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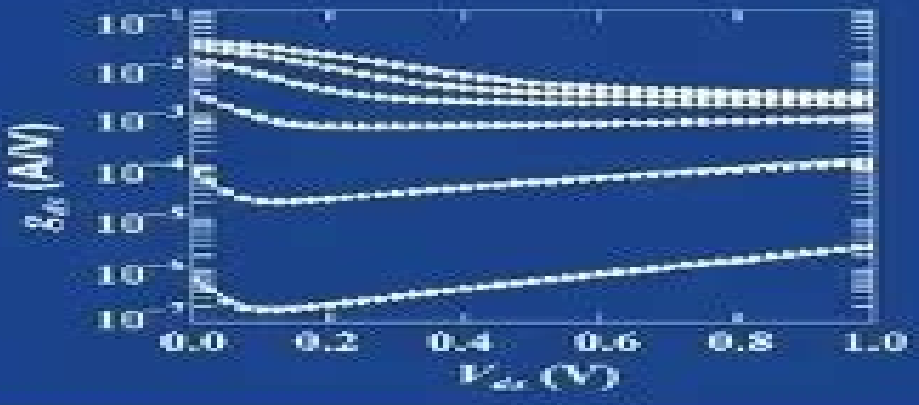
# MOSFET MODELING FOR VLSI SIMULATION

## Theory and Practice




Narain Arora

World Scientific

# Mosfet Modeling For Vlsi Simulation Theory And Practice

Dana Ferguson

**Mosfet Modeling For Vlsi Simulation Theory And Practice:**

MOSFET Models for VLSI Circuit Simulation Narain D. Arora,2012-12-06 Metal Oxide Semiconductor MOS transistors are the basic building block ofMOS 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 IC s 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 Mosfet Modeling for VLSI Simulation Narain Arora,2007 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,1993-11-17 The Physics and Modeling of Mosfets Mitiko Miura-Mattausch,2008 This volume provides a timely description of the latest compact MOS transistor models for circuit simulation The first generation BSIM3 and BSIM4 models that have dominated circuit simulation in the last decade are no longer capable of characterizing all the important features of modern sub 100nm MOS transistors This book discusses the second generation MOS transistor models that are now in urgent demand and being brought into the initial

phase of manufacturing applications It considers how the models are to include the complete drift diffusion theory using the surface potential variable in the MOS transistor channel in order to give one characterization equation Physics And Modeling Of Mosfets, The: Surface-potential Model Hisim Tatsuya Ezaki,Hans Jurgen Mattausch,Mitiko Miura-mattausch,2008-06-03 This volume provides a timely description of the latest compact MOS transistor models for circuit simulation The first generation BSIM3 and BSIM4 models that have dominated circuit simulation in the last decade are no longer capable of characterizing all the important features of modern sub 100nm MOS transistors This book discusses the second generation MOS transistor models that are now in urgent demand and being brought into the initial phase of manufacturing applications It considers how the models are to include the complete drift diffusion theory using the surface potential variable in the MOS transistor channel in order to give one characterization equation **Compact Hierarchical Bipolar Transistor Modeling with Hicum** Michael Schr□ter,Anjan Chakravorty,2010 Compact Hierarchical Bipolar Transistor Modeling with HICUM will be of great practical benefit to professionals from the process development modeling and circuit design community who are interested in the application of bipolar transistors which include the SiGe C HBTs fabricated with existing cutting edge process technology The book begins with an overview on the different device designs of modern bipolar transistors along with their relevant operating conditions while the subsequent chapter on transistor theory is subdivided into a review of mostly classical theories brought into context with modern technology and a chapter on advanced theory that is required for understanding modern device designs This book aims to provide a solid basis for the understanding of modern compact models *Electromigration in ULSI Interconnections* Cher Ming Tan,2010 Electromigration in ULSI Interconnections provides a comprehensive description of the electro migration in integrated circuits It is intended for both beginner and advanced readers on electro migration in ULSI interconnections It begins with the basic knowledge required for a detailed study on electro migration and examines the various interconnected systems and their evolution employed in integrated circuit technology The subsequent chapters provide a detailed description of the physics of electro migration in both Al and Cu based Interconnections in the form of theoretical experimental and numerical modeling studies The differences in the electro migration of Al and Cu based interconnections and the corresponding underlying physical mechanisms for these differences are explained The test structures testing methodology failure analysis methodology and statistical analysis of the test data for the experimental studies on electro migration are presented in a concise and rigorous manner Methods of numerical modeling for the interconnect electro migration and their applications to the understanding of electro migration physics are described in detail with the aspects of material properties interconnection design and interconnect process parameters on the electro migration performances of interconnects in ULSI further elaborated upon Finally the extension of the studies to narrow interconnections is introduced and future challenges on the study of electro migration are outlined and discussed **Electronics** Michael Olorunfunmi Kolawole,2020-06-15 This book

gives clear explanations of the technical aspects of electronics engineering from basic classical device formulations to the use of nanotechnology to develop efficient quantum electronic systems As well as being up to date this book provides a broader range of topics than found in many other electronics books This book is written in a clear accessible style and covers topics in a comprehensive manner This book s approach is strongly application based with key mathematical techniques introduced helpful examples used to illustrate the design procedures and case studies provided where appropriate By including the fundamentals as well as more advanced techniques the author has produced an up to date reference that meets the requirements of electronics and communications students and professional engineers Features Discusses formulation and classification of integrated circuits Develops a hierarchical structure of functional logic blocks to build more complex digital logic circuits Outlines the structure of transistors bipolar JFET MOSFET or MOS CMOS their processing techniques their arrangement forming logic gates and digital circuits optimal pass transistor stages of buffered chain sources and types of noise and performance of designed circuits under noisy conditions Explains data conversion processes choice of the converter types and inherent errors Describes electronic properties of nanomaterials the crystallites size reduction effect and the principles of nanoscale structure fabrication Outlines the principles of quantum electronics leading to the development of lasers masers reversible quantum gates and circuits and applications of quantum cells and fabrication methods including self assembly quantum dot cellular automata and tunneling superconducting circuits and describes quantum error correction techniques Problems are provided at the end of each chapter to challenge the reader s understanding *High Frequency MOSFET Modeling for RF Applications* Xiaodong Jin,2001 Technology CAD Systems Franz Fasching,Stefan Halama,Siegfried Selberherr,2012-12-06 As the cost of developing new semiconductor technology at ever higher bit gate densities continues to grow the value of using accurate TCAD simu lation tools for design and development becomes more and more of a necessity to compete in today s business The ability to tradeoff wafer starts in an advanced piloting facility for simulation analysis and optimization utilizing a virtual fab S W tool set is a clear economical asset for any semiconductor development company Consequently development of more sophisticated accurate physics based and easy to use device and process modeling tools will receive continuing attention over the coming years The cost of maintaining and paying for one s own internal modeling tool development effort however has caused many semiconductor development companies to consider replacing some or all of their internal tool development effort with the purchase of vendor modeling tools While some noteably larger companies have insisted on maintaining their own internal modeling tool development organization others have elected to depend totally on the tools offered by the TCAD vendors and have consequently reduced their mod eling staffs to a bare minimal support function Others are seeking to combine the best of their internally developed tool suite with robust proven tools provided by the vendors hoping to achieve a certain synergy as well as savings through this approach In the following sections we describe IBM s internally developed suite of TCAD modeling tools and show several applications of

the use of these tools *MOSFET Models for SPICE Simulation* William Liu,2001-02-21 An expert guide to understanding and making optimum use of BSIM Used by more chip designers worldwide than any other comparable model the Berkeley Short Channel IGFET Model BSIM has over the past few years established itself as the de facto standard MOSFET SPICE model for circuit simulation and CMOS technology development Yet until now there have been no independent expert guides or tutorials to supplement the various BSIM manuals currently available Written by a noted expert in the field this book fills that gap in the literature by providing a comprehensive guide to understanding and making optimal use of BSIM3 and BSIM4 Drawing upon his extensive experience designing with BSIM William Liu provides a brief history of the model discusses the various advantages of BSIM over other models and explores the reasons why BSIM3 has been adopted by the majority of circuit manufacturers He then provides engineers with the detailed practical information and guidance they need to master all of BSIM s features He Summarizes key BSIM3 components Represents the BSIM3 model with equivalent circuits for various operating conditions Provides a comprehensive glossary of modeling terminology Lists alphabetically BSIM3 parameters along with their meanings and relevant equations Explores BSIM3 s flaws and provides improvement suggestions Describes all of BSIM4 s improvements and new features Provides useful SPICE files which are available online at the Wiley ftp site **Digital Technical Journal of Digital Equipment Corporation** ,1985 **Semiconductor Process Reliability in Practice** Zhenghao Gan,Waisum Wong,Juin J. Liou,2012-10-06 Proven processes for ensuring semiconductor device reliability Co written by experts in the field Semiconductor Process Reliability in Practice contains detailed descriptions and analyses of reliability and qualification for semiconductor device manufacturing and discusses the underlying physics and theory The book covers initial specification definition test structure design analysis of test structure data and final qualification of the process Real world examples of test structure designs to qualify front end of line devices and back end of line interconnects are provided in this practical comprehensive guide Coverage includes Basic device physics Process flow for MOS manufacturing Measurements useful for device reliability characterization Hot carrier injection Gate oxide integrity GOI and time dependent dielectric breakdown TDDB Negative bias temperature instability Plasma induced damage Electrostatic discharge protection of integrated circuits Electromigration Stress migration Intermetal dielectric breakdown IEEE International Conference on Electronics, Circuits and Systems ,1998 Choice ,2007 Book Review Index - 2009 Cumulation Dana Ferguson,2009-08 Book Review Index provides quick access to reviews of books periodicals books on tape and electronic media representing a wide range of popular academic and professional interests The up to date coverage wide scope and inclusion of citations for both newly published and older materials make Book Review Index an exceptionally useful reference tool More than 600 publications are indexed including journals and national general interest publications and newspapers Book Review Index is available in a three issue subscription covering the current year or as an annual cumulation covering the past year **Japanese Journal of Applied Physics** ,1999 *CAS ... Proceedings* ,1996 *JJAP*

,2010 Nanoelectronic Mixed-Signal System Design Saraju Mohanty,2015-02-20 Covering both the classical and emerging nanoelectronic technologies being used in mixed signal design this book addresses digital analog and memory components Winner of the Association of American Publishers 2016 PROSE Award in the Textbook Physical Sciences Mathematics category Nanoelectronic Mixed Signal System Design offers professionals and students a unified perspective on the science engineering and technology behind nanoelectronics system design Written by the director of the NanoSystem Design Laboratory at the University of North Texas this comprehensive guide provides a large scale picture of the design and manufacturing aspects of nanoelectronic based systems It features dual coverage of mixed signal circuit and system design rather than just digital or analog only Key topics such as process variations power dissipation and security aspects of electronic system design are discussed Top down analysis of all stages from design to manufacturing Coverage of current and developing nanoelectronic technologies not just nano CMOS Describes the basics of nanoelectronic technology and the structure of popular electronic systems Reveals the techniques required for design excellence and manufacturability

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