areas of quantum information and hybrid electric vehicles. The book is filled with the most recent developments in the burgeoning field of wide bandgap semiconductor technology and includes information from cutting-edge semiconductor companies as well as material from leading universities and research institutions. By taking both scholarly and industrial perspectives, the book is designed to be a useful resource for scientists, academics, and corporate researchers and developers. This important book: Presents a review of wide bandgap materials and recent developments Links the high potential of the wide bandgap semiconductor with the technologic implementation capabilities Offers a unique combination academic and industrial perspectives Meets the demand for a resource that addresses wide bandgap materials in a comprehensive manner Written for materials scientists, semiconductor physicists, electrical engineers, Wide Bandgap Semiconductors for Power Electronics provides a state of the art guide to the technology and application of SiC and related wide bandgap materials.

Provides insight on both classical means and new trends in the application of power electronic and artificial intelligence techniques in power system operation and control This book presents advanced solutions for power system controllability improvement, transmission capability enhancement and operation planning. The book is organized into three parts. The first part describes the CSC-HVDC and VSC-HVDC technologies, the second part presents the FACTS devices, and the third part refers to the artificial intelligence techniques. All technologies and tools approached in this book are essential for power system development to comply with the smart grid requirements. Discusses detailed operating principles and diagrams, theory of modeling, control strategies and physical installations around the world of HVDC and FACTS systems Covers a wide range of Artificial Intelligence techniques that are successfully applied for many power system problems, from planning and monitoring to operation and control Each chapter is carefully edited, with drawings and illustrations that helps the reader to easily understand the principles of operation or application Advanced Solutions in Power Systems: HVDC, FACTS, and Artificial Intelligence is written for graduate students, researchers in transmission and distribution networks, and power system operation. This book also serves as a reference for professional software developers and practicing engineers.

The primary goal of this book is to provide a sound understanding of wide bandgap Silicon Carbide (SiC) power semiconductor device simulation using Silvaco© ATLAS Technology Computer Aided Design (TCAD) software. Physics-based TCAD modeling of SiC power devices can be extremely challenging due to the wide bandgap of the semiconductor material. The material presented in this book aims to shorten the learning curve required to start successful SiC device simulation by providing a detailed explanation of simulation code and the impact of various modeling and simulation parameters on the simulation results. Non-isothermal simulation to predict heat dissipation and lattice temperature rise in a SiC device structure under switching condition has been explained in detail. Key pointers including runtime error messages, code debugging, implications of using certain models and parameter values, and other factors beneficial to device simulation are provided based on the authors' experience while simulating SiC device structures. This book is useful for students, researchers, and semiconductor professionals working in the area of SiC semiconductor technology. Readers will be provided with the source code of several fully functional simulation programs that illustrate the use of Silvaco© ATLAS to simulate SiC power device structure, as well as supplementary material for download.

Silicon carbide (SiC), a wide-bandgap semiconductor material, greatly improves the performance of power semiconductor devices. Its electrical characteristics have a positive impact on the size, efficiency, and weight of the power electronics systems. Parasitic circuit elements and thermal properties are critical to the power electronics module design. This thesis investigates the various aspects of layout design, electrical simulation, thermal simulation, and peripheral design of SiC power electronic modules. ANSYS simulator was used to design and simulate the power electronic modules. The parasitic circuit elements of the power module were obtained from the device parameters given in the datasheet of these SiC bare devices together with the model established in the Q3D simulator. A temperature simulation model is established using SolidWorks to investigate the thermal performance of the power module. The designs of soldering and sintering fixtures are presented. A 1.7kV silicon carbide (SiC) junction field-effect transistor (JFET) cascode power electronic module was designed as an example. By comparing the different module designs, some conclusions are elucidated.

Since the 1997 publication of "Silicon Carbide - A Review of Fundamental Questions and Applications to Current Device Technology" edited by Choyke, et al., there has been impressive progress in both the fundamental and developmental aspects of the SiC field. So there is a growing need to update the scientific community on the important events in research and development since then. The editors have again gathered an outstanding team of the world's leading SiC researchers and design engineers to write on the most recent developments in SiC.

One of the first thing that comes to your mind after hearing the term “corrosion” is corrosion of a metal. Corrosion is a basically harmful phenomenon, but it can be useful in some cases. For instance, environment’s pollution with corrosion products and damage to the performance of a system are among its harmful effects, whereas electric energy generation in a battery and cathodic protection of many structures are among its advantages. However, these advantages are almost nothing as compared to the costs and effects imposed by its

detrimental influences. The enormous costs of this phenomenon can be better understand through studying the published statistics on direct and indirect corrosion damages on economy of governments. The direct cost of corrosion is near 3 % of the gross domestic product (GDP) of USA. Considering this huge cost, it is necessary to develop and expand the corrosion science and its protection technologies.

ISPSD is the premier forum for technical discussion in all areas of power semiconductor devices and integrated circuits, their hybrid technologies and applications

The rapidly advancing Silicon Carbide technology has a great potential in high temperature and high frequency electronics. High thermal stability and outstanding chemical inertness make SiC an excellent material for high-power, low-loss semiconductor devices. The present volume presents the state of the art of SiC device fabrication and characterization. Topics covered include: SiC surface cleaning and etching techniques; electrical characterization methods and processing of ohmic contacts to silicon carbide; analysis of contact resistivity dependence on material properties; limitations and accuracy of contact resistivity measurements; ohmic contact fabrication and test structure design; overview of different metallization schemes and processing technologies; thermal stability of ohmic contacts to SiC, their protection and compatibility with device processing; Schottky contacts to SiC; Schottky barrier formation; Schottky barrier inhomogeneity in SiC materials; technology and design of 4H-SiC Schottky and Junction Barrier Schottky diodes; Si/SiC heterojunction diodes; applications of SiC Schottky diodes in power electronics and temperature/light sensors; high power SiC unipolar and bipolar switching devices; different types of SiC devices including material and technology constraints on device performance; applications in the area of metal contacts to silicon carbide; status and prospects of SiC power devices.

Power semiconductor devices are widely used for the control and management of electrical energy. The improving performance of power devices has enabled cost reductions and efficiency increases resulting in lower fossil fuel usage and less environmental pollution. This book provides the first cohesive treatment of the physics and design of silicon carbide power devices with an emphasis on unipolar structures. It uses the results of extensive numerical simulations to elucidate the operating principles of these important devices.

With the benefits of fast switching speed, low on-resistance and high thermal conductivity, silicon carbide (SiC) devices are being implemented in converter designs with high efficiency and high power density. Consequently, SiC power modules are needed. However, some of the preestablished package designs for silicon based power modules are not suitable to manifest the advantages of SiC devices. Therefore, this thesis aims at optimizing the package design to utilize the fast switching capability of SiC devices. First, the power loop parasitic inductance induced by the package can lead to large voltage spikes with the fast switching SiC device. It can potentially exceed the device's voltage ratings and affect its safe operation. Second, to achieve high power density design with SiC devices, the package's cooling performance needs to be improved. Third, to design a package for high current applications with multiple chips in parallel, a proper scaling method is needed to ensure all the devices undertake the same voltage stress in switching transients. For P-cell/N-cell designs with split scaling, a new parasitic parameter, namely, middle-point parasitic inductance Lm?i?d?d?l?e? will be introduced. Its role should be understood. Lastly, the unbalanced dynamic switching loss can lead to different state junction temperatures among paralleled devices. Thermal coupling can help to reduce the temperature imbalance, and its role should be quantitatively investigated. To meet the first two requirements, a new package design is proposed with reduced parasitic inductance and double-sided cooling. Compared to a baseline package, more than 60% reduction of parasitic inductance is achieved. The middle-point parasitic inductance's effect on device's switching transients is analyzed in the frequency domain. Then a dedicated power module is fabricated with the capability of varying Lm?i?d?d?l?e?. Experiment results show that as Lm?i?d?d?l?e? increases, different voltage stresses are imposed on the MOSFET and anti-parallel diode. Electrothermal simulations are implemented to investigate steady state junction temperatures of paralleled devices considering unbalanced switching losses at different thermal coupling conditions. It is observed that both devices' junction temperatures will increase as the coupling coefficient is increased. However, the junction temperature imbalance will decrease. This is verified by the experiment result.

Design, Control and Application of Modular Multilevel Converters for HVDC Transmission Systems is a comprehensive guide to semiconductor technologies applicable for MMC design, component sizing control, modulation, and application of the MMC technology for HVDC transmission. Separated into three distinct parts, the first offers an overview of MMC technology, including information on converter component sizing, Control and Communication, Protection and Fault Management, and Generic Modelling and Simulation. The second covers the applications of MMC in offshore WPP, including planning, technical and economic requirements and optimization options, fault management, dynamic and transient stability. Finally, the third chapter explores the applications of MMC in HVDC transmission and Multi Terminal configurations, including Supergrids. Key features: Unique coverage of the offshore application and optimization of MMC-HVDC schemes for the export of offshore wind energy to the mainland. Comprehensive explanation of MMC application in HVDC and MTDC transmission technology. Detailed description of MMC components, control and modulation, different modeling approaches, converter dynamics under steady-state and fault contingencies including application and housing of MMC in HVDC schemes for onshore and offshore. Analysis of DC fault detection and protection technologies, system studies required for the integration of HVDC terminals to offshore wind power plants, and commissioning procedures for onshore and offshore HVDC terminals. A set of self-explanatory simulation models for HVDC test cases is available to download from the companion website. This book provides essential reading for graduate students and researchers, as well as field engineers and professionals who require an in-depth understanding of MMC technology.

The IGBT device has proved to be a highly important Power Semiconductor, providing the basis for adjustable speed motor drives (used in air conditioning and refrigeration and railway locomotives), electronic ignition systems for gasolinepowered motor vehicles and energy-saving compact fluorescent light bulbs. Recent applications include plasma displays (flat-screen TVs) and electric power transmission systems, alternative energy systems and energy storage. This book is the first available to cover the applications of the IGBT, and provide the essential information needed by applications engineers to design new products using the device, in sectors including consumer, industrial, lighting, transportation, medical and renewable energy. The author, B. Jayant Baliga, invented the IGBT in 1980 while working for GE. His book will unlock IGBT for a new generation of engineering applications, making it essential reading for a wide audience of electrical engineers and design engineers, as well as an important publication for semiconductor specialists. Essential design information for applications engineers utilizing IGBTs in the consumer, industrial, lighting, transportation, medical and renewable energy sectors. Readers will learn the methodology for the design of IGBT chips including edge terminations, cell topologies, gate layouts, and integrated current sensors. The first book to cover applications of the IGBT, a device manufactured around the world by more than a dozen companies with sales exceeding $5 Billion; written by the inventor of the device.

High Performance Control of AC Drives with Matlab®/Simulink Explore this indispensable update to a popular graduate text on electric drive techniques and the latest converters used in industry The Second Edition of High Performance Control of AC Drives with Matlab®/Simulink delivers an updated and thorough overview of topics central to the understanding of AC motor drive systems. The book includes new material on medium voltage drives, covering state-of-the-art technologies and challenges in the industrial drive system, as well as their components, and control, current source inverter-based drives, PWM techniques for multilevel inverters, and low switching frequency modulation for voltage source inverters. This book covers three-phase and multiphase (more than three-phase) motor drives including their control and practical problems faced in the field (e.g., adding LC

filters in the output of a feeding converter), are considered. The new edition contains links to Matlab®/Simulink models and PowerPoint slides ideal for teaching and understanding the material contained within the book. Readers will also benefit from the inclusion of: A thorough introduction to high performance drives, including the challenges and requirements for electric drives and medium voltage industrial applications An exploration of mathematical and simulation models of AC machines, including DC motors and squirrel cage induction motors A treatment of pulse width modulation of power electronic DC-AC converter, including the classification of PWM schemes for voltage source and current source inverters Examinations of harmonic injection PWM and field-oriented control of AC machines Voltage source and current source inverter-fed drives and their control Modelling and control of multiphase motor drive system Supported with a companion website hosting online resources. Perfect for senior undergraduate, MSc and PhD students in power electronics and electric drives, High Performance Control of AC Drives with Matlab®/Simulink will also earn a place in the libraries of researchers working in the field of AC motor drives and power electronics engineers in industry.
Silicon Carbide - this easy to manufacture compound of silicon and carbon is said to be THE emerging material for applications in electronics. High thermal conductivity, high electric field breakdown strength and high maximum current density make it most promising for high-powered semiconductor devices. Apart from applications in power electronics, sensors, and NEMS, SiC has recently gained new interest as a substrate material for the manufacture of controlled graphene. SiC and graphene research is oriented towards end markets and has high impact on areas of rapidly growing interest like electric vehicles. This volume is devoted to high power devices products and their challenges in industrial application. Readers will benefit from reports on development and reliability aspects of Schottky barrier diodes, advantages of SiC power MOSFETs, or SiC sensors. The authors discuss MEMS and NEMS as SiC-based electronics for automotive industry as well as SiC-based circuit elements for high temperature applications, and the application of transistors in PV-inverters. The list of contributors reads like a "Who's Who" of the SiC community, strongly benefiting from collaborations between research institutions and enterprises active in SiC crystal growth and device development. Among the former are CREE Inc. and Fraunhofer ISE, while the industry is represented by Toshiba, Nissan, Infineon, NASA, Naval Research Lab, and Rensselaer Polytechnic Institute, to name but a few.
Power Electronics Handbook, Fourth Edition, brings together over 100 years of combined experience in the specialist areas of power engineering to offer a fully revised and updated expert guide to total power solutions. Designed to provide the best technical and most commercially viable solutions available, this handbook undertakes any or all aspects of a project requiring specialist design, installation, commissioning and maintenance services. Comprising a complete revision throughout and enhanced chapters on semiconductor diodes and transistors and thyristors, this volume includes renewable resource content useful for the new generation of engineering professionals. This market leading reference has new chapters covering electric traction theory and motors and wide band gap (WBG) materials and devices. With this book in hand, engineers will be able to execute design, analysis and evaluation of assigned projects using sound engineering principles and adhering to the business policies and product/program requirements. Includes a list of leading international academic and professional contributors Offers practical concepts and developments for laboratory test plans Includes new technical chapters on electric vehicle charging and traction theory and motors Includes renewable resource content useful for the new generation of engineering professionals
Wide Bandgap Power Semiconductor Packaging: Materials, Components, and Reliability addresses the key challenges that WBG power semiconductors face during integration, including heat resistance, heat dissipation and thermal stress, noise reduction at high frequency and discrete components, and challenges in interfacing, metallization, plating, bonding and wiring. Experts on the topic present the latest research on materials, components and methods of reliability and evaluation for WBG power semiconductors and suggest solutions to pave the way for integration. As wide bandgap (WBG) power semiconductors, SiC and GaN, are the latest promising electric conversion devices because of their excellent features, such as high breakdown voltage, high frequency capability, and high heat-resistance beyond 200 C, this book is a timely resource on the topic. Examines the key challenges of wide bandgap power semiconductor packaging at various levels, including materials, components and device performance Provides the latest research on potential solutions, with an eye towards the end goal of system integration Discusses key problems, such as thermal management, noise reduction, challenges in interconnects and substrates
Wind Energy Conversion System covers the technological progress of wind energy conversion systems, along with potential future trends. It includes recently developed wind energy conversion systems such as multi-converter operation of variable-speed wind generators, lightning protection schemes, voltage flicker mitigation and prediction schemes for advanced control of wind generators. Modeling and control strategies of variable speed wind generators are discussed, together with the frequency converter topologies suitable for grid integration. Wind Energy Conversion System also describes offshore farm technologies including multi-terminal topology and space-based wind observation schemes, as well as both AC and DC based wind farm topologies. The stability and reliability of wind farms are discussed, and grid integration issues are examined in the context of the most recent industry guidelines. Wind power smoothing, one of the big challenges for transmission system operators, is a particular focus. Fault ride through and frequency fluctuation mitigation using energy storage options are also covered. Efficiency analyses are presented for different types of commercially available wind turbine generator systems, large scale wind generators using superconducting material, and the integration of offshore wind and marine current farms. Each chapter is written by a leader in the wind energy arena, making Wind Energy Conversion System a valuable reference for researchers and students of wind energy.
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.

1 Static Power Converters 2 Power Devices, Passive Components and System Integrations 3 Modeling, Simulation, EMI and Reliability 4 Electric Machines, Actuators and Sensors 5 Motor Control and Drives 6 Motion Control and Robotics 7 Conversion Technologies for Renewable Energy and Energy Saving 8 Power Electronics Applied to Transmission, Smart Grid, DC grid and Distribution Systems 9 Power Electronics and Drives Applied to Railway Systems 10 Power Electronics and Drives Applied to Electric and Hybrid Vehicles 11 Power Supply Technologies for Information and Communication Systems 12 Power Electronics and Drives Applied to Home Appliance 13 Power Electronics and Drives for Industrial Applications 14 Education in Power Electronics and Electrical Engineering 15 Other Related Topics

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.

Silicon (Si) is by far the most widely used semiconductor material for power devices. On the other hand, Si-based power devices are approaching their material limits, which has provoked a lot of efforts to find alternatives to Si-based power devices for better performance. With the rapid innovations and developments in the semiconductor industry, Silicon Carbide (SiC) power devices have progressed from immature prototypes in laboratories to a viable alternative to Si-based power devices in high-efficiency and high-power density applications. SiC devices have numerous persuasive advantages--high-breakdown voltage, high-operating electric field, high-operating temperature, high-switching frequency and low losses. Silicon Carbide (SiC) devices belong to the so-called wide band gap semiconductor group, which offers a number of attractive characteristics for high voltage power semiconductors when compared to commonly used silicon (Si). Recently, some SiC power devices, for example, Schottky-barrier diodes (SBDs), metal-oxide-semiconductor field-effecttransistors (MOSFETs), junction FETs (JFETs), and their integrated modules have come onto the market. Physics and Technology of Silicon Carbide Devices abundantly describes recent technologies on manufacturing, processing, characterization, modeling, etc. for SiC devices.

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

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.

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.

This report documents the impact of the Megawatt Program on SiC power development. The executive summary section contains an extensive discussion of the program objectives, technical approach, technical challenges, development tasks, program accomplishments, transition and scientific results. This program has advanced the SiC power device technology on many fronts spanning from devices to applications. Specifically, high performance PiN diodes, GTOs, DIMOS and MGTs were designed, simulated and characterized; manufacturable processes for PiN diodes and GTOs were developed; their static and dynamic

performance was evaluated; Si and SiC hybrid half-bridge inverter modules were fabricated; and novel application concepts for SiC power devices were formulated and analyzed. The knowledge accumulated under this program was shared with the sponsor and the DoD community at first and then published to accelerate the technology transition.