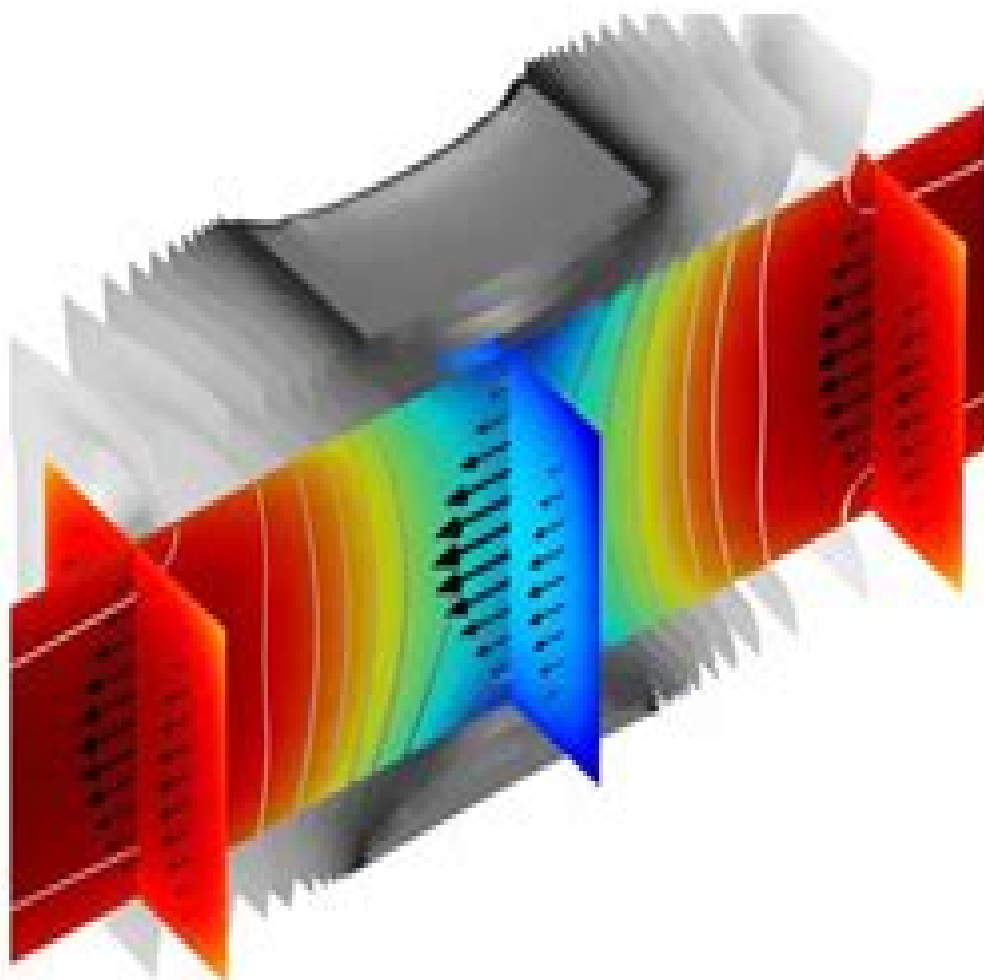


# Semiconductor Device Physics Simulation

Chien Liu  
COMSOL Inc.



# Semiconductor Device Physics And Simulation

**Christopher M. Snowden**



## **Semiconductor Device Physics And Simulation:**

**Semiconductor Device Physics and Simulation** J.S. Yuan, Juin Jei Liou, 1998-05-31 The advent of the microelectronics technology has made ever increasing numbers of small devices on a same chip The rapid emergence of ultra large scaled integrated ULSI technology has moved device dimension into the sub quarter micron regime and put more than 10 million transistors on a single chip While traditional closed form analytical models furnish useful intuition into how semiconductor devices behave they no longer provide consistently accurate results for all modes of operation of these very small devices The reason is that in such devices various physical mechanisms affect the device performance in a complex manner and the conventional assumptions i e one dimensional treatment low level injection quasi static approximation etc employed in developing analytical models become questionable Thus the use of numerical device simulation becomes important in device modeling Researchers and engineers will rely even more on device simulation for device design and analysis in the future This book provides comprehensive coverage of device simulation and analysis for various modern semiconductor devices It will serve as a reference for researchers engineers and students who require in depth up to date information and understanding of semiconductor device physics and characteristics The materials of the book are limited to conventional and mainstream semiconductor devices photonic devices such as light emitting and laser diodes are not included nor does the book cover device modeling device fabrication and circuit applications

**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

**Semiconductor Device Physics and Simulation** J.S. Yuan, Juin Jei Liou, 2013-11-22 The advent of the microelectronics technology has made ever increasing numbers of small devices on a same chip The rapid emergence of ultra large scaled integrated ULSI technology has moved device dimension into the sub quarter micron regime and put more than 10 million transistors on a single chip While traditional closed form analytical models furnish useful intuition into how semiconductor devices behave they no longer provide consistently accurate results for all modes of operation of these very small devices The reason is that in such devices

various physical mechanisms affect the device performance in a complex manner and the conventional assumptions i.e. one dimensional treatment low level injection quasi static approximation etc employed in developing analytical models become questionable Thus the use of numerical device simulation becomes important in device modeling Researchers and engineers will rely even more on device simulation for device design and analysis in the future This book provides comprehensive coverage of device simulation and analysis for various modern semiconductor devices It will serve as a reference for researchers engineers and students who require in depth up to date information and understanding of semiconductor device physics and characteristics The materials of the book are limited to conventional and mainstream semiconductor devices photonic devices such as light emitting and laser diodes are not included nor does the book cover device modeling device fabrication and circuit applications

**Semiconductor Devices** Kevin M. Kramer, W. Nicholas G. Hitchon, 1997 CD ROM contains Win32 version of SGFramework and the simulations contained in the book *Semiconductor Modeling Techniques* Xavier Marie, Naci Balkan, 2012-06-26 This book describes the key theoretical techniques for semiconductor research to quantitatively calculate and simulate the properties It presents particular techniques to study novel semiconductor materials such as 2D heterostructures quantum wires quantum dots and nitrogen containing III V alloys The book is aimed primarily at newcomers working in the field of semiconductor physics to give guidance in theory and experiment The theoretical techniques for electronic and optoelectronic devices are explained in detail *Advanced Semiconductor Device Physics and Modeling* Juin J. Liou, 1994-01-01 This reference provides detailed information on semiconductor physics and modelling

*Noise in Semiconductor Devices* Fabrizio Bonani, Giovanni Ghione, 2013-03-09 The design and optimization of electronic systems often requires appraisal of the electrical noise generated by active devices and at a technological level the ability to properly design active elements in order to minimize when possible their noise Examples of critical applications are of course receiver front ends in RF and optoelectronic transmission systems but also front end stages in sensors and in a completely different context nonlinear circuits such as oscillators mixers and frequency multipliers The rapid development of silicon RF applications has recently fostered the interest toward low noise silicon devices for the lower microwave band such as low noise MOS transistors at the same time the RF and microwave ranges are becoming increasingly important in fast optical communication systems Thus high frequency noise modeling and simulation of both silicon and compound semiconductor based bipolar and field effect transistors can be considered as an important and timely topic This does not exclude of course low frequency noise which is relevant also in the RF and microwave ranges when ever it is up converted within a nonlinear system either autonomous as an oscillator or non autonomous as a mixer or frequency multiplier The aim of the present book is to provide a thorough introduction to the physics based numerical modeling of semiconductor devices operating both in small signal and in large signal conditions In the latter instance only the non autonomous case was considered and thus the present treatment does not directly extend to oscillators Three-Dimensional Simulation of

Semiconductor Devices Roland Kircher, Wolfgang Bergner, 2013-03-09      **The Monte Carlo Method for Semiconductor Device Simulation** Carlo Jacoboni, Paolo Lugli, 1989-10-30 This volume presents the application of the Monte Carlo method to the simulation of semiconductor devices reviewing the physics of transport in semiconductors followed by an introduction to the physics of semiconductor devices      **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      **Nitride Semiconductor Devices** Joachim Piprek, 2007-06-27 This is the first book to be published on physical principles mathematical models and practical simulation of GaN based devices Gallium nitride and its related compounds enable the fabrication of highly efficient light emitting diodes and lasers for a broad spectrum of wavelengths ranging from red through yellow and green to blue and ultraviolet Since the breakthrough demonstration of blue laser diodes by Shuji Nakamura in 1995 this field has experienced tremendous growth worldwide Various applications can be seen in our everyday life from green traffic lights to full color outdoor displays to high definition DVD players In recent years nitride device modeling and simulation has gained importance and advanced software tools are emerging Similar developments occurred in the past with other semiconductors such as silicon where computer simulation is now an integral part of device development and fabrication This book presents a review of modern device concepts and models written by leading researchers in the field It is intended for scientists and device engineers who are interested in employing computer simulation for nitride device design and analysis      **Semiconductor Devices Explained** Ton J. Mouthaan, 1999 Offers an innovative and accessible new approach to the teaching of the fundamentals of semiconductor components by exploiting simulation to explain the mechanisms behind current in semiconductor structures Simulation is a popular tool used by engineers and scientists in device and process research and the accompanying two dimensional process and device simulation software MicroTec enables students to make their own devices and allows the recreation of real performance under varying parameters There is also an accompanying ftp site containing ICECREAM software Integrated Circuits and Electronics group Computerized Remedial Education And Mastering which improves understanding of the physics involved and covers semiconductor physics junction diodes silicon bipolar and MOS transistors and photonic devices like LEDs and lasers Features include MicroTec diskette containing a two dimensional process and device simulator on which the many simulation exercises mentioned in the text can be performed thereby facilitating learning through experimentation Computer aided education software accessible vita ftp featuring question and answer games which enables students to enhance their understanding of the physics involved and allows lecturers to set assignments Broad coverage spanning the common devices pn junctions metal semiconductor junctions photocells lasers bipolar transistors and MOS transistors

Discussion of fundamental concepts and technological principles offering the student a valuable grounding in semiconductor physics Examination of the implications of recent research on small dimensions reliability problems and breakdown mechanisms Semiconductor Devices Explained offers a comprehensive new approach to teaching the fundamentals of semiconductor components based on the use of the accompanying process and device simulation software Simulation is a popular tool used by engineers and scientists in device and process research It supports the understanding of basic phenomena by linking the theory to hands on applications and real world problems with semiconductor devices Throughout the text students are encouraged to augment their understanding by undertaking simulations and creating their own devices The ICECREAM programme Integrated Circuits and Electronics group Computerized Remedial Education And Mastering question and answer game leads students through the concepts of common devices and makes learning fun There is also a self test element in which a data bank generates questions on the fundamentals of semiconductor junctions enabling students to assess their progress Larger projects suitable for use as examination assignments are also incorporated The test package is freely available to lecturers from the author on request The remedial component of ICECREAM is available from the Wiley ftp site MicroTec comes on a disk in the back of the book      **Semiconductor Optoelectronic Devices** Joachim

Piprek,2003-01-07 This book builds a much needed bridge between theoretical and experimental research in optoelectronics by providing both fundamental knowledge in semiconductor physics and real world simulation examples      Elementary Semiconductor Device Physics Kazuya Masu,Shuhei Amakawa,2024-10-31 This book by two leading experts on integrated circuit design adopts an untraditional approach to introducing semiconductor devices to beginners The authors use circuit theory to provide a digestible explanation of energy band theory and understanding of energy band diagrams After briefly summarizing the basics of semiconductors the authors describe semiconductor devices from a circuit theoretic point of view making the book especially suitable for circuit design students and engineers Further to the emphasis on the circuit perspective the book then uses circuit theory to introduce readers to the famously indigestible energy bands of crystalline solids Additionally the book explains how to read physics from energy band diagrams of semiconductor devices in great detail The key to appreciating the real power of energy band diagrams is shown to lie in the understanding of the concept of the quasi Fermi levels introduced in 1949 by William Shockley but remaining elusive to date and therefore often omitted from energy band diagrams To rectify this some of the energy band diagrams presented in this book complete with quasi Fermi levels were drawn using a device simulator a k a technology computer aided design TCAD offering quantitative information about device physics The book could therefore also serve as a hands on course text in TCAD drawn band diagram reading Because no prior exposure to quantum mechanics is required and the book does not attempt to teach it this book is ideal for students in various disciplines who may or may not be specializing in semiconductor devices The numerous practical examples of reading TCAD based energy band diagrams are also invaluable to practicing semiconductor device engineers

Analysis and Simulation of Semiconductor Devices Siegfried Selberherr,1984      **Simulation of Semiconductor Devices and Processes, Vol. 5** Siegfried Selberherr,Hannes Stippel,Ernst Strasser,1993      *Compound Semiconductor Device Physics* Sandip Tiwari,2013-10-22 This book provides one of the most rigorous treatments of compound semiconductor device physics yet published A complete understanding of modern devices requires a working knowledge of low dimensional physics the use of statistical methods and the use of one two and three dimensional analytical and numerical analysis techniques With its systematic and detailed discussion of these topics this book is ideal for both the researcher and the student Although the emphasis of this text is on compound semiconductor devices many of the principles discussed will also be useful to those interested in silicon devices Each chapter ends with exercises that have been designed to reinforce concepts to complement arguments or derivations and to emphasize the nature of approximations by critically evaluating realistic conditions One of the most rigorous treatments of compound semiconductor device physics yet published Essential reading for a complete understanding of modern devices Includes chapter ending exercises to facilitate understanding

**3D TCAD Simulation for Semiconductor Processes, Devices and Optoelectronics** Simon Li,Suihua Li,2011-10-01 Technology computer aided design or TCAD is critical to today s semiconductor technology and anybody working in this industry needs to know something about TCAD This book is about how to use computer software to manufacture and test virtually semiconductor devices in 3D It brings to life the topic of semiconductor device physics with a hands on tutorial approach that de emphasizes abstract physics and equations and emphasizes real practice and extensive illustrations Coverage includes a comprehensive library of devices representing the state of the art technology such as SuperJunction LDMOS GaN LED devices etc      **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 develop ment 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 contempor ary 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 consis tently 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      **The Physics of Semiconductor Devices** R. K. Sharma, D.S. Rawal, 2019-01-31 This book disseminates the current knowledge of semiconductor physics and its applications across the scientific community It is based on a biennial workshop that provides the participating research groups with a stimulating platform for interaction and collaboration with colleagues from the same scientific community The book discusses the latest developments in the field of III nitrides materials devices compound semiconductors VLSI technology optoelectronics sensors photovoltaics crystal growth epitaxy and characterization graphene and other 2D materials and organic semiconductors



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