Monte Carlo Device Simulation: Full Band and Beyond

edited by

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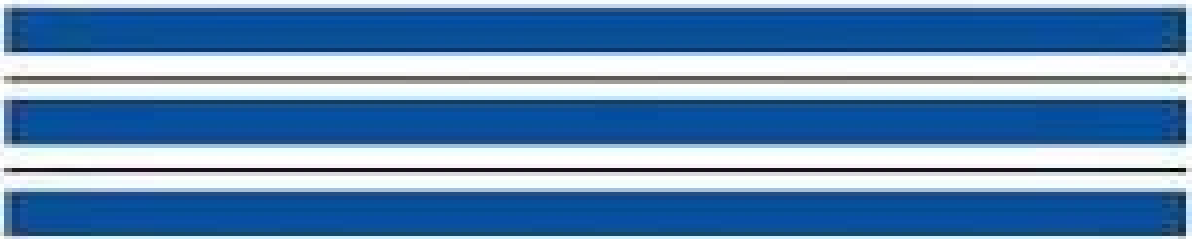

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Monte Carlo Device Simulation Full Band And Beyond

Supriyo Bandyopadhyay,Marc Cahay

Monte Carlo Device Simulation Full Band And Beyond:

Monte Carlo Device Simulation Karl Hess,2012-10-11 Monte Carlo simulation is now a well established method for studying semiconductor devices and is particularly well suited to highlighting physical mechanisms and exploring material properties Not surprisingly the more completely the material properties are built into the simulation up to and including the use of a full band structure the more powerful is the method Indeed it is now becoming increasingly clear that phenomena such as reliabil ity related hot electron effects in MOSFETs cannot be understood satisfac torily without using full band Monte Carlo The IBM simulator DAMOCLES therefore represents a landmark of great significance DAMOCLES sums up the total of Monte Carlo device modeling experience of the past and reaches with its capabilities and opportunities into the distant future This book therefore begins with a description of the IBM simulator The second chapter gives an advanced introduction to the physical basis for Monte Carlo simulations and an outlook on why complex effects such as collisional broadening and intracollisional field effects can be important and how they can be included in the simulations References to more basic intro the book The third chapter ductory material can be found throughout describes a typical relationship of Monte Carlo simulations to experimental data and indicates a major difficulty the vast number of deformation poten tials required to simulate transport throughout the entire Brillouin zone The fourth chapter addresses possible further extensions of the Monte Carlo approach and subtleties of the electron electron interaction **Monte Carlo Device Simulation** Karl Hess,2012-12-06 Monte Carlo simulation is now a well established method for studying semiconductor devices and is particularly well suited to highlighting physical mechanisms and exploring material properties Not surprisingly the more completely the material properties are built into the simulation up to and including the use of a full band structure the more powerful is the method Indeed it is now becoming increasingly clear that phenomena such as reliabil ity related hot electron effects in MOSFETs cannot be understood satisfac torily without using full band Monte Carlo The IBM simulator DAMOCLES therefore represents a landmark of great significance DAMOCLES sums up the total of Monte Carlo device modeling experience of the past and reaches with its capabilities and opportunities into the distant future This book therefore begins with a description of the IBM simulator The second chapter gives an advanced introduction to the physical basis for Monte Carlo simulations and an outlook on why complex effects such as collisional broadening and intracollisional field effects can be important and how they can be included in the simulations References to more basic intro the book The third chapter ductory material can be found throughout describes a typical relationship of Monte Carlo simulations to experimental data and indicates a major difficulty the vast number of deformation poten tials required to simulate transport throughout the entire Brillouin zone The fourth chapter addresses possible further extensions of the Monte Carlo approach and subtleties of the electron electron interaction **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

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 *Simulation of Semiconductor Devices and Processes* Heiner Ryssel,Peter Pichler,2012-12-06 SISDEP 95 provides an international forum for the presentation of state of the art research and development results in the area of numerical process and device simulation Continuously shrinking device dimensions the use of new materials and advanced processing steps in the manufacturing of semiconductor devices require new and improved software The trend towards increasing complexity in structures and process technology demands advanced models describing all basic effects and sophisticated two and three dimensional tools for almost arbitrarily designed geometries The book contains the latest results obtained by scientists from more than 20 countries on process simulation and modeling simulation of process equipment device modeling and simulation of novel devices power semiconductors and sensors on device simulation and parameter extraction for circuit models practical application of simulation numerical methods and software Monte Carlo Simulation of Semiconductor Devices C. Moglestue,2013-04-17 Particle simulation of semiconductor devices is a rather new field which has started to catch the interest of the world s scientific community It represents a time continuous solution of Boltzmann s transport equation or its quantum mechanical equivalent and the field equation without encountering the usual numerical problems associated with the direct solution The technique is based on first physical principles by following in detail the transport histories of indi vidual particles and gives a profound insight into the physics of semiconductor devices The method can be applied to devices of any geometrical complexity and material composition It yields an accurate description of the device which is not limited by the assumptions made behind the alternative drift diffusion and hydrodynamic models which represent approximate solutions to the transport equation While the development of the particle modelling technique has

been hampered in the past by the cost of computer time today this should not be held against using a method which gives a profound physical insight into individual devices and can be used to predict the properties of devices not yet manufactured Employed in this way it can save the developer much time and large sums of money both important considerations for the laboratory which wants to keep abreast of the field of device research Applying it to al ready existing electronic components may lead to novel ideas for their improvement The Monte Carlo particle simulation technique is applicable to microelectronic components of any arbitrary shape and complexity **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 *Transport Simulation in Microelectronics* Alfred Kersch,William J. Morokoff,2012-12-06 Computer simulation of semiconductor processing equipment and devices requires the use of a wide variety of numerical methods Of these methods the Monte Carlo approach is perhaps most fundamentally suited to mod eling physical events occurring on microscopic scales which are intricately connected to the particle structure of nature Here physical phenomena can be simulated by following simulation particles such as electrons molecules photons etc through a statistical sampling of scattering events Monte Carlo is however generally looked on as a last resort due to the extremely slow convergence of these methods It is of interest then to examine when in microelectronics it is necessary to use Monte Carlo methods how such methods may be improved and what are the alternatives This book ad dresses three general areas of simulation which frequently arise in semicon ductor modeling where Monte Carlo methods playa significant role In the first chapter the basic mathematical theory of the Boltzmann equation for particle transport is presented The following chapters are devoted to the modeling of the transport processes and the associated Monte Carlo meth ods Specific examples of industrial applications illustrate the effectiveness and importance of these methods Two of these areas concern simulation of physical particles which may be assigned a time dependent position and velocity This includes the molecules of a dilute gas used in such processing equipment as chemi cal vapor decomposition reactors and sputtering reactors We also consider charged particles moving within a semiconductor lattice **Transport of Information-Carriers in Semiconductors and Nanodevices** El-Saba, Muhammad,2017-03-31 Rapid developments in technology have led to enhanced electronic systems and applications When utilized correctly these can have significant impacts on communication and computer systems Transport of Information Carriers in Semiconductors and Nanodevices is an innovative source of academic material on transport modelling in semiconductor material and nanoscale devices Including a range of perspectives on relevant topics such as charge carriers semiclassical transport theory and organic semiconductors this is an ideal publication for engineers

researchers academics professionals and practitioners interested in emerging developments on transport equations that govern information carriers **Ionizing Radiation Effects in Electronics** Marta Bagatin,Simone Gerardin,2018-09-03 Ionizing Radiation Effects in Electronics From Memories to Imagers delivers comprehensive coverage of the effects of ionizing radiation on state of the art semiconductor devices The book also offers valuable insight into modern radiation hardening techniques The text begins by providing important background information on radiation effects their underlying mechanisms and the use of Monte Carlo techniques to simulate radiation transport and the effects of radiation on electronics The book then Explains the effects of radiation on digital commercial devices including microprocessors and volatile and nonvolatile memories static random access memories SRAMs dynamic random access memories DRAMs and Flash memories Examines issues like soft errors total dose and displacement damage together with hardening by design solutions for digital circuits field programmable gate arrays FPGAs and mixed analog circuits Explores the effects of radiation on fiber optics and imager devices such as complementary metal oxide semiconductor CMOS sensors and charge coupled devices CCDs Featuring real world examples case studies extensive references and contributions from leading experts in industry and academia Ionizing Radiation Effects in Electronics From Memories to Imagers is suitable both for newcomers who want to become familiar with radiation effects and for radiation experts who are looking for more advanced material or to make effective use of beam time **Theory of Electron Transport in Semiconductors** Carlo Jacoboni,2010-09-05 This book originated out of a desire to provide students with an instrument which might lead them from knowledge of elementary classical and quantum physics to moderntheoreticaltechniques for the analysisof electrontransport in semiconductors The book is basically a textbook for students of physics material science and electronics Rather than a monograph on detailed advanced research in a speci c area it intends to introduce the reader to the fascinating eld of electron dynamics in semiconductors a eld that through its applications to electronics greatly contributed to the transformationof all our lives in the second half of the twentieth century and continues to provide surprises and new challenges The eld is so extensive that it has been necessary to leave aside many subjects while others could be dealt with only in terms of their basic principles The book is divided into ve major parts Part I moves from a survey of the fundamentals of classical and quantum physics to a brief review of basic semiconductor physics Its purpose is to establish a common platform of language and symbols and to make the entire treatment as far as pos ble self contained Parts II and III respectively develop transport theory in bulk semiconductors in semiclassical and quantum frames Part IV is devoted to semiconductor structures including devices and mesoscopic coherent s tems Finally Part V develops the basic theoretical tools of transport theory within the modern nonequilibrium Green function formulation starting from an introduction to second quantization formalism

Semiconductor Transport David Ferry,2016-08-12 The information revolution would have been radically different or impossible without the use of the materials known generically as semiconductors The properties of these materials

particularly the potential for doping with impurities to create transistors and diodes and controlling the local potential by gates are essential for microelectronics Semiconductor Transport is an introductory text on electron transport in semiconductor materials and is written for advanced undergraduates and graduate students The book provides a thorough treatment of modern approaches to the transport properties of semiconductors and their calculation It also introduces those aspects of solid state physics which are vitally important for understanding transport in them FinFETs and Other Multi-Gate Transistors J.-P. Colinge,2008 This book explains the physics and properties of multi gate field effect transistors MuGFETs how they are made and how circuit designers can use them to improve the performances of integrated circuits It covers the emergence of quantum effects due to the reduced size of the devices and describes the evolution of the MOS transistor from classical structures to SOI silicon on insulator and then to MuGFETs **Introduction to Spintronics** Supriyo Bandyopadhyay,Marc Cahay,2015-09-18 Introduction to Spintronics provides an accessible organized and progressive presentation of the quantum mechanical concept of spin and the technology of using it to store process and communicate information Fully updated and expanded to 18 chapters featuring many new drill problems this edition reflects the explosion of study in spin related physics addressing seven important physical phenomena with spintronic device applications It discusses spintronics without magnetism which allows one to manipulate spin currents by purely electrical means It explores lateral spin orbit interaction and its many nuances as well as the possibility to implement spin polarizers and analyzers using quantum point contacts It also introduces the concept of single domain nanomagnet based computing Simulation of Transport in Nanodevices François Triozon,Philippe Dollfus,2016-11-22 Linear current voltage pattern has been and continues to be the basis for characterizing evaluating performance and designing integrated circuits but is shown not to hold its supremacy as channel lengths are being scaled down In a nanoscale circuit with reduced dimensionality in one or more of the three Cartesian directions quantum effects transform the carrier statistics In the high electric field the collision free ballistic transform is predicted while in low electric field the transport remains predominantly scattering limited In a micro nano circuit even a low logic voltage of 1 V is above the critical voltage triggering nonohmic behavior that results in ballistic current saturation A quantum emission may lower this ballistic velocity **Progress in Computational Physics of Matter** Luciano Reatto,Franca Manghi,1995 The aim of the book is to describe some of the recent advances through computer simulation in a broad sense in the understanding of the complex processes occurring in solids and liquids The rapid growth of computer power including the new parallel processors has stimulated a ferment of new theoretical and computational ideas which have been developed in particular by the authors in a pluriennal research project supported by Consiglio Nazionale delle Ricerche CNR for the development of novel software for large scale computations The book will cover advances in ab initio Car Parrinello molecular dynamics quantum monte carlo simulations self consistent density functional computation of electronic states classical molecular dynamics simulation of thermodynamic processes chemical

reactions and transport properties Besides the description of the results of these techniques in leading edge applications the book will address specific aspects of the algorithms and software which have been developed by the authors in order to implement in an efficient way the new theoretical advances in these computationally intensive problems These aspects which are generally not discussed in any detail in the literature can be of great help for newcomers in the field **Nanophononics** Zlatan Aksamija,2017-11-22 Heat in most semiconductor materials including the traditional group IV elements Si Ge diamond III V compounds GaAs wide bandgap GaN and carbon allotropes graphene CNTs as well as emerging new materials like transition metal dichalcogenides TMDCs is stored and transported by lattice vibrations phonons Phonon generation through interactions with electrons in nanoelectronics power and nonequilibrium devices and light optoelectronics is the central mechanism of heat dissipation in nanoelectronics This book focuses on the area of thermal effects in nanostructures including the generation transport and conversion of heat at the nanoscale level Phonon transport including thermal conductivity in nanostructured materials as well as numerical simulation methods such as phonon Monte Carlo Green s functions and first principles methods feature prominently in the book which comprises four main themes i phonon generation heat dissipation i nanoscale phonon transport iii applications devices including thermoelectrics and iv emerging materials graphene 2D The book also covers recent advances in nanophononics the study of phonons at the nanoscale Applications of nanophononics focus on thermoelectric TE and tandem TE photovoltaic energy conversion The applications are augmented by a chapter on heat dissipation and self heating in nanoelectronic devices The book concludes with a chapter on thermal transport in nanoscale graphene ribbons covering recent advances in phonon transport in 2D materials The book will be an excellent reference for researchers and graduate students of nanoelectronics device engineering nanoscale heat transfer and thermoelectric energy conversion The book could also be a basis for a graduate special topics course in the field of nanoscale heat and energy **Physics and Modeling of Tera-and Nano-devices** Maxim Ryzhii,Victor Ryzhii,2008 Physics and Modeling of Tera and Nano Devices is a compilation of papers by well respected researchers working in the field of physics and modeling of novel electronic and optoelectronic devices The topics covered include devices based on carbon nanotubes generation and detection of terahertz radiation in semiconductor structures including terahertz plasma oscillations and instabilities terahertz photomixing in semiconductor heterostructures spin and microwave induced phenomena in low dimensional systems and various computational aspects of device modeling Researchers as well as graduate and postgraduate students working in this field will benefit from reading this book 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 Topics In High Field Transport In Semiconductors Kevin F Brennan,P Paul Ruden,2001-07-31 This book examines some of the charge carrier transport issues encountered in the field of modern semiconductor devices and novel materials Theoretical approaches to the understanding and modeling of the relevant physical phenomena seen in devices that have very small spatial dimensions and that operate under high electric field strength are described in papers written by leading experts and pioneers in this field In addition the book examines the transport physics encountered in novel materials such as wide band gap semiconductors GaN SiC etc as well as organic semiconductors Topics in High Field Transport in Semiconductors provides a comprehensive overview that will be beneficial to newcomers as well as engineers and researchers engaged in this exciting field

The Enigmatic Realm of **Monte Carlo Device Simulation Full Band And Beyond**: Unleashing the Language is Inner Magic

In a fast-paced digital era where connections and knowledge intertwine, the enigmatic realm of language reveals its inherent magic. Its capacity to stir emotions, ignite contemplation, and catalyze profound transformations is nothing lacking extraordinary. Within the captivating pages of **Monte Carlo Device Simulation Full Band And Beyond** a literary masterpiece penned by way of a renowned author, readers attempt a transformative journey, unlocking the secrets and untapped potential embedded within each word. In this evaluation, we shall explore the book is core themes, assess its distinct writing style, and delve into its lasting effect on the hearts and minds of people who partake in its reading experience.

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