

## Sic Power Module Rohm

Unfriendly to conventional electronic devices, circuits, and systems, extreme environments represent a serious challenge to designers and mission architects. The first truly comprehensive guide to this specialized field, *Extreme Environment Electronics* explains the essential aspects of designing and using devices, circuits, and electronic systems intended to operate in extreme environments, including across wide temperature ranges and in radiation-intense scenarios such as space. The *Definitive Guide to Extreme Environment Electronics* Featuring contributions by some of the world's foremost experts in extreme environment electronics, the book provides in-depth information on a wide array of topics. It begins by describing the extreme conditions and then delves into a description of suitable semiconductor technologies and the modeling of devices within those technologies. It also discusses reliability issues and failure mechanisms that readers need to be aware of, as well as best practices for the design of these electronics. Continuing beyond just the "paper design" of building blocks, the book rounds out coverage of the design realization process with verification techniques and chapters on electronic packaging for extreme environments. The final set of chapters describes actual chip-level designs for applications in energy and space exploration. Requiring only a basic background in electronics, the book combines theoretical and practical aspects in each self-contained chapter. Appendices supply additional background material. With its broad coverage and depth, and the expertise of the contributing authors, this is an invaluable reference for engineers, scientists, and technical managers, as well as researchers and graduate students. A hands-on resource, it explores what is required to successfully operate electronics in the most demanding conditions.

This comprehensive handbook provides readers with a single-source reference to the theoretical fundamentals, physical mechanisms and principles of operation of all known microwave devices and various radars. The author discusses proven methods of computation and design development, process, schematic, schematic-technical and construction peculiarities of each breed of the microwave devices, as well as the most popular and original technical solutions for radars. Coverage also includes the history of creation of the most widely used radars, as well as guidelines for their potential upgrading. Offers readers a comprehensive, systematized view of all contemporary knowledge, acquired during the last 20 years, on radars and related disciplines; Provides a single-source reference on the physical mechanisms and principles of operation of the basic components of radio location devices, including theoretical aspects of designing the necessary, high-efficiency electronic devices and systems, as well as key, practical methods of computation and design; Presents complex topics using simple language, minimizing mathematics.

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.

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.

Today, there is a great deal of attention focused on sustainable growth worldwide. The increase in efficiency in the use of energy may even, in this historical moment, bring greater benefit than the use of renewable energies. Electricity appears to be the most sustainable of energies and the most promising hope for a planet capable of growing without compromising its own health and that of its inhabitants. Power electronics and electrical drives are the key technologies that will allow energy savings through the reduction of energy losses in many applications. This Special Issue has collected several scientific contributions related to energy efficiency in electrical equipment. Some articles are dedicated to the use and optimization of permanent magnet motors, which allow obtaining the highest level of efficiency. Most of the contributions describe the energy improvements that can be achieved with power electronics and the use of suitable control techniques. Last but not least, some articles describe interesting solutions for hybrid vehicles, which were created mainly to save energy in the smartest way possible.

Technologies that enable powering a device without the need for being connected with a cable to the grid are gaining attention in recent years due to the advantages that they provide. They are a commodity to users and provide additional functionalities that

promote autonomy among the devices. *Emerging Capabilities and Applications of Wireless Power Transfer* is an essential reference source that analyzes the different applications of wireless power transfer technologies and how the technologies are adapted to fulfill the electrical, magnetic, and design-based requirements of different applications. Featuring research on topics such as transfer technologies, circuit analysis, and inductive power transfer, this book is a vital resource for academicians, electrical engineers, scientists, researchers, and industry professionals seeking coverage on device power and creating autonomy through alternative power options for devices.

Designing and building power semiconductor modules requires a broad, interdisciplinary base of knowledge and experience, ranging from semiconductor materials and technologies, thermal management, and soldering to environmental constraints, inspection techniques, and statistical process control. This diversity poses a significant challenge to engine

This exploration of the technical progress of wind energy conversion systems also examines potential future trends and includes recently developed systems such as those for multi-converter operation of variable-speed wind generators and lightning protection.

Take the "black magic" out of switching power supplies with *Practical Switching Power Supply Design!* This is a comprehensive "hands-on" guide to the theory behind, and design of, PWM and resonant switching supplies. You'll find information on switching supply operation and selecting an appropriate topology for your application. There's extensive coverage of buck, boost, flyback, push-pull, half bridge, and full bridge regulator circuits. Special attention is given to semiconductors used in switching supplies. RFI/EMI reduction, grounding, testing, and safety standards are also detailed. Numerous design examples and equations are given and discussed. Even if your primary expertise is in logic or microprocessor engineering, you'll be able to design a power supply that's right for your application with this essential guide and reference! Gives special attention to resonant switching power supplies, a state-of-the-art trend in switching power supply design Approaches switching power supplies in an organized way beginning with the advantages of switching supplies and their basic operating principles Explores various configurations of pulse width modulated (PWM) switching supplies and gives readers ideas for the direction of their designs Especially useful for practicing design engineers whose primary specialty is not in analog or power engineering fields

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 AlGaIn/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.

Hybrid energy systems integrate multiple sources of power generation, storage, and transport mechanisms and can facilitate increased usage of cleaner, renewable, and more efficient energy sources. *Hybrid Power: Generation, Storage, and Grids* discusses hybrid energy systems from fundamentals through applications and discusses generation, storage, and grids. *Highlights fundamentals and applications of hybrid energy storage* Discusses use in hybrid and electric vehicles and home energy needs *Discusses issues related to hybrid renewable energy systems connected to the utility grid* *Describes the usefulness of hybrid microgrids and various forms of off-grid energy such as mini-grids, nanogrids, and stand-alone systems* *Covers the use of hybrid renewable energy systems for rural electrification around the world* *Discusses various forms and applications of hybrid energy systems, hybrid energy storage, hybrid microgrids, and hybrid off-grid energy systems* *Details simulation and optimization of hybrid renewable energy systems* This book is aimed at advanced students and researchers in academia, government, and industry, seeking a comprehensive overview of the basics, technologies, and applications of hybrid energy systems.

*Compiles current research into the analysis and design of power electronic converters for industrial applications and renewable energy systems, presenting modern and future applications of power electronics systems in the field of electrical vehicles* *With emphasis on the importance and long-term viability of Power Electronics for Renewable Energy* this book brings together the state of the art knowledge and cutting-edge techniques in various stages of research. The topics included are not currently available for practicing professionals and aim to enable the reader to directly apply the knowledge gained to their designs. The book addresses the practical issues of current and future electric and plug-in hybrid electric vehicles (PHEVs), and focuses primarily on power electronics and motor drives based solutions for electric vehicle (EV) technologies. Propulsion system requirements and motorsizing for EVs is discussed, along with practical system sizing examples. Key EV battery technologies are explained as well as corresponding battery management issues. PHEV power system architectures and advanced power electronics intensive charging infrastructures for EVs and PHEVs are detailed. EV/PHEV interface with renewable energy is described, with practical examples. This book explores new topics for further research needed world-wide, and defines existing challenges, concerns, and selected problems that comply with international trends, standards, and programs for electric power conversion, distribution, and sustainable energy development. It will lead to the advancement of the current state-of-the-art applications of power electronics for renewable energy, transportation, and industrial applications and will help add experience in the various industries and academia about the energy conversion technology and distributed energy sources. Combines state of the art global expertise to present the latest research on power electronics and its application in transportation, renewable energy and different industrial applications *Offers an overview of existing technology and future trends, with*

discussion and analysis of different types of converters and control techniques (power converters, high performance power devices, power system, high performance control system and novel applications) Systematic explanation to provide researchers with enough background and understanding to go deeper in the topics covered in the book 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 gasoline powered 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.

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

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.

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.

The comprehensive and authoritative guide to power electronics in renewable energy systems Power electronics plays a significant role in modern industrial automation and high- efficiency energy systems. With contributions from an international group of noted experts, Power Electronics in Renewable Energy Systems and Smart Grid: Technology and Applications offers a comprehensive review of the technology and applications of power electronics in renewable energy systems and smart grids. The authors cover information on a variety of energy systems including wind, solar, ocean, and geothermal energy systems as well as fuel cell systems and bulk energy storage systems. They also examine smart grid elements, modeling, simulation, control, and AI applications. The book's twelve chapters offer an application-oriented and tutorial viewpoint and also contain technology status review. In addition, the book contains

illustrative examples of applications and discussions of future perspectives. This important resource: Includes descriptions of power semiconductor devices, two level and multilevel converters, HVDC systems, FACTS, and more Offers discussions on various energy systems such as wind, solar, ocean, and geothermal energy systems, and also fuel cell systems and bulk energy storage systems Explores smart grid elements, modeling, simulation, control, and AI applications Contains state-of-the-art technologies and future perspectives Provides the expertise of international authorities in the field Written for graduate students, professors in power electronics, and industry engineers, *Power Electronics in Renewable Energy Systems and Smart Grid: Technology and Applications* offers an up-to-date guide to technology and applications of a wide-range of power electronics in energy systems and smart grids.

*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.

Unmanned aerial vehicles (UAVs) are being increasingly used in different applications in both military and civilian domains. These applications include surveillance, reconnaissance, remote sensing, target acquisition, border patrol, infrastructure monitoring, aerial imaging, industrial inspection, and emergency medical aid. Vehicles that can be considered autonomous must be able to make decisions and react to events without direct intervention by humans. Although some UAVs are able to perform increasingly complex autonomous manoeuvres, most UAVs are not fully autonomous; instead, they are mostly operated remotely by humans. To make UAVs fully

autonomous, many technological and algorithmic developments are still required. For instance, UAVs will need to improve their sensing of obstacles and subsequent avoidance. This becomes particularly important as autonomous UAVs start to operate in civilian airspaces that are occupied by other aircraft. The aim of this volume is to bring together the work of leading researchers and practitioners in the field of unmanned aerial vehicles with a common interest in their autonomy. The contributions that are part of this volume present key challenges associated with the autonomous control of unmanned aerial vehicles, and propose solution methodologies to address such challenges, analyse the proposed methodologies, and evaluate their performance.

Power electronics technology is still an emerging technology, and it has found its way into many applications, from renewable energy generation (i.e., wind power and solar power) to electrical vehicles (EVs), biomedical devices, and small appliances, such as laptop chargers. In the near future, electrical energy will be provided and handled by power electronics and consumed through power electronics; this not only will intensify the role of power electronics technology in power conversion processes, but also implies that power systems are undergoing a paradigm shift, from centralized distribution to distributed generation. Today, more than 1000 GW of renewable energy generation sources (photovoltaic (PV) and wind) have been installed, all of which are handled by power electronics technology. The main aim of this book is to highlight and address recent breakthroughs in the range of emerging applications in power electronics and in harmonic and electromagnetic interference (EMI) issues at device and system levels as discussed in ?robust and reliable power electronics technologies, including fault prognosis and diagnosis technique stability of grid-connected converters and ?smart control of power electronics in devices, microgrids, and at system levels.

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. In this book, nine papers focusing on different fields of power electronics are gathered, all of which are in line with the present trends in research and industry. Given the generality of the Special Issue, the covered topics range from electrothermal models and losses models in semiconductors and magnetics to converters used in high-power applications. In this last case, the papers address specific problems such as the distortion due to zero-current detection or fault investigation using the fast Fourier transform, all being focused on analyzing the topologies of high-power high-density applications, such as the dual active bridge or the H-bridge multilevel inverter. All the papers provide enough insight in the analyzed issues to be used as the starting point of any research. Experimental or simulation results are presented to validate and help with the understanding of the proposed ideas. To summarize, this book will help the reader to solve specific problems in industrial equipment or to increase their knowledge in specific fields.

Continuous cost reduction of photovoltaic (PV) systems and the rise of power auctions resulted in the establishment of PV power not only as a green energy source but also as a cost-effective solution to the electricity generation market. Various commercial solutions for grid-connected PV systems are available at any power level, ranging from multi-megawatt utility-scale solar farms to sub-kilowatt residential PV installations. Compared to utility-scale systems, the feasibility of small-scale residential PV installations is still limited by existing technologies that have not yet properly address issues like operation in weak grids, opaque and partial shading, etc. New market drivers such as warranty improvement to match the PV module lifespan, operation voltage range extension for application flexibility, and embedded energy storage for load shifting have again put small-scale PV systems in the spotlight. This Special Issue collects the latest developments in the field of power electronic converter topologies, control, design, and optimization for better energy yield, power conversion efficiency, reliability, and longer lifetime of the small-scale PV systems. This Special Issue will serve as a reference and update for academics, researchers, and practicing engineers to inspire new research and developments that pave the way for next-generation PV systems for residential and small commercial applications.

Volume is indexed by Thomson Reuters CPCI-S (WoS). This volume is divided into 3 chapters. The first, focused on Materials and Elaboration Techniques, describes various types of material such as composites, polymers, semiconductors, metals, ceramics, bio-materials, inorganic alloys, textile, porous, crystalline, amorphous and hybrids elaborated by various means such as vapor-phase, liquid-phase, plasma, ion-based and laser-assisted techniques, soft chemistry, self-assembly, bonding, sintering, and including bulk, surface, interface, thin-film and nano-materials. The second chapter, on Characterization Techniques and Properties, covers both physical (optical, structural, electrical, mechanical, magnetic, damage, aging...) and chemical (surface and bulk composition, imaging, impurity, reactivity, catalysis, aging, oxidation, corrosion) aspects. The last chapter, Applications, focuses on subjects such as: (i) environment and energy (renewable energy, storage and energy conversion, transport),

(ii) health, biomedical and life science, (iii) electronic devices and systems (micro-nano electronics, power electronics, photonics and optoelectronics, systems, storage and heat management) and (iv) cultural heritage (e.g. archeology).

### SiC based Miniaturized Devices MDPI

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.

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 experiencing 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.

Die anspruchsvollen CO<sub>2</sub>-Ziele bis 2030/2050 werden unser Mobilitätsverhalten massiv verändern. Ein wichtiger Beitrag wird von elektrifizierten Fahrzeugantrieben erwartet. Das Buch gibt einen Überblick über alle heute diskutierten elektrifizierten Antriebskonzepte für Pkw vom Mikro-Hybrid bis zum Brennstoffzellen-Auto. Neben den Definitionen werden die einzelnen Komponenten für den elektrifizierten Antrieb, wie z.B. E-Motoren, Batterien, Supercaps, Leistungselektronik, Brennstoffzellen Getriebe und Aktoren auf der Ebene eines Basiswissens beschrieben. Die einzelnen Architekturen und Topologien der Hybride werden ebenso wie die reinen Elektroantriebe vorgestellt. Zum Gesamtsystem gehören das Thermomanagement, die Typgenehmigung, die besonderen Herausforderungen an die Akustik sowie elektromagnetische Verträglichkeit (EMV). Der Umgang mit den Hochvolt-Systemen erfordert neue Sicherheitsstandards und die Ladetechnik gehört zu den Schlüsseltechnologien für die Akzeptanz der Batterie-Elektrofahrzeuge. Der Brennstoffzellen basierte Elektroantrieb zeigt weitere Möglichkeiten für die Zukunft auf. Die Auswirkungen der Teilelektrifizierung des Antriebs auf den Verbrennungsmotor im hybriden Antriebskonzept runden die Betrachtungen ab.

A comprehensive introduction and up-to-date reference to SiC power semiconductor devices covering topics from material properties to applications. Based on a number of breakthroughs in SiC material science and fabrication technology in the 1980s and 1990s, the first SiC Schottky barrier diodes (SBDs) were released as commercial products in 2001. The SiC SBD market has grown significantly since that time, and SBDs are now used in a variety of power systems, particularly switch-mode power supplies and motor controls. SiC power MOSFETs entered commercial production in 2011, providing rugged, high-efficiency switches for high-frequency power systems. In this wide-ranging book, the authors draw on their considerable experience to present both an introduction to SiC materials, devices, and applications and an in-depth reference for scientists and engineers working in this fast-moving field. Fundamentals of Silicon Carbide Technology covers basic properties of SiC materials, processing technology, theory and analysis of practical devices, and an overview of the most important systems applications. Specifically included are: A complete discussion of SiC material properties, bulk crystal growth, epitaxial growth, device fabrication technology, and characterization techniques. Device physics and operating

equations for Schottky diodes, pin diodes, JBS/MPS diodes, JFETs, MOSFETs, BJTs, IGBTs, and thyristors. A survey of power electronics applications, including switch-mode power supplies, motor drives, power converters for electric vehicles, and converters for renewable energy sources. Coverage of special applications, including microwave devices, high-temperature electronics, and rugged sensors. Fully illustrated throughout, the text is written by recognized experts with over 45 years of combined experience in SiC research and development. This book is intended for graduate students and researchers in crystal growth, material science, and semiconductor device technology. The book is also useful for design engineers, application engineers, and product managers in areas such as power supplies, converter and inverter design, electric vehicle technology, high-temperature electronics, sensors, and smart grid technology.

The book presents an in-depth review and analysis of Silicon Carbide device processing. The main topics are: (1) Silicon Carbide Discovery, Properties and Technology, (2) Processing and Application of Dielectrics in Silicon Carbide Devices, (3) Doping by Ion Implantation, (4) Plasma Etching and (5) Fabrication of Silicon Carbide Nanostructures and Related Devices. The book is also suited as supplementary textbook for graduate courses. Keywords: Silicon Carbide, SiC, Technology, Processing, Semiconductor Devices, Material Properties, Polytypism, Thermal Oxidation, Post Oxidation Annealing, Surface Passivation, Dielectric Deposition, Field Effect Mobility, Ion Implantation, Post Implantation Annealing, Channeling, Surface Roughness, Dry Etching, Plasma Etching, Ion Etching, Sputtering, Chemical Etching, Plasma Chemistry, Micromasking, Microtrenching, Nanocrystal, Nanowire, Nanotube, Nanopillar, Nanoelectromechanical Systems (NEMS).

This book presents the art of advanced MOSFET modeling for integrated circuit simulation and design. It provides the essential mathematical and physical analyses of all the electrical, mechanical and thermal effects in MOS transistors relevant to the operation of integrated circuits. Particular emphasis is placed on how the BSIM model evolved into the first ever industry standard SPICE MOSFET model for circuit simulation and CMOS technology development. The discussion covers the theory and methodology of how a MOSFET model, or semiconductor device models in general, can be implemented to be robust and efficient, turning device physics theory into a production-worthy SPICE simulation model. Special attention is paid to MOSFET characterization and model parameter extraction methodologies, making the book particularly useful for those interested or already engaged in work in the areas of semiconductor devices, compact modeling for SPICE simulation, and integrated circuit design. 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.

Due to the increasing world population, energy consumption is steadily climbing, and there is a demand to provide solutions for sustainable and renewable energy production, such as wind turbines and photovoltaics. Power electronics are being used to interface renewable sources in order to maximize the energy yield, as well as smoothly integrate them within the grid. In many cases, power electronics are able to ensure a large amount of energy saving in pumps, compressors, and ventilation systems. This book explains the operations behind different renewable generation technologies in order to better prepare the reader for practical applications. Multiple chapters are included on the state-of-the-art and possible technology developments within the next 15 years. The book provides a comprehensive overview of the current renewable energy technology in terms of system configuration, power circuit usage, and control. It contains two design examples for small wind turbine system and PV power system, respectively, which are useful for real-life installation, as well as many computer simulation models.

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. *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

Halbleiter-Leistungsbaulemente sind das Kernstück der Leistungselektronik. Sie bestimmen die Leistungsfähigkeit und machen neuartige und verlustarme Schaltungen erst möglich. In dem Band wird neben den Halbleiter-Leistungsbaulementen 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.

Described as "Who owns whom, the family tree of every major corporation in America," the directory is indexed by name (parent and subsidiary), geographic location, Standard Industrial Classification (SIC) Code, and corporate responsibility.

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