

# Modern Semiconductor Devices For Integrated Circuits

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Semiconductor Devices: Physics and Technology, 3rd Edition

## Atomic Layer Deposition for Semiconductors

Learn the basic properties and designs of modern VLSI devices, as well as the factors affecting performance, with this thoroughly updated second edition. The first edition has been widely adopted as a standard textbook in microelectronics in many major US universities and worldwide. The internationally renowned authors highlight the intricate interdependencies and subtle trade-offs between various practically important device parameters, and provide an in-depth discussion of device scaling and scaling limits of CMOS and bipolar devices. Equations and parameters provided are checked continuously against the reality of silicon data, making the book equally useful in practical transistor design and in the classroom. Every chapter has been updated to include the latest developments, such as MOSFET scale length theory, high-field transport model and SiGe-base bipolar devices.

## Semiconductor Device Physics and Design

This book, Amplifiers: Analysis and Design, is the second of four books of a larger work, Fundamentals of Electronics. It is comprised of four chapters that describe the fundamentals of amplifier performance. Beginning with a review of two-port analysis, the first chapter introduces the modeling of the response of transistors to AC signals. Basic one-transistor amplifiers are extensively discussed. The next

chapter expands the discussion to multiple transistor amplifiers. The coverage of simple amplifiers is concluded with a chapter that examines power amplifiers. This discussion defines the limits of small-signal analysis and explores the realm where these simplifying assumptions are no longer valid and distortion becomes present. The final chapter concludes the book with the first of two chapters in *Fundamentals of Electronics* on the significant topic of feedback amplifiers. *Fundamentals of Electronics* has been designed primarily for use in an upper division course in electronics for electrical engineering students. Typically such a course spans a full academic year consisting of two semesters or three quarters. As such, *Amplifiers: Analysis and Design*, and two other books, *Electronic Devices and Circuit Applications*, and *Active Filters and Amplifier Frequency Response*, form an appropriate body of material for such a course. Secondary applications include the use with *Electronic Devices and Circuit Applications* in a one-semester electronics course for engineers or as a reference for practicing engineers.

## **Modern Semiconductor Devices for Integrated Circuits**

Circuit simulation is essential in integrated circuit design, and the accuracy of circuit simulation depends on the accuracy of the transistor model. BSIM3v3 (BSIM for Berkeley Short-channel IGFET Model) has been selected as the first MOSFET model for standardization by the Compact Model Council, a consortium of leading companies in semiconductor and design tools. In the next few years, many fabless and integrated semiconductor companies are expected to switch from dozens of other MOSFET models to BSIM3. This will require many device engineers and most circuit designers to learn the basics of BSIM3. *MOSFET Modeling & BSIM3 User's Guide* explains the detailed physical effects that are important in modeling MOSFETs, and presents the derivations of compact model expressions so that users can understand the physical meaning of the model equations and parameters. It is the first book devoted to BSIM3. It treats the BSIM3 model in detail as used in digital, analog and RF circuit design. It covers the complete set of models, i.e., I-V model, capacitance model, noise model, parasitics model, substrate current model, temperature effect model and non quasi-static model. *MOSFET Modeling & BSIM3 User's Guide* not only addresses the device modeling issues but also provides a user's guide to the device or circuit design engineers who use the BSIM3 model in digital/analog circuit design, RF modeling, statistical modeling, and technology prediction. This book is written for circuit designers and device engineers, as well as device scientists worldwide. It is also suitable as a reference for graduate courses and courses in circuit design or device modelling. Furthermore, it can be used as a textbook for industry courses devoted to BSIM3. *MOSFET Modeling & BSIM3 User's Guide* is comprehensive and practical. It is balanced between the background information and advanced discussion of BSIM3. It is helpful to experts and students alike.

## **Fundamentals of Electronics: Book 1**

The book covers the entire topic from the basics of optoelectronics, device physics of photodetectors and light emitters, simulation of photodetectors, and technological aspects of optoelectronic integration in microelectronics to circuit aspects and practical applications. It summarizes the state of the art in integrated silicon optoelectronics and reviews recent publications on this topic. Results of

basic research on silicon light emitters are included as well, while published results are compared with each other and with the work of the author.

## **Compact Models for Integrated Circuit Design (Open Access)**

GaAs processing has reached a mature stage. New semiconductor compounds are emerging that will dominate future materials and device research, although the processing techniques used for GaAs will still remain relevant. This book covers all aspects of the current state of the art of III-V processing, with emphasis on HBTs. It is aimed at practicing engineers and graduate students and engineers new to the field of III-V semiconductor IC processing. The book's primary purpose is to discuss all aspects of processing of active and passive devices, from crystal growth to backside processing, including lithography, etching, and film deposition.

## **Principles of Semiconductor Devices**

The book summarizes and compares recent advancements in the development of novel lateral power transistors (LDMOS devices) for integrated circuits in power electronic applications. In its first part, the book motivates the necessity for lateral power transistors by a top-down approach: First, it presents typical energy conversion applications in modern industrial, automotive and consumer electronics. Next, it introduces common circuit topologies suitable for these applications, and discusses the feasibility for monolithic integration. Finally, the combination of power and logic functionality on a single chip is motivated and the requirements and limitations for the power semiconductor devices are deduced. The second part describes the evolution of lateral power transistors over the past decades from the simple pin-type concept to double-acting RESURF topologies. It describes the principle of operation for these LDMOS devices and discusses limitations of lateral power devices. Moreover, figures-of-merit are presented which can be used to evaluate the performance of the novel lateral power transistors described in this book with respect to the LDMOS devices. In the last part, [...] the fundamental physical concepts including charge compensation and trench gate topologies are discussed. Also, the status of research in LDMOS devices on silicon carbide is presented. Advantages and drawbacks for each of these integration approaches are summarized, and the feasibility with respect to power electronic applications is evaluated.

## **Fundamentals of Electronics: Book 2**

### **Semiconductor Device Modeling with Spice**

Modern Semiconductor Quantum Physics has the following constituents: (1) energy band theory: pseudopotential method (empirical and ab initio); density functional theory; quasi-particles; LCAO method; k.p method; spin-orbit splitting; effective mass and Luttinger parameters; strain effects and deformation potentials; temperature effects. (2) Optical properties: absorption and exciton effect; modulation spectroscopy; photo luminescence and photo luminescence excitation; Raman scattering and polaritons; photoionization. (3) Defects and Impurities: effective

mass theory and shallow impurity states; deep state cluster method, super cell method, Green's function method; carrier recombination kinetics; trapping transient measurements; electron spin resonance; electron lattice interaction and lattice relaxation effects; multi-phonon nonradiative recombination; negative U center, DX center and EL2 Defects. (4) Semiconductor surfaces: two dimensional periodicity and surface reconstruction; surface electronic states; photo-electron spectroscopy; LEED, STM and other experimental methods. (5) Low-dimensional structures: Heterojunctions, quantum wells; superlattices, quantum-confined Stark effect and Wannier-Stark ladder effects; resonant tunneling, quantum Hall effect, quantum wires and quantum dots. This book can be used as an advanced textbook on semiconductor physics for graduate students in physics and electrical engineering departments. It is also useful as a research reference for solid state scientists and semiconductor device engineers.

## Introduction to Semiconductor Device Modelling

Semiconductor Physics and Materials Intrinsic and extrinsic semiconductors, Conduction mechanism in extrinsic semiconductors, Carrier concentrations, Drift and diffusion mechanisms, Drift and diffusion current densities, Excess carriers, Recombination process, Mean carrier lifetime, Conductivity, Mobility, Mass action law, Einstein relationship. Semiconductor materials used in optoelectronic devices and modern semiconductor devices and integrated circuits - GaAs, SiGe, GaAsP. Semiconductor Diodes A brief overview of following types of diodes, their peculiarities and applications Rectifier, Signal, Switching, Power, Tunnel, Shockley, Gunn, PIN. Semiconductor P-N Junction Diode : Open circuited step graded junction, Metallurgical junctions and ohmic contacts, Depletion region, Barrier potential, Forward and reverse biased diode operation. V-I characteristic equation of diode (no derivation). Volt equivalent of temperature, Temperature dependence of V-I characteristics, DC load line. Forward and reverse dynamic resistance, Small signal and large signal diode models. Diode data sheet specifications - PIV, IFM Surge,  $I_{AV}$ . Switching Diodes - Diode switching times, Junction capacitances. (No derivations). Field Effect Transistors An overview of different types of FETs viz. JFET, MOSFET, MESFET, Peculiarities of these types and their application areas. JFET : JFET construction, Symbol, Basic operation, V-I characteristics, Transfer characteristics ( Shockley's equation), Cut-off & Pinch-off voltages, Transconductance, Input resistance & Capacitance. Drain to source resistance. Universal JFET bias curve. Biasing arrangements for JFET - Biasing against device variation, Biasing for zero current drift. JFET as voltage controlled current source. JFET data sheet specifications -  $I_{DSS}$ ,  $V_P$ ,  $g_m$ ,  $r_d$ ,  $R_{DS}$  or  $R_D$  (ON). JFET Amplifiers : CS, CD, CG amplifiers. Their analysis using small signal JFET model. MOSFETs An overview of following MOSFET types - D-MOSFET, E-MOSFET, Power MOSFET, n-MOS, p-MOS and CMOS devices. Handling precautions for CMOS devices. D and E-MOSFET characteristics and parameters, Non ideal voltage current characteristics viz. Finite output resistance, body effect, sub threshold conduction, Breakdown effects and temperature effects. MOSFET biasing, Introduction to MOSFET as VLSI device. Bipolar Junction transistor An overview of different types of BJTs - Small signal and large signal low frequency types, Switching/RF, Heterojunction types. Peculiarities of these types and their application areas. BJT Biasing and Basic Amplifier Configurations : Need for biasing BJT, DC analysis of BJT circuits, Typical junction voltages for cut-off, Active and saturation regions, Voltage divider bias and

its analysis for stability factors, Small signal-low frequency h-parameter model, Variation of h-parameters with operating point, Other small signal models, Derivations for CE configuration for  $A_i$ ,  $R_i$ ,  $R_o$ ,  $A_{vs}$ ,  $A_{vs}$  in terms of h-parameters, Comparison of performance parameters with CB and CC configurations in tabular form. Need for multistage amplifiers and suitability of CE, CC and CB configurations in multistage amplifiers, Small signal and DC data sheet specifications for BJT. Concept of frequency response, Human ear response to audio frequencies, Significance of Octaves and Decades. The decibel unit. Square wave testing of amplifiers. Miller's theorem. Effect of coupling, bypass, junction and stray capacitances on frequency response for BJT and FET amplifiers. Concept of dominant pole. N stage cascade amplifier, Band pass of cascaded stages (effect on frequency response). Concept of GBW. (No derivations).

## **Modern Semiconductor Devices for Integrated Circuits**

Fault analysis of highly-integrated semiconductor circuits has become an indispensable discipline in the optimization of product quality. Integrated Circuit Failure Analysis describes state-of-the-art procedures for exposing suspected failure sites in semiconductor devices. The author adopts a hands-on problem-oriented approach, founded on many years of practical experience, complemented by the explanation of basic theoretical principles. Features include: Advanced methods in device preparation and technical procedures for package inspection and semiconductor reliability. Illustration of chip isolation and step-by-step delayering of chips by wet chemical and modern plasma dry etching techniques. Particular analysis of bipolar and MOS circuits, although techniques are equally relevant to other semiconductors. Advice on the choice of suitable laboratory equipment. Numerous photographs and drawings providing guidance for checking results. Focusing on modern techniques, this practical text will enable both academic and industrial researchers and IC designers to expand the range of analytical and preparative methods at their disposal and to adapt to the needs of new technologies.

## **Power Integrity Analysis and Management for Integrated Circuits**

From power electronics to power integrated circuits (PICs), smart power technologies, devices, and beyond, Integrated Power Devices and TCAD Simulation provides a complete picture of the power management and semiconductor industry. An essential reference for power device engineering students and professionals, the book not only describes the physics inside integrated power semiconductor devices such as lateral double-diffused metal oxide semiconductor field-effect transistors (LDMOSFETs), lateral insulated-gate bipolar transistors (LIGBTs), and super junction LDMOSFETs but also delivers a simple introduction to power management systems. Instead of abstract theoretical treatments and daunting equations, the text uses technology computer-aided design (TCAD) simulation examples to explain the design of integrated power semiconductor devices. It also explores next generation power devices such as gallium nitride power high electron mobility transistors (GaN power HEMTs). Including a virtual process flow for smart PIC technology as well as a hard-to-find technology

development organization chart, Integrated Power Devices and TCAD Simulation gives students and junior engineers a head start in the field of power semiconductor devices while helping to fill the gap between power device engineering and power management systems.

## **Integrated Silicon Optoelectronics**

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## **Modern Semiconductor Device Physics**

Modern Semiconductor Devices for Integrated Circuits, First Edition introduces readers to the world of modern semiconductor devices with an emphasis on integrated circuit applications. KEY TOPICS: Electrons and Holes in Semiconductors; Motion and Recombination of Electrons and Holes; Device Fabrication Technology; PN and Metal-Semiconductor Junctions; MOS Capacitor; MOS Transistor; MOSFETs in ICs—Scaling, Leakage, and Other Topics; Bipolar Transistor. MARKET: Written by an experienced teacher, researcher, and expert in industry practices, this succinct and forward-looking text is appropriate for anyone interested in semiconductor devices for integrated circuits, and serves as a suitable reference text for practicing engineers.

## **History of Semiconductor Engineering**

## **Physics of Semiconductor Devices**

Compact Models for Integrated Circuit Design: Conventional Transistors and Beyond provides a modern treatise on compact models for circuit computer-aided design (CAD). Written by an author with more than 25 years of industry experience in semiconductor processes, devices, and circuit CAD, and more than 10 years of academic experience in teaching compact modeling courses, this first-of-its-kind book on compact SPICE models for very-large-scale-integrated (VLSI) chip design offers a balanced presentation of compact modeling crucial for addressing current modeling challenges and understanding new models for emerging devices. Starting from basic semiconductor physics and covering state-of-the-art device regimes from conventional micron to nanometer, this text: Presents industry standard models for bipolar-junction transistors (BJTs), metal-oxide-semiconductor (MOS) field-effect-transistors (FETs), FinFETs, and tunnel field-effect transistors (TFETs), along with statistical MOS models Discusses the major issue of process variability, which severely impacts device and circuit performance in advanced technologies and requires statistical compact models Promotes further research of the evolution and development of compact models for VLSI circuit design and analysis Supplies fundamental and practical knowledge necessary for efficient integrated circuit (IC) design using nanoscale devices Includes exercise problems at the end of each chapter and extensive references at the end of the book Compact Models for Integrated Circuit Design: Conventional Transistors and Beyond is intended for

senior undergraduate and graduate courses in electrical and electronics engineering as well as for researchers and practitioners working in the area of electron devices. However, even those unfamiliar with semiconductor physics gain a solid grasp of compact modeling concepts from this book. The Open Access version of this book, available at <https://doi.org/10.1201/b19117>, has been made available under a Creative Commons Attribution-Non Commercial-No Derivatives 4.0 license.

## **Fundamentals of Modern VLSI Devices**

Compound semiconductor devices form the foundation of solid-state microwave and optoelectronic technologies used in many modern communication systems. In common with their low frequency counterparts, these devices are often represented using equivalent circuit models, but it is often necessary to resort to physical models in order to gain insight into the detailed operation of compound semiconductor devices. Many of the earliest physical models were indeed developed to understand the 'unusual' phenomena which occur at high frequencies. Such was the case with the Gunn and IMPATI diodes, which led to an increased interest in using numerical simulation methods. Contemporary devices often have feature sizes so small that they no longer operate within the familiar traditional framework, and hot electron or even quantum mechanical models are required. The need for accurate and efficient models suitable for computer aided design has increased with the demand for a wider range of integrated devices for operation at microwave, millimetre and optical frequencies. The apparent complexity of equivalent circuit and physics-based models distinguishes high frequency devices from their low frequency counterparts . . . Over the past twenty years a wide range of modelling techniques have emerged suitable for describing the operation of compound semiconductor devices. This book brings together for the first time the most popular techniques in everyday use by engineers and scientists. The book specifically addresses the requirements and techniques suitable for modelling GaAs, InP, ternary and quaternary semiconductor devices found in modern technology.

## **Semiconductor Detector Systems**

Semiconductor Device Physics and Design teaches readers how to approach device design from the point of view of someone who wants to improve devices and can see the opportunity and challenges. It begins with coverage of basic physics concepts, including the physics behind polar heterostructures and strained heterostructures. The book then details the important devices ranging from p-n diodes to bipolar and field effect devices. By relating device design to device performance and then relating device needs to system use the student can see how device design works in the real world.

## **Lateral Power Transistors in Integrated Circuits**

This book deals mainly with physical device models which are developed from the carrier transport physics and device geometry considerations. The text concentrates on silicon and gallium arsenide devices and includes models of silicon

bipolar junction transistors, junction field effect transistors (JFETs), MESFETs, silicon and GaAs MESFETs, transferred electron devices, pn junction diodes and Schottky varactor diodes. The modelling techniques of more recent devices such as the heterojunction bipolar transistors (HBT) and the high electron mobility transistors are discussed. This book contains details of models for both equilibrium and non-equilibrium transport conditions. The modelling Technique of Small-scale devices is discussed and techniques applicable to submicron-dimensioned devices are included. A section on modern quantum transport analysis techniques is included. Details of essential numerical schemes are given and a variety of device models are used to illustrate the application of these techniques in various fields.

## **The Physics of Semiconductors**

A complete guide to current knowledge and future trends in ULSI devices Ultra-Large-Scale Integration (ULSI), the next generation of semiconductor devices, has become a hot topic of investigation. ULSI Devices provides electrical and electronic engineers, applied physicists, and anyone involved in IC design and process development with a much-needed overview of key technology trends in this area. Edited by two of the foremost authorities on semiconductor device physics, with contributions by some of the best-known researchers in the field, this comprehensive reference examines such major ULSI devices as MOSFET, nonvolatile semiconductor memory (NVSM), and the bipolar transistor, and the improvements these devices offer in power consumption, low-voltage and high-speed operation, and system-on-chip for ULSI applications. Supplemented with introductory material and references for each chapter as well as more than 400 illustrations, coverage includes: \* The physics and operational characteristics of the different components \* The evolution of device structures the ultimate limitations on device and circuit performance \* Device miniaturization and simulation \* Issues of reliability and the hot carrier effect \* Digital and analog circuit building blocks \*An Instructor's Manual presenting detailed solutions to all the problems in the book is available from the Wiley editorial department

## **Semiconductor Devices : Basic Principles**

For courses in semiconductor devices. Prepare your students for the semiconductor device technologies of today and tomorrow. Modern Semiconductor Devices for Integrated Circuits, First Edition introduces students to the world of modern semiconductor devices with an emphasis on integrated circuit applications. Written by an experienced teacher, researcher, and expert in industry practices, this succinct and forward-looking text is appropriate for both undergraduate and graduate students, and serves as a suitable reference text for practicing engineers.

## **Nonvolatile Semiconductor Memories**

## **ULSI Devices**

This book provides readers with a variety of tools to address the challenges posed by hot carrier degradation, one of today's most complicated reliability issues in

semiconductor devices. Coverage includes an explanation of carrier transport within devices and book-keeping of how they acquire energy ("become hot"), interaction of an ensemble of colder and hotter carriers with defect precursors, which eventually leads to the creation of a defect, and a description of how these defects interact with the device, degrading its performance.

## **Integrated Power Devices and TCAD Simulation**

An in-depth, up-to-date presentation of the physics and operational principles of all modern semiconductor devices The companion volume to Dr. Sze's classic Physics of Semiconductor Devices, Modern Semiconductor Device Physics covers all the significant advances in the field over the past decade. To provide the most authoritative, state-of-the-art information on this rapidly developing technology, Dr. Sze has gathered the contributions of world-renowned experts in each area. Principal topics include bipolar transistors, compound-semiconductor field-effect-transistors, MOSFET and related devices, power devices, quantum-effect and hot-electron devices, active microwave diodes, high-speed photonic devices, and solar cells. Supported by hundreds of illustrations and references and a problem set at the end of each chapter, Modern Semiconductor Device Physics is the essential text/reference for electrical engineers, physicists, material scientists, and graduate students actively working in microelectronics and related fields.

## **Hot Carrier Degradation in Semiconductor Devices**

This book is the first to explain FinFET modeling for IC simulation and the industry standard - BSIM-CMG - describing the rush in demand for advancing the technology from planar to 3D architecture, as now enabled by the approved industry standard. The book gives a strong foundation on the physics and operation of FinFET, details aspects of the BSIM-CMG model such as surface potential, charge and current calculations, and includes a dedicated chapter on parameter extraction procedures, providing a step-by-step approach for the efficient extraction of model parameters. With this book you will learn: Why you should use FinFET The physics and operation of FinFET Details of the FinFET standard model (BSIM-CMG) Parameter extraction in BSIM-CMG FinFET circuit design and simulation Authored by the lead inventor and developer of FinFET, and developers of the BSIM-CM standard model, providing an experts' insight into the specifications of the standard The first book on the industry-standard FinFET model - BSIM-CMG

## **Modern Semiconductor Devices for Integrated Circuits**

Market\_Desc: · Electrical Engineers Special Features: · Over 150 solved examples that clarify concepts are integrated throughout the text. · End-of-chapter summary tables and hundreds of figures are included to reinforce the intricacies of modern semiconductor devices· Coverage of device optimization issues shows the reader how in each device one has to trade one performance against another About The Book: This introductory text presents a well-balanced coverage of semiconductor physics and device operation and shows how devices are optimized for applications. The text begins with an exploration of the basic physical processes

upon which all semiconductor devices are based. Next, the author focuses on the operation of the important semiconductor devices along with issues relating to the optimization of device performance.

### **III-V Integrated Circuit Fabrication Technology**

New Techniques and Tools for Ensuring On-Chip Power Integrity—Down to Nanoscale As chips continue to scale, power integrity issues are introducing unexpected project complexity and cost. In this book, two leading industry innovators thoroughly discuss the power integrity challenges that engineers face in designing at nanoscale levels, introduce new analysis and management techniques for addressing these issues, and provide breakthrough tools for hands-on problem solving. Raj Nair and Dr. Donald Bennett first provide a complete foundational understanding of power integrity, including ULSI issues, practical aspects of power delivery, and the benefits of a total power integrity approach to optimizing chip physical designs. They introduce advanced power distribution network modeling, design, and analysis techniques that highlight abstraction and physics-based analysis, while also incorporating traditional circuit- and field-solver based approaches. They also present advanced techniques for floorplanning and power integrity management, and help designers anticipate emerging challenges associated with increased integration. Anasim RLCsim.exe, a new tool for power integrity aware floorplanning, is downloadable for free at [anasim.com/category/software](http://anasim.com/category/software). The authors systematically explore power integrity implications, analysis, and management for integrated circuits. Present practical examples and industry best practices for a broad spectrum of chip design applications. Discuss distributed and high-bandwidth voltage regulation, differential power path design, and the significance of on-chip inductance to power integrity. Review both traditional and advanced modeling techniques for integrated circuit power integrity analysis, and introduce continuum modeling. Explore chip, package, and board interactions for power integrity and EMI, and bring together industry best practices and examples. Introduce advanced concepts for power integrity management, including non-linear capacitance devices, impedance modulation, and active noise regulation. Power Integrity Analysis and Management for Integrated Circuits' coverage of both fundamentals and advanced techniques will make this book indispensable to all engineers responsible for signal integrity, power integrity, hardware, or system design—especially those working at the nanoscale level.

### **Advanced Theory of Semiconductor Devices**

The awaited revision of Semiconductor Devices: Physics and Technology offers more than 50% new or revised material that reflects a multitude of important discoveries and advances in device physics and integrated circuit processing. Offering a basic introduction to physical principles of modern semiconductor devices and their advanced fabrication technology, the third edition presents students with theoretical and practical aspects of every step in device characterizations and fabrication, with an emphasis on integrated circuits. Divided into three parts, this text covers the basic properties of semiconductor materials, emphasizing silicon and gallium arsenide; the physics and characteristics of semiconductor devices bipolar, unipolar special microwave and photonic devices;

and the latest processing technologies, from crystal growth to lithographic pattern transfer.

## **The Physics of Semiconductors**

This book provides a detailed treatment of radiation effects in electronic devices, including effects at the material, device, and circuit levels. The emphasis is on transient effects caused by single ionizing particles (single-event effects and soft errors) and effects produced by the cumulative energy deposited by the radiation (total ionizing dose effects). Bipolar (Si and SiGe), metal-oxide-semiconductor (MOS), and compound semi-conductor technologies are discussed. In addition to considering the specific issues associated with high-performance devices and technologies, the book includes the background material necessary for understanding radiation effects at a more general level.

## **Devices for Integrated Circuits**

The Third Edition of the standard textbook and reference in the field of semiconductor devices This classic book has set the standard for advanced study and reference in the semiconductor device field. Now completely updated and reorganized to reflect the tremendous advances in device concepts and performance, this Third Edition remains the most detailed and exhaustive single source of information on the most important semiconductor devices. It gives readers immediate access to detailed descriptions of the underlying physics and performance characteristics of all major bipolar, field-effect, microwave, photonic, and sensor devices. Designed for graduate textbook adoptions and reference needs, this new edition includes: A complete update of the latest developments New devices such as three-dimensional MOSFETs, MODFETs, resonant-tunneling diodes, semiconductor sensors, quantum-cascade lasers, single-electron transistors, real-space transfer devices, and more Materials completely reorganized Problem sets at the end of each chapter All figures reproduced at the highest quality Physics of Semiconductor Devices, Third Edition offers engineers, research scientists, faculty, and students a practical basis for understanding the most important devices in use today and for evaluating future device performance and limitations. A Solutions Manual is available from the editorial department.

## **Integrated Circuits and Semiconductor Devices: Theory and Application**

"This dynamic text applies physics concepts and equations to practical, real-world applications of semiconductor device theory"--

## **Solar Cells**

Graduate text with comprehensive treatment of semiconductor device physics and engineering, and descriptions of real optoelectronic devices.

## **Compound Semiconductor Device Modelling**

This book, *Electronic Devices and Circuit Application*, is the first of four books of a larger work, *Fundamentals of Electronics*. It is comprised of four chapters describing the basic operation of each of the four fundamental building blocks of modern electronics: operational amplifiers, semiconductor diodes, bipolar junction transistors, and field effect transistors. Attention is focused on the reader obtaining a clear understanding of each of the devices when it is operated in equilibrium. Ideas fundamental to the study of electronic circuits are also developed in the book at a basic level to lessen the possibility of misunderstandings at a higher level. The difference between linear and non-linear operation is explored through the use of a variety of circuit examples including amplifiers constructed with operational amplifiers as the fundamental component and elementary digital logic gates constructed with various transistor types. *Fundamentals of Electronics* has been designed primarily for use in an upper division course in electronics for electrical engineering students. Typically such a course spans a full academic year consisting of two semesters or three quarters. As such, *Electronic Devices and Circuit Applications*, and the following two books, *Amplifiers: Analysis and Design* and *Active Filters and Amplifier Frequency Response*, form an appropriate body of material for such a course. Secondary applications include the use in a one-semester electronics course for engineers or as a reference for practicing engineers.

## **Radiation Effects and Soft Errors in Integrated Circuits and Electronic Devices**

This book develops the device physics of the Si and III-V compound semiconductor devices used in integrated circuits. Important equations are derived from basic physical concepts. The physics of these devices are related to the parameters used in SPICE. Terminology is intended to prepare students for reading technical journals on semiconductor devices. This text is suitable for first-year graduate students and seniors in Electrical Engineering; graduate students in Material Science and Chemical Engineering, interested in semiconductor materials; Computer Science students interested in custom VLSI design; and professionals in the semiconductor industry.

## **Modern Semiconductor Quantum Physics**

Semiconductor sensors patterned at the micron scale combined with custom-designed integrated circuits have revolutionized semiconductor radiation detector systems. Designs covering many square meters with millions of signal channels are now commonplace in high-energy physics and the technology is finding its way into many other fields, ranging from astrophysics to experiments at synchrotron light sources and medical imaging. This book is the first to present a comprehensive discussion of the many facets of highly integrated semiconductor detector systems, covering sensors, signal processing, transistors and circuits, low-noise electronics, and radiation effects. The diversity of design approaches is illustrated in a chapter describing systems in high-energy physics, astronomy, and astrophysics. Finally a chapter "Why things don't work" discusses common pitfalls. Profusely illustrated, this book provides a unique reference in a key area of modern science.

## **Integrated Circuit Failure Analysis**

The 3rd edition of this successful textbook contains ample material for a comprehensive upper-level undergraduate or beginning graduate course, guiding readers to the point where they can choose a special topic and begin supervised research. The textbook provides a balance between essential aspects of solid-state and semiconductor physics, on the one hand, and the principles of various semiconductor devices and their applications in electronic and photonic devices, on the other. It highlights many practical aspects of semiconductors such as alloys, strain, heterostructures, nanostructures, that are necessary in modern semiconductor research but typically omitted in textbooks. Coverage also includes additional advanced topics, such as Bragg mirrors, resonators, polarized and magnetic semiconductors, nanowires, quantum dots, multi-junction solar cells, thin film transistors, carbon-based nanostructures and transparent conductive oxides. The text derives explicit formulas for many results to support better understanding of the topics. The Physics of Semiconductors requires little or no prior knowledge of solid-state physics and evolved from a highly regarded two-semester course. In the third edition several topics are extended and treated in more depth including surfaces, disordered materials, amorphous semiconductors, polarons, thermopower and noise. More than 1800 references guide the reader to historic and current literature including original and review papers and books.

## **Semiconductor Devices & Circuits**

### **MOSFET Modeling & BSIM3 User's Guide**

This book provides a unique account of the history of integrated circuit, the microelectronics industry and the people involved in the development of transistor and integrated circuit. In this richly illustrated account the author argues that the group of inventors was much larger than originally thought. This is a personal recollection providing the first comprehensive behind-the-scenes account of the history of the integrated circuit.

## **Integrated Microelectronic Devices**

Electrical Engineering Advanced Theory of Semiconductor Devices Semiconductor devices are ubiquitous in today's world and are found increasingly in cars, kitchens and electronic door locks, attesting to their presence in our daily lives. This comprehensive book provides the fundamentals of semiconductor device theory from basic quantum physics to computer-aided design. Advanced Theory of Semiconductor Devices will improve your understanding of computer simulation of devices through a thorough discussion of basic equations, their validity, and numerical solutions as they are contained in current simulation tools. You will gain state-of-the-art knowledge of devices used in both III-V compounds and silicon technology. Specially featured are novel approaches and explanations of electronic transport, particularly in p—n junction diodes. Close attention is also given to innovative treatments of quantum-well laser diodes and hot electron effects in silicon technology. This in-depth book is written for engineers, graduate students,

and research scientists in solid-state electronics who want to gain a better understanding of the principles underlying semiconductor devices.

## **FinFET Modeling for IC Simulation and Design**

Offering thorough coverage of atomic layer deposition (ALD), this book moves from basic chemistry of ALD and modeling of processes to examine ALD in memory, logic devices and machines. Reviews history, operating principles and ALD processes for each device.

## **Semiconductor Devices: Physics and Technology, 3rd Edition**

A modern take on microelectronic device engineering Microelectronics is a 50-year-old engineering discipline still undergoing rapid evolution and societal adoption. Integrated Microelectronic Devices: Physics and Modeling fills the need for a rigorous description of semiconductor device physics that is relevant to modern nanoelectronics. The central goal is to present the fundamentals of semiconductor device operation with relevance to modern integrated microelectronics. Emphasis is devoted to frequency response, layout, geometrical effects, parasitic issues and modeling in integrated microelectronics devices (transistors and diodes). In addition to this focus, the concepts learned here are highly applicable in other device contexts. This text is suitable for a one-semester junior or senior-level course by selecting the front sections of selected chapters (e.g. 1-9). It can also be used in a two-semester senior-level or a graduate-level course by taking advantage of the more advanced sections.

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