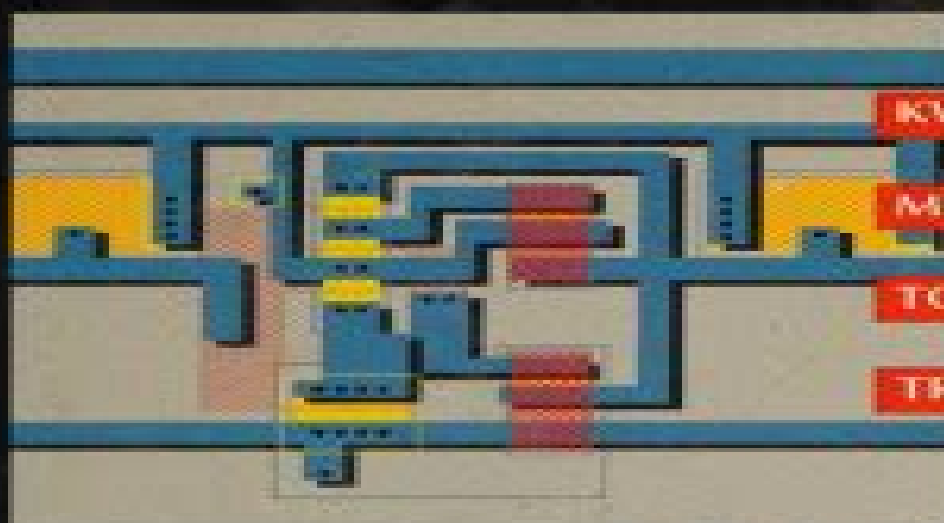


# SEMICONDUCTOR DEVICE MODELING

*for*

# VLSI



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# Semiconductor Device Modeling For Vlsi

**Rachel Lee, Michael Shur**



## Semiconductor Device Modeling For Vlsi:

*Semiconductor Device Modeling for VLSI* Rachel Lee, Michael Shur, 1993-08      **Semiconductor Device Modeling for VLSI** Kwyro Lee, 1993-01-01 Explains basic semiconductor physics and looks at bipolar junction metal oxide semiconductor field effect and compound semiconductor field effect transistors thin film transistors and circuit simulation      Mosfet Modeling For Vlsi Simulation: Theory And Practice Narain Arora, 2007-02-14 A reprint of the classic text this book popularized compact modeling of electronic and semiconductor devices and components for college and graduate school classrooms and manufacturing engineering over a decade ago The first comprehensive book on MOS transistor compact modeling it was the most cited among similar books in the area and remains the most frequently cited today The coverage is device physics based and continues to be relevant to the latest advances in MOS transistor modeling This is also the only book that discusses in detail how to measure device model parameters required for circuit simulations The book deals with the MOS Field Effect Transistor MOSFET models that are derived from basic semiconductor theory Various models are developed ranging from simple to more sophisticated models that take into account new physical effects observed in submicron transistors used in today's 1993 MOS VLSI technology The assumptions used to arrive at the models are emphasized so that the accuracy of the models in describing the device characteristics are clearly understood Due to the importance of designing reliable circuits device reliability models are also covered Understanding these models is essential when designing circuits for state of the art MOS ICs      **MOSFET Models for VLSI Circuit Simulation** Narain D. Arora, 2012-12-06 Metal Oxide Semiconductor MOS transistors are the basic building block of MOS integrated circuits I C Very Large Scale Integrated VLSI circuits using MOS technology have emerged as the dominant technology in the semiconductor industry Over the past decade the complexity of MOS ICs has increased at an astonishing rate This is realized mainly through the reduction of MOS transistor dimensions in addition to the improvements in processing Today VLSI circuits with over 3 million transistors on a chip with effective or electrical channel lengths of 0.5 microns are in volume production Designing such complex chips is virtually impossible without simulation tools which help to predict circuit behavior before actual circuits are fabricated However the utility of simulators as a tool for the design and analysis of circuits depends on the adequacy of the device models used in the simulator This problem is further aggravated by the technology trend towards smaller and smaller device dimensions which increases the complexity of the models There is extensive literature available on modeling these short channel devices However there is a lot of confusion too Often it is not clear what model to use and which model parameter values are important and how to determine them After working over 15 years in the field of semiconductor device modeling I have felt the need for a book which can fill the gap between the theory and the practice of MOS transistor modeling This book is an attempt in that direction      **Semiconductor Device Modeling for VLSI** Kwyro Lee, 1993      Analysis and Simulation of Semiconductor Devices S. Selberherr, 2012-12-06 The invention of

semiconductor devices is a fairly recent one considering classical time scales in human life The bipolar transistor was announced in 1947 and the MOS transistor in a practically usable manner was demonstrated in 1960 From these beginnings the semiconductor device field has grown rapidly The first integrated circuits which contained just a few devices became commercially available in the early 1960s Immediately thereafter an evolution has taken place so that today less than 25 years later the manufacture of integrated circuits with over 400 000 devices per single chip is possible Coincident with the growth in semiconductor device development the literature concerning semiconductor device and technology issues has literally exploded In the last decade about 50 000 papers have been published on these subjects The advent of so called Very Large Scale Integration VLSI has certainly revealed the need for a better understanding of basic device behavior The miniaturization of the single transistor which is the major prerequisite for VLSI nearly led to a breakdown of the classical models of semiconductor devices

**Compound Semiconductor Device Modelling** Christopher M. Snowden, Robert E. Miles, 2012-12-06 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 IMPATT 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

*Device Modeling for Analog and RF CMOS Circuit Design* Trond Ytterdal, Yuhua Cheng, Tor A. Fjeldly, 2003-08-01 Bridges the gap between device modelling and analog circuit design Includes dedicated software enabling actual circuit design Covers the three significant models BSIM3 Model 9 and EKV Presents practical guidance on device development and circuit implementation The authors offer a combination of extensive academic and industrial experience

**Handbook of Semiconductor Manufacturing Technology** Yoshio Nishi, Robert Doering, 2017-12-19 Retaining the comprehensive and in depth approach that cemented the bestselling first edition's place as a standard reference in the field the Handbook of

Semiconductor Manufacturing Technology Second Edition features new and updated material that keeps it at the vanguard of today's most dynamic and rapidly growing field. Iconic experts Robert Doering and Yoshio Nishi have again assembled a team of the world's leading specialists in every area of semiconductor manufacturing to provide the most reliable authoritative and industry leading information available. Stay Current with the Latest Technologies. In addition to updates to nearly every existing chapter, this edition features five entirely new contributions on Silicon on insulator SOI materials and devices, Supercritical CO<sub>2</sub> in semiconductor cleaning, Low dielectrics, Atomic layer deposition, Damascene copper electroplating, Effects of terrestrial radiation on integrated circuits, ICs. Reflecting rapid progress in many areas, several chapters were heavily revised and updated and in some cases rewritten to reflect rapid advances in such areas as interconnect technologies, gate dielectrics, photomask fabrication, IC packaging and 300 mm wafer fabrication. While no book can be up to the minute with the advances in the semiconductor field, the Handbook of Semiconductor Manufacturing Technology keeps the most important data, methods, tools and techniques close at hand.

**Advanced Device Modeling and Simulation** Tibor Grasser, 2003. Microelectronics is one of the most rapidly changing scientific fields today. The tendency to shrink devices as far as possible results in extremely small devices which can no longer be described using simple analytical models. This book covers various aspects of advanced device modeling and simulation. As such, it presents extensive reviews and original research by outstanding scientists. The bulk of the book is concerned with the theory of classical and quantum mechanical transport modeling based on macroscopic spherical harmonics and Monte Carlo methods.

Introduction to Semiconductor Device Modelling Christopher M. Snowden, 1998. 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.

**RF and Microwave Semiconductor Device Handbook** Mike Golio, 2017-12-19. Offering a single volume reference for high frequency semiconductor devices, this handbook covers basic material characteristics, system level concerns and constraints, simulation and modeling of devices and packaging. Individual chapters detail the properties and characteristics of each semiconductor device type including Varactors, Schottky diodes, transit time devices, BJTs, HBTs, MOSFETs, MESFETs and HEMTs. Written by leading researchers in the field, the RF and Microwave Semiconductor Device Handbook provides an

excellent starting point for programs involving development technology comparison or acquisition of RF and wireless semiconductor devices

**Semiconductor Device Modelling** Christopher M. Snowden, 2012-12-06 Semiconductor device modelling has developed in recent years from being solely the domain of device physicists to span broader technological disciplines involved in device and electronic circuit design and development The rapid emergence of very high speed high density integrated circuit technology and the drive towards high speed communications has meant that extremely small scale device structures are used in contemporary designs The characterisation and analysis of these devices can no longer be satisfied by electrical measurements alone Traditional equivalent circuit models and closed form analytical models cannot always provide consistently accurate results for all modes of operation of these very small devices Furthermore the highly competitive nature of the semiconductor industry has led to the need to minimise development costs and lead time associated with introducing new designs This has meant that there has been a greater demand for models capable of increasing our understanding of how these devices operate and capable of predicting accurate quantitative results The desire to move towards computer aided design and expert systems has reinforced the need for models capable of representing device operation under DC small signal large signal and high frequency operation It is also desirable to relate the physical structure of the device to the electrical performance This demand for better models has led to the introduction of improved equivalent circuit models and a upsurge in interest in using physical models

*Silicon And Beyond: Advanced Device Models And Circuit Simulators* Tor A Fjeldly, Michael S Shur, 2000-04-20 The steady downscaling of device feature size combined with a rapid increase in circuit complexity as well as the introduction of new device concepts based on non silicon material systems poses great challenges for device and circuit designers One of the major tasks is the development of new and improved device models needed for accurate device and circuit design Another task is the development of new circuit simulation tools to handle very large and complex circuits This book addresses both these issues with up to date reviews written by leading experts in the field The first three chapters of the book discuss advanced device models both for existing technologies and for new emerging technologies Among the topics covered are models for MOSFETs thin film transistors TFTs and compound semiconductor devices including GaAs HEMTs and HFETs heterodimensional devices quantum tunneling devices as well as wide bandgap devices Chapters 4 and 5 discuss advanced circuit simulators that hold promise for handling circuits of much higher complexity than what is possible for typical state of the art circuit simulators today

Bipolar transistor and MOSFET device models Kunihiro Suzuki, 2016-03-02 Continuous efforts to develop new semiconductor devices enable device manufacturers to make significant improvements in the information technology sector Bipolar transistors and MOSFETs are two special electronic device components that are used to construct very large scale integrated VLSI circuits allowing engineers to create powerful machines that are power efficient VLSI device characterization depends largely on semiconductor device modeling which is based on physical and electronic principles Bipolar transistor and MOSFET device

models is a textbook that describes basic functions and characterization models of these two types of transistors. Readers will learn about the processes employed to derive these models which will help them understand the modeling process. Chapters in this text cover the fundamentals of semiconductor devices: the pn junction, high and low injection region models for bipolar transistors, and different MOSFET models such as channel doping models and gated SOI models. Key features of this book include step by step easy to understand presentation of model information on innovative semiconductor devices, an overview of model derivation, assumptions, approximations, and limitations, novel experimental information on semiconductor parameters such as gate fringe capacitance, silicided source/drain resistance, and threshold voltage shift. Bipolar transistor and MOSFET device models are an essential learning resource for advanced students and professional engineers involved in semiconductor device modeling and fabrication divisions.

*MOSFET Modeling & BSIM3 User's Guide* Yuhua Cheng, Chenming Hu, 2007-05-08

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.

*MOSFET Modeling for Circuit Analysis and Design* Carlos Galup-Montoro, Mario Cherem Schneider, 2007

This is the first book dedicated to the next generation of MOSFET models. Addressed to circuit designers with an in-depth treatment that appeals to device specialists, the book presents a fresh view of compact modeling, having completely abandoned the regional modeling approach. Both an overview of the basic physics theory required to build compact MOSFET models and a unified treatment of inversion charge and surface potential models are provided. The needs

of digital analog and RF designers as regards the availability of simple equations for circuit designs are taken into account Compact expressions for hand analysis or for automatic synthesis valid in all operating regions are presented throughout the book All the main expressions for computer simulation used in the new generation compact models are derived Since designers in advanced technologies are increasingly concerned with fluctuations the modeling of fluctuations is strongly emphasized A unified approach for both space matching and time noise fluctuations is introduced

**Introduction to Device Modeling and Circuit Simulation** Tor A. Fjeldly, Trond Ytterdal, Michael S. Shur, 1998 This book is a useful reference for practicing electrical engineers as well as a textbook for a junior senior or graduate level course in electrical engineering The authors combine two subjects device modeling and circuit simulation by providing a large number of well prepared examples of circuit simulations immediately following the description of many device models

**Springer Handbook of Semiconductor Devices** Massimo Rudan, Rossella Brunetti, Susanna Reggiani, 2022-11-10 This Springer Handbook comprehensively covers the topic of semiconductor devices embracing all aspects from theoretical background to fabrication modeling and applications Nearly 100 leading scientists from industry and academia were selected to write the handbook's chapters which were conceived for professionals and practitioners material scientists physicists and electrical engineers working at universities industrial R D and manufacturers Starting from the description of the relevant technological aspects and fabrication steps the handbook proceeds with a section fully devoted to the main conventional semiconductor devices like e g bipolar transistors and MOS capacitors and transistors used in the production of the standard integrated circuits and the corresponding physical models In the subsequent chapters the scaling issues of the semiconductor device technology are addressed followed by the description of novel concept based semiconductor devices The last section illustrates the numerical simulation methods ranging from the fabrication processes to the device performances Each chapter is self contained and refers to related topics treated in other chapters when necessary so that the reader interested in a specific subject can easily identify a personal reading path through the vast contents of the handbook

**III-V Nitride Semiconductors** Edward T. Yu, 2002-09-06 The concepts in this book will provide a comprehensive overview of the current state for a broad range of nitride semiconductor devices as well as a detailed introduction to selected materials and processing issues of general relevance for these applications This compilation is very timely given the level of interest and the current stage of research in nitride semiconductor materials and device applications This volume consists of chapters written by a number of leading researchers in nitride materials and device technology addressing Ohmic and Schottky contacts AlGaInN multiple quantum well laser diodes nitride vertical cavity emitting lasers and ultraviolet photodetectors This unique volume provides a comprehensive review and introduction to application and devices based on GaN and related compounds for newcomers to the field and stimulus to further advances for experienced researchers



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