Sic Power Devices And Modules Rohm Semiconductor

ELLIANA MYLA

Modeling And Electrothermal Simulation Of Sic Power Devices: Using Silvaco© Atlas Springer Nature
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.

High Performance Control of AC Drives with Matlab/Simulink The Electrochemical Society
Power Electronic Packaging presents an in-depth overview of power electronic packaging design, assembly,reliability and modeling. Since there is a drastic difference between IC fabrication and power electronic packaging, the book systematically introduces typical power electronic packaging design, assembly, reliability and failure analysis and material selection so readers can clearly understand each task's unique characteristics. Power electronic packaging is one of the fastest growing segments in the power electronic industry, due to the rapid growth of power integrated circuit (IC) fabrication, especially for applications like portable,

consumer, home, computing and automotive electronics. This book also covers how advances in both semiconductor content and power advanced package design have helped cause advances in power device capability in recent years. The author extrapolates the most recent trends in the book's areas of focus to highlight where further improvement in materials and techniques can drive continued advancements, particularly in thermal management, usability, efficiency, reliability and overall cost of power semiconductor solutions.

Gallium Nitride and Silicon Carbide Power Technologies 7 CRC Press

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.

Wind Energy Conversion Systems Energy Engineering

APEC focuses on the practical and applied aspects of the power electronics business The conference addresses issues of immediate and long term importance to practicing power electronics engineer

Gallium Nitride Power Devices Springer Science & Business Media

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.

Power Electronics Handbook BoD – Books on Demand

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.

High Power SiC Modules for HEVs and PHEVs Springer Science & Business Media

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 SiC Power Module DesignPerformance, Robustness and Reliability

Technical scope of the conference covers power semiconductor devices and power integrated circuits, including but not limited to device physics, modeling, design, fabrication, materials, packaging and integration, device reliability, and device circuit interactions It will include 6 different technical tracks, namely, High Voltage Power Devices (HV), Low Voltage Devices and Power IC Device Technology (LVT), Power IC Design (ICD), GaN and Nitride Base Compound Materials (GaN), SiC and Other Materials (SiC), Module and Package Technologies (PK)

2021 33rd International Symposium on Power Semiconductor Devices and ICs (ISPSD) MDPI

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.

Gallium Nitride and Silicon Carbide Power Technologies 4 The Electrochemical Society

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 Lmiddle 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 Lmiddle. Experiment results show that as Lmiddle 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.

Growth, Characterization, Devices and Applications World Scientific Publishing Company

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.

Physics and Technology of Silicon Carbide Devices Materials Research Forum LLC

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.

Materials, Physics, Design, and Applications CRC Press

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.

Performance, Robustness and Reliability John Wiley & Sons

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2018 International Power Electronics Conference (IPEC Niigata 2018 ECCE Asia) Artech House

ADEPT Project: Cree is developing silicon carbide (SiC) power transistors that are 50% more energy efficient than traditional transistors. Transistors act like a switch, controlling the electrical energy that flows through an electrical circuit. Most power transistors today use silicon semiconductors to conduct electricity. However, transistors with SiC semiconductors operate at much higher temperatures, as well as higher voltage and power levels than their silicon counterparts. SiC-based transistors are also smaller and require less cooling than those made with traditional silicon power technology. Cree's SiC transistors will enable electrical circuits to handle higher power levels more efficiently, and they will result in much smaller and lighter electrical devices and power converters. Cree, an established leader in SiC technology, has already released a commercially available SiC transistor that can operate at up to 1,200 volts. The company has also demonstrated a utility-scale SiC transistor that operates at up to 15,000 volts.

Metal Contacts to Silicon Carbide: Physics, Technology, Applications John Wiley & Sons

SiC Power Module DesignPerformance, Robustness and ReliabilityIET

15 KV SiC IGBT Power Modules for Grid Scale Power Conversion John Wiley & Sons

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

Silicon Carbide, Volume 2 World Scientific

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.

Wide Bandgap Semiconductor Power Devices World Scientific

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

GaN Transistors for Efficient Power Conversion Woodhead Publishing

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