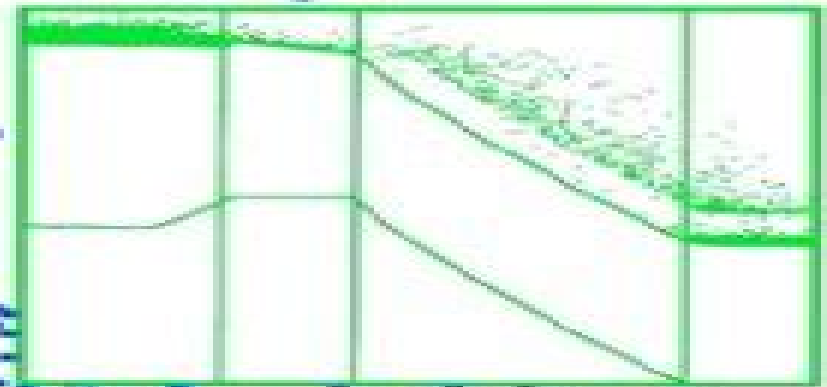


NUMERICAL SIMULATION OF SUBMICRON SEMICONDUCTOR DEVICES



KAZUTAKA TOMIZAWA

Numerical Simulation Of Submicron Semiconductor Devices

Tibor Grasser



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 **Hierarchical Device Simulation** Christoph Jungemann, Bernd Meinerzhagen, 2012-12-06

This book summarizes the research of more than a decade Its early motivation dates back to the eighties and to the memorable talks Dr C Moglestue FHG Freiburg gave on his Monte Carlo solutions of the Boltzmann transport equation at the NASECODE conferences in Ireland At that time numerical semiconductor device modeling basically implied the application of the drift diffusion model On the one hand those talks clearly showed the potential of the Monte Carlo model for an accurate description of many important transport issues that cannot adequately be addressed by the drift diffusion approximation On the other hand they also clearly demonstrated that at that time only very few experts were able to extract useful results from a Monte Carlo simulator With this background Monte Carlo research activities were started in 1986 at the University of Aachen RWTH Aachen Germany Different to many other Monte Carlo research groups the Monte Carlo research in Aachen took place in an environment of active drift diffusion and hydrodynamic model development **The Physics of Submicron**

Semiconductor Devices Harold L. Grubin, David K. Ferry, C. Jacoboni, 2013-11-11 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 NONSTATIONARY 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

Numerical Simulation Mykhaylo Andriychuk, 2012-09-19 Numerical Simulation from Theory to Industry is the edited book

containing 25 chapters and divided into four parts Part 1 is devoted to the background and novel advances of numerical simulation second part contains simulation applications in the macro and micro electrodynamics Part 3 includes contributions related to fluid dynamics in the natural environment and scientific applications the last fourth part is dedicated to simulation in the industrial areas such as power engineering metallurgy and building Recent numerical techniques as well as software the most accurate and advanced in treating the physical phenomena are applied in order to explain the investigated processes in terms of numbers Since the numerical simulation plays a key role in both theoretical and industrial research this book related to simulation of many physical processes will be useful for the pure research scientists applied mathematicians industrial engineers and post graduate students

Numerical Methods in Electromagnetics W.H.A. SCHILDERS,E.J.W. TER MATEN,2005-04-04 This special volume provides a broad overview and insight in the way numerical methods are being used to solve the wide variety of problems in the electronics industry Furthermore its aim is to give researchers from other fields of application the opportunity to benefit from the results which have been obtained in the electronics industry Complete survey of numerical methods used in the electronic industry Each chapter is selfcontained Presents state of the art applications and methods Internationally recognised authors

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

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

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

Handbook of Optoelectronic Device Modeling and Simulation Joachim Piprek, 2017-10-12 Optoelectronic devices are now ubiquitous in our daily lives from light emitting diodes LEDs in many household appliances to solar cells for energy This handbook shows how we can probe the underlying and highly complex physical processes using modern mathematical models and numerical simulation for optoelectronic device design analysis and performance optimization It reflects the wide availability of powerful computers and advanced commercial software which have opened the door for non specialists to perform sophisticated modeling and simulation tasks The chapters comprise the know how of more than a hundred experts from all over the world The handbook is an ideal starting point for beginners but also gives experienced researchers the opportunity to renew and broaden their knowledge in this expanding field

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

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

Hot Carrier Degradation in Semiconductor Devices Tibor Grassner, 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

Full-band Monte Carlo Simulation of Electrons and Holes in Strained Si and SiGe Fabian M. Bufler, 1998

Mathematical Problems in Semiconductor Physics Angelo Marcello Anile, Walter Allegretto, Christian Ringhofer, 2003-12-10 On the the mathematical aspects of the theory of carrier transport in semiconductor devices The subjects covered include hydrodynamical models for semiconductors based on the maximum entropy principle of extended thermodynamics mathematical theory of drift diffusion

equations with applications and the methods of asymptotic analysis *Computational Methods for Electromagnetic Phenomena* Wei Cai, 2013-01-03 The first book of its kind to cover a wide range of computational methods for electromagnetic phenomena from atomistic to continuum scales this integrated and balanced treatment of mathematical formulations algorithms and the underlying physics enables us to engage in innovative and advanced interdisciplinary computational research **Wave Propagation** Andrey Petrin, 2011-03-16 The book collects original and innovative research studies of the experienced and actively working scientists in the field of wave propagation which produced new methods in this area of research and obtained new and important results Every chapter of this book is the result of the authors achieved in the particular field of research The themes of the studies vary from investigation on modern applications such as metamaterials photonic crystals and nanofocusing of light to the traditional engineering applications of electrodynamics such as antennas waveguides and radar investigations Introduction to the Physics of Electron Emission Kevin L. Jensen, 2024-08-19 A practical in depth description of the physics behind electron emission physics and its usage in science and technology Electron emission is both a fundamental phenomenon and an enabling component that lies at the very heart of modern science and technology Written by a recognized authority in the field with expertise in both electron emission physics and electron beam physics An Introduction to Electron Emission provides an in depth look at the physics behind thermal field photo and secondary electron emission mechanisms how that physics affects the beams that result through space charge and emittance growth and explores the physics behind their utilization in an array of applications The book addresses mathematical and numerical methods underlying electron emission describing where the equations originated how they are related and how they may be correctly used to model actual sources for devices using electron beams Writing for the beam physics and solid state communities the author explores applications of electron emission methodology to solid state statistical and quantum mechanical ideas and concepts related to simulations of electron beams to condensed matter solid state and fabrication communities Provides an extensive description of the physics behind four electron emission mechanisms field photo and secondary and how that physics relates to factors such as space charge and emittance that affect electron beams Introduces readers to mathematical and numerical methods their origins and how they may be correctly used to model actual sources for devices using electron beams Demonstrates applications of electron methodology as well as quantum mechanical concepts related to simulations of electron beams to solid state design and manufacture Designed to function as both a graduate level text and a reference for research professionals Introduction to the Physics of Electron Emission is a valuable learning tool for postgraduates studying quantum mechanics statistical mechanics solid state physics electron transport and beam physics It is also an indispensable resource for academic researchers and professionals who use electron sources model electron emission develop cathode technologies or utilize electron beams **Handbook of Nanostructured Materials and Nanotechnology, Five-Volume Set** Hari Singh Nalwa, 1999-10-29 Nanostructured materials is one of the

hottest and fastest growing areas in today's materials science field along with the related field of solid state physics Nanostructured materials and their based technologies have opened up exciting new possibilities for future applications in a number of areas including aerospace automotive x ray technology batteries sensors color imaging printing computer chips medical implants pharmacy and cosmetics The ability to change properties on the atomic level promises a revolution in many realms of science and technology Thus this book details the high level of activity and significant findings are available for those involved in research and development in the field It also covers industrial findings and corporate support This five volume set summarizes fundamentals of nano science in a comprehensive way The contributors enlisted by the editor are at elite institutions worldwide Key Features Provides comprehensive coverage of the dominant technology of the 21st century Written by 127 authors from 16 countries making this truly international First and only reference to cover all aspects of nanostructured materials and nanotechnology

Quantum Transport in Ultrasmall Devices David K. Ferry, Harold L. Grubin, Carlo Jacoboni, A.-P. Jauho, 2012-12-06 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 μm 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

Compound Semiconductor Electronics Michael Shur, 1996 In many respects compound semiconductor technology has reached the age of maturity when applications will have been defined yields are high enough and well established and gallium arsenide and related compounds have carved many important niches in electronics This book reviews the state of the art of compound semiconductor electronics It covers the microwave millimeter wave and submillimeter wave devices monolithic microwave and digital integrated circuits made from compound semiconductors and emerging wide band semiconductor materials The book is written by leading experts in compound semiconductor electronics from industry and academia and strikes the balance between practical applications record breaking results and design and modeling tools specific for compound semiconductor technology Engineers scientists and graduate students working in solid state electronics and especially in the area of compound semiconductor electronics will find this book very useful It could also be used as a text or a supplementary text for graduate courses in this field

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