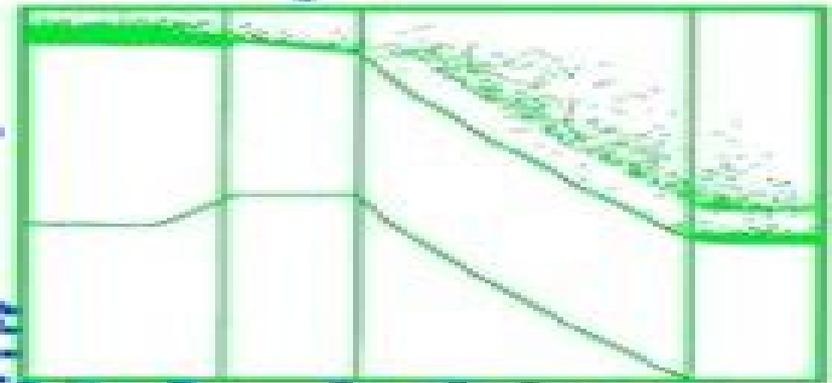


# NUMERICAL SIMULATION OF SUBMICRON SEMICONDUCTOR DEVICES



KAZUTAKA TOMIZAWA

# Numerical Simulation Of Submicron Semiconductor Devices

**Siegfried Selberherr, Hannes  
Stippel, Ernst Strasser**



## **Numerical Simulation Of Submicron Semiconductor Devices:**

*Numerical Simulation of Submicron Semiconductor Devices* Kazutaka Tomizawa, 1993-01-01 Describes the basic theory of carrier transport develops numerical algorithms used for transport problems or device simulations and presents real world examples of implementation

*Numerical Simulation of Semiconductor Structures* Abel Garcia-Barrientos, Vladimir Grimalsky, 2013-10-21 The investigation of new materials devices and techniques to improve the performance of telecommunications spectroscopy and radar systems applications has caused that the study of non stationary effects of space charge in semiconductor structures be a strategy research area in the field of high speed semiconductor devices Therefore this book focuses in the study of the non stationary effects of the space charge in semiconductor structures where the nonlinear wave interaction in active media may serve to improve the high frequency performance of semiconductor devices

**Numerical Models for the Simulation of Nonstationary Effects in Submicron Semiconductor Devices** Edwin Chihchuan Kan, 1992 Numerical modeling of nonstationary transport effects using partial differential equations derived from the Boltzmann Transport Equation BTE is investigated Augmented drift diffusion ADD models and improved energy transport ET models for submicron device simulation are constructed and numerically implemented Analytical derivation of the length coefficient for the ADD models is presented for both single and multi valley approximations Results of typical nsp nsp ballistic diodes for Si and GaAs are presented The extension of the ADD model to two dimensions is then formulated and the implementation problems with the standard box integration method as used in conventional drift diffusion DD models are examined Improved ET models are derived from the zeroth and second moments of the Boltzmann transport equation and from the presumed function form of the even part of the distribution function Energy band nonparabolicity and non Maxwellian distribution effects are included to first order The ET models are amenable to an efficient self consistent discretization with standard techniques taking advantage of the similarity between current and energy flow equations Numerical results for ballistic diodes and MOSFETs are presented Typical spurious velocity overshoot spikes obtained in conventional hydrodynamics simulations of ballistic diodes are virtually eliminated By comparing the formulation of the ET and HD models we find that the spurious spike is caused by the momentum relaxation time approximation and the resulting form of the thermal diffusion terms Calculations based on a two carrier population model at the anode junction further confirm our analysis of the spurious spike

*The Physics of Submicron Semiconductor Devices (Nato Asi Series. Series B. Physics, Vol 180)* Harold L. Grubin, David K. Ferry, C. Jacoboni, 1988 The papers contained in the volume represent lectures delivered as a 1983 NATO ASI held at Urbino Italy The lecture series was designed to identify the key submicron and ultrasubmicron device physics transport materials and contact issues Nonequilibrium transport quantum transport interfacial and size constraints issues were also highlighted The ASI was supported by NATO and the European Research Office H L Grubin D K Ferry C Jacoboni v CONTENTS MODELLING OF SUB MICRON DEVICES 1 E Constant BOLTZMANN

TRANSPORT EQUATION 33 K Hess TRANSPORT AND MATERIAL CONSIDERATIONS FOR SUBMICRON DEVICES 45 H L Grubin EPITAXIAL GROWTH FOR SUB MICRON STRUCTURES 179 C E C Wood INSULATOR SEMICONDUCTOR INTERFACES 195 C W Wilms en THEORY OF THE ELECTRONIC STRUCTURE OF SEMICONDUCTOR SURFACES AND INTERFACES 223 C Calandra DEEP LEVELS AT COMPOUND SEMICONDUCTOR INTERFACES 253 W Monch ENSEMBLE MONTE CARLO TECHNIQUES 289 C Jacoboni NOISE AND DIFFUSION IN SUBMICRON STRUCTURES 323 L Reggiani SUPERLATTICES 361 K Hess SUBMICRON LITHOGRAPHY 373 C D W Wilkinson and S P Beaumont QUANTUM EFFECTS IN DEVICE STRUCTURES DUE TO SUBMICRON CONFINEMENT IN ONE DIMENSION 401 B D McCombe vii viii CONTENTS PHYSICS OF HETEROSTRUCTURES AND HETEROSTRUCTURE DEVICES 445 P J Price CORRELATION EFFECTS IN SHORT TIME NONS TAT I ONARY TRANSPORT 477 J J Niez DEVICE DEVICE INTERACTIONS 503 D K Ferry QUANTUM TRANSPORT AND THE WIGNER FUNCTION 521 G J Iafrate FAR INFRARED MEASUREMENTS OF VELOCITY OVERSHOOT AND HOT ELECTRON DYNAMICS IN SEMICONDUCTOR DEVICES 577 S J Allen Jr

**Simulation of Semiconductor Devices and Processes, Vol. 5** Siegfried Selberherr, Hannes Stippel, Ernst Strasser, 1993 *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

**Modelling of Interface Carrier Transport for Device Simulation** Dietmar Schroeder, 2013-03-09 This book represents a comprehensive text devoted to charge transport at semiconductor interfaces and its consideration in device simulation by interface and boundary conditions It contains a broad review of the physics modelling and simulation of electron transport at interfaces in semiconductor devices Particular emphasis is put on the consistent derivation of interface or boundary conditions for semiconductor device simulation The book is of interest with respect to a wide range of electronic engineering activities as process design device design process characterization research in microelectronics or device simulator development It is also useful for students and lecturers in courses of electronic engineering and it supplements the library of technically oriented solid state physicists The deepest roots of this book date back to the mid seventies Being a student of electrical engineering who was exposed for the first time to the material of semiconductor device electronics I was puzzled by noticing that much emphasis was put on a thorough introduction and understanding of the basic semiconductor equations while the boundary conditions for these equations received very much less attention Until today on many occasions one could get the impression that boundary conditions are unimportant accessories they do not stand on their own besides

the bulk transport equations although it is clear that they are of course a necessary complement of these

*Applications of Silicon-Germanium Heterostructure Devices* C.K Maiti,G.A Armstrong,2001-07-20 The first book to deal with the design and optimization of transistors made from strained layers Applications of Silicon Germanium Heterostructure Devices combines three distinct topics technology device design and simulation and applications in a comprehensive way Important aspects of the book include key technology issues for the growth of st

*Viscous Profiles and Numerical Methods for Shock Waves* Michael Shearer,1991-01-01 One strongly represented theme is the power of ideas from dynamical systems that are being adapted and developed in the context of shock waves

*Simulation of Semiconductor Devices and Processes* Siegfried Selberherr,Hannes Stippel,Ernst Strasser,2012-12-06 The Fifth International Conference on Simulation of Semiconductor Devices and Processes SISDEP 93 continues a series of conferences which was initiated in 1984 by K Board and D R J Owen at the University College of Wales Swansea where it took place a second time in 1986 Its organization was succeeded by G Baccarani and M Rudan at the University of Bologna in 1988 and W Fichtner and D Aemmer at the Federal Institute of Technology in Zurich in 1991 This year the conference is held at the Technical University of Vienna Austria September 7 9 1993 This conference shall provide an international forum for the presentation of out standing research and development results in the area of numerical process and de vice simulation The miniaturization of today s semiconductor devices the usage of new materials and advanced process steps in the development of new semiconduc tor technologies suggests the design of new computer programs This trend towards more complex structures and increasingly sophisticated processes demands advanced simulators such as fully three dimensional tools for almost arbitrarily complicated geometries With the increasing need for better models and improved understand ing of physical effects the Conference on Simulation of Semiconductor Devices and Processes brings together the simulation community and the process and device en gineers who need reliable numerical simulation tools for characterization prediction and development

**Hot Carrier Degradation in Semiconductor Devices** Tibor Grasser,2014-10-29 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

**Scientific Computing in Electrical Engineering SCEE 2010** Bastiaan Michielsen,Jean-René Poirier,2012-01-06 Selected from papers presented at the 8th Scientific Computation in Electrical Engineering conference in Toulouse in 2010 the contributions to this volume cover every angle of numerically modelling electronic and electrical systems including computational electromagnetics circuit theory and simulation and device modelling On computational electromagnetics the chapters examine cutting edge material ranging from low frequency electrical machine modelling problems to issues in high frequency scattering Regarding

circuit theory and simulation the book details the most advanced techniques for modelling networks with many thousands of components Modelling devices at microscopic levels is covered by a number of fundamental mathematical physics papers while numerous papers on model order reduction help engineers and systems designers to bring their modelling of industrial scale systems within the reach of present day computational power Complementing these more specific papers the volume also contains a selection of mathematical methods which can be used in any application domain

**Computational Modeling in Semiconductor Processing** M. Meyyappan,1995 This book provides you with in depth coverage of the models governing equations and numerical techniques suitable for process simulation so you can give your designs the competitive edge You will understand the basic principles of transport phenomena gas phase and surface reactions in electronics material processing and learn practical numerical techniques used in process simulations

**Monte Carlo Simulation of Electron Dynamics in Quantum Cascade Lasers** Xujiao Gao,2008 *Principles and Analysis of AlGaAs/GaAs Heterojunction Bipolar Transistors* Juin J. Liou,1996 The first book devoted entirely to HBTs this reference examines the basic concept standard and advanced structures noise performance reliability issues and simulation It s main emphasis is on device physics and its mathematical representations through which the operational characterization of AlGaAs GaAs HBTs can be understood It enables device engineers device researchers and circuit designers to increase their knowledge of HBT principles and behavior with significantly less literature research time and to design optimal HBTs with minimal design time Extensively referenced with 150 illustrations and 250 equations

**ICIAM 91** Robert E. O'Malley,1992-01-01 Proceedings Computer Arithmetic Algebra OOP

**Analysis and Design of Si/SiGe Terahertz Diodes** Xiaochuan Bi,2006 Quantum Transport in Ultrasmall Devices David K. Ferry,1995-07-31 The operation of semiconductor devices depends upon the use of electrical potential barriers such as gate depletion in controlling the carrier densities electrons and holes and their transport Although a successful device design is quite complicated and involves many aspects the device engineering is mostly to devise a best device design by defining optimal device structures and manipulating impurity profiles to obtain optimal control of the carrier flow through the device This becomes increasingly difficult as the device scale becomes smaller and smaller Since the introduction of integrated circuits the number of individual transistors on a single chip has doubled approximately every three years As the number of devices has grown the critical dimension of the smallest feature such as a gate length which is related to the transport length defining the channel has consequently declined The reduction of this design rule proceeds approximately by a factor of 1.4 each generation which means we will be using 0.1015  $\mu\text{m}$  rules for the 4 Gb chips a decade from now If we continue this extrapolation current technology will require 30 nm design rules and a cell 3.2 size

**The RF and Microwave Handbook** John Michael Golio,Janet Golio,2008 The growth of wireless technology over the past decade is reflected in this guide It covers WiMAX broadband cable a comprehensive range of other topics This volume RF and Microwave Applications and Systems includes a wide range of articles that discuss RF and microwave

systems used for communication and radar and heating applications Commercial avionics medical and military applications are addressed An overview of commercial communications systems is provided Past current and emerging cellular systems navigation systems and satellite based systems are discussed Specific voice and data commercial systems are investigated more thoroughly in individual chapters that follow Detailed discussions of military electronics avionics and radar both military and automotive are provided in separate chapters A chapter focusing on FR microwave energy used for therapeutic medicine is also provided Systems considerations including thermal mechanical reliability power management and safety are discussed in separate chapters Engineering processes are also explored in articles about corporate initiatives cost modeling and design reviews The book closes with a discussion of the underlying physics of electromagnetic propagation and interference In addition to new chapters on WiMAX and broadband cable nearly every existing chapter features extensive updates and several were completely rewritten to reflect the massive changes areas such as radio navigation and electronic warfare

Quasi-hydrodynamic Semiconductor Equations Ansgar Jüngel,2001

Decoding **Numerical Simulation Of Submicron Semiconductor Devices**: Revealing the Captivating Potential of Verbal Expression

In a period characterized by interconnectedness and an insatiable thirst for knowledge, the captivating potential of verbal expression has emerged as a formidable force. Its ability to evoke sentiments, stimulate introspection, and incite profound transformations is genuinely awe-inspiring. Within the pages of "**Numerical Simulation Of Submicron Semiconductor Devices**," a mesmerizing literary creation penned with a celebrated wordsmith, readers embark on an enlightening odyssey, unraveling the intricate significance of language and its enduring affect our lives. In this appraisal, we shall explore the book's central themes, evaluate its distinctive writing style, and gauge its pervasive influence on the hearts and minds of its readership.

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