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[(Numerical Simulation of Submicron Semiconductor Devices ...

K. Tomizawa, 'Numerical Simulation of Submicron Semiconductor Devices' (The Artech House Materials Science Library, 1993). Principles of Solar Cells, LEDs and Related Devices: The Role of the PN ...

Describes the basic theory of carrier transport, develops numerical algorithms used for transport problems or device simulations, and presents real-world examples of implementation.

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.

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.

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 $nsp+ - n - nsp+$ 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.

This monograph is the first on physics-based simulations of novel strained Si and SiGe devices. It provides an in-depth description of the full-band monte-carlo method for SiGe and discusses the common theoretical background of the drift-diffusion, hydrodynamic and Monte-

Carlo models and their synergy.

Partial Contents: LSI layout verification system using circuit simulation programs; Application of numerical simulation in the modeling of I.C. device structures; Discretization methods for the semiconductor equations; Two-dimensional numerical analysis of doping processes; Submicron device simulation; A singular perturbation analysis of discretisation methods for the parabolic semicondutor device equations; Two-dimensional analysis of the back region of I.B.C. silicon solar cells; Two dimensional simulation of VLSI processes: a solution using finite element method; The influence of various mobility models on the iteration process and solution of the basic semiconductor equations; Surface and bulk-dominaTED PUNCH-through in short-channel MOSFETS; Adaptation of stiff methods to simulation of impurity diffusion in semiconductors; Application of parabolic partial differential equations to semiconductor device modeling; Calculation of quasi-static device behavior with small computational burden; Modeling the body effect of a short channel MOSFET. Steady state numerical analysis of single carrier two dimensional semiconductor devices using the control area approximation; Carrier mobility at interfaces; Nonstatic modeling of submicron transistors; Numerical solutions of the electrical properties of GaAs/Al1-x GaxAs superlattices and heterojunctions; An accurate 2-d simulation program of MOS transistors using the finite element method, and interfaced to other process simulation programs; Numerical simulation of the phase memory in nonlinear active media with diffusion; Finite element modelling of junction terminations in reverse-biased semiconductor devices.

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.

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 wich 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

This book contains a comprehensive review of the physics, modelling and simulation of electron transport at interfaces in semiconductor devices. It combines a review of existing interface charge transport models with original developments, and introduces a unified representation of charge transport at semiconductor interfaces.