

# Basic Solid-State Electronics

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# Basic Solid State Electronics Vol 1

**Wai-Kai Chen**



## Basic Solid State Electronics Vol 1:

Makromodellierung parasitärer Substrateffekte von Bipolartransistoren einer BiCMOS-Technologie Roland Fischer, 1998-01-21 Inhaltsangabe Einleitung Die vorliegende Arbeit behandelt die Modellierung und die Erklärung parasitärer Substrateffekte wie sie bei lateralen Transistorstrukturen auftreten Der Modellierung von lateralen Transistoren wurde schon einmal Ende der 60er Jahre große Beachtung zuteil Einhergehend mit den Bestrebungen hin zu immer kleineren Strukturen und einfachen Technologien wurden zahlreiche Untersuchungen zu diesem Thema vorgenommen Die Abhandlungen zu dieser Zeit beschreiben sich denn auch meist mit prinzipiellen Beschreibungen der Funktionsweise der Lateralstrukturen im Hinblick auf Verbesserungen in ihrer Effektivität Mit dem Aufkommen der MOS sank auch das Interesse an Bipolartechnologien und damit auch an der Modellierung von lateralen pnp Transistoren Nachdem gerade in neuester Zeit neue Kombinationstechnologien entwickelt werden in denen Analog und Digitalfunktionen auf einem Chip realisiert werden sollen den sogenannten BiCMOS Technologien kommen auch vermehrt wieder laterale Transistoren zum Einsatz Ein Grund dafür ist dass man bei der Integration von Bipolartransistoren in einer BiCMOS Kombinationstechnologie aus Gründen der vereinfachten Prozessführung gezwungen ist die Strukturen der Transistoren gegenüber Standard Bipolartechnologien zu modifizieren Neben veränderten Dotierungskonzentrationen Eindringtiefen oder Abschirmungsmaßnahmen ergeben sich vor allem im strukturellen Aufbau der Transistoren Veränderungen Im Bipolarteil solcher BiCMOS Prozesse werden deshalb die pnp Transistoren meist in lateraler Form ausgeführt Darüber hinaus findet eine Optimierung des Prozesses im Hinblick auf die npn Transistoren statt da mit ihnen naturgemäß effektivere Bauteile hergestellt werden können Ein großes Problem bei lateralen Transistoren ist zum einen das nicht mehr spezifische Transistorverhalten wie es in vertikalen Bauteilen auftritt und zum Beispiel von Simulationsprogrammen wie SPICE nachgebildet wird zum anderen treten parasitäre Effekte auf welche die Güte der Transistoren verschlechtern Die Unterschiede in der Struktur und in den Dotierungsverhältnissen lassen sich mit Hilfe der folgenden Beispiele beschreiben Da die lateralen Entfernungen normalerweise größer sind als die vertikalen ergibt sich eine geringere Transitfrequenz Aufgrund der Technologie werden Emitter und Kollektor im gleichen Prozessschritt wie die Basis der vertikalen Transistoren implementiert und besitzen deshalb auch die gleichen

**Lifetime Factors in Silicon** R. D. Westbrook, 1980

**Tradeoffs and Optimization in Analog CMOS Design** David Binkley, 2008-09-15 Analog CMOS integrated circuits are in widespread use for communications entertainment multimedia biomedical and many other applications that interface with the physical world Although analog CMOS design is greatly complicated by the design choices of drain current channel width and channel length present for every MOS device in a circuit these design choices afford significant opportunities for optimizing circuit performance This book addresses tradeoffs and optimization of device and circuit performance for selections of the drain current inversion coefficient and channel length where channel width is implicitly considered The inversion coefficient is used as a technology independent measure of MOS inversion that permits

design freely in weak moderate and strong inversion This book details the significant performance tradeoffs available in analog CMOS design and guides the designer towards optimum design by describing An interpretation of MOS modeling for the analog designer motivated by the EKV MOS model using tabulated hand expressions and figures that give performance and tradeoffs for the design choices of drain current inversion coefficient and channel length performance includes effective gate source bias and drain source saturation voltages transconductance efficiency transconductance distortion normalized drain source conductance capacitances gain and bandwidth measures thermal and flicker noise mismatch and gate and drain leakage current Measured data that validates the inclusion of important small geometry effects like velocity saturation vertical field mobility reduction drain induced barrier lowering and inversion level increases in gate referred flicker noise voltage In depth treatment of moderate inversion which offers low bias compliance voltages high transconductance efficiency and good immunity to velocity saturation effects for circuits designed in modern low voltage processes Fabricated design examples that include operational transconductance amplifiers optimized for various tradeoffs in DC and AC performance and micropower low noise preamplifiers optimized for minimum thermal and flicker noise A design spreadsheet available at the book web site that facilitates rapid optimum design of MOS devices and circuits Tradeoffs and Optimization in Analog CMOS Design is the first book dedicated to this important topic It will help practicing analog circuit designers and advanced students of electrical engineering build design intuition rapidly optimize circuit performance during initial design and minimize trial and error circuit simulations

**The VLSI Handbook** Wai-Kai Chen, 2018-10-03 For the new millenium Wai Kai Chen introduced a monumental reference for the design analysis and prediction of VLSI circuits The VLSI Handbook Still a valuable tool for dealing with the most dynamic field in engineering this second edition includes 13 sections comprising nearly 100 chapters focused on the key concepts models and equations Written by a stellar international panel of expert contributors this handbook is a reliable comprehensive resource for real answers to practical problems It emphasizes fundamental theory underlying professional applications and also reflects key areas of industrial and research focus WHAT S IN THE SECOND EDITION Sections on Low power electronics and design VLSI signal processing Chapters on CMOS fabrication Content addressable memory Compound semiconductor RF circuits High speed circuit design principles SiGe HBT technology Bipolar junction transistor amplifiers Performance modeling and analysis using SystemC Design languages expanded from two chapters to twelve Testing of digital systems Structured for convenient navigation and loaded with practical solutions The VLSI Handbook Second Edition remains the first choice for answers to the problems and challenges faced daily in engineering practice

**Stochastic Approaches to Electron Transport in Micro- and Nanostructures** Mihail Nedjalkov, Ivan Dimov, Siegfried Selberherr, 2021-04-05 The book serves as a synergistic link between the development of mathematical models and the emergence of stochastic Monte Carlo methods applied for the simulation of current transport in electronic devices Regarding the models the historical evolution path beginning from the classical charge carrier

transport models for microelectronics to current quantum based nanoelectronics is explicatively followed Accordingly the solution methods are elucidated from the early phenomenological single particle algorithms applicable for stationary homogeneous physical conditions up to the complex algorithms required for quantum transport based on particle generation and annihilation The book fills the gap between monographs focusing on the development of the theory and the physical aspects of models their application and their solution methods and monographs dealing with the purely theoretical approaches for finding stochastic solutions of Fredholm integral equations

**Wave Scattering from Statistically Rough Surfaces** F. G. Bass, I. M. Fuks, 2013-10-22 Wave Scattering from Statistically Rough Surfaces discusses the complications in radio physics and hydro acoustics in relation to wave transmission under settings seen in nature Some of the topics that are covered include radar and sonar the effect of variations in topographic relief or ocean waves on the transmission of radio and sound waves the reproduction of radio waves from the lower layers of the ionosphere and the oscillations of signals within the earth ionosphere waveguide The book begins with some fundamental idea of wave transmission theory and the theory of random processes as used to rough surfaces and to wave fields This discussion is followed by an analysis of the average fields of sound and electromagnetic waves A section on spatial correlation characteristics in the approximation of small perturbations is then given Another chapter of the text explains the Kirchhoff method The book will provide useful information to physicists mechanical engineer students and researchers in the field of acoustics

**Advancing Silicon Carbide Electronics Technology I** Konstantinos Zekentes, Konstantin Vasilevskiy, 2018-09-20 The rapidly advancing Silicon Carbide technology has a great potential in high temperature and high frequency electronics High thermal stability and outstanding chemical inertness make SiC an excellent material for high power low loss semiconductor devices The present volume presents the state of the art of SiC device fabrication and characterization Topics covered include SiC surface cleaning and etching techniques electrical characterization methods and processing of ohmic contacts to silicon carbide analysis of contact resistivity dependence on material properties limitations and accuracy of contact resistivity measurements ohmic contact fabrication and test structure design overview of different metallization schemes and processing technologies thermal stability of ohmic contacts to SiC their protection and compatibility with device processing Schottky contacts to SiC Schottky barrier formation Schottky barrier inhomogeneity in SiC materials technology and design of 4H SiC Schottky and Junction Barrier Schottky diodes Si SiC heterojunction diodes applications of SiC Schottky diodes in power electronics and temperature light sensors high power SiC unipolar and bipolar switching devices different types of SiC devices including material and technology constraints on device performance applications in the area of metal contacts to silicon carbide status and prospects of SiC power devices

*The Wigner Monte Carlo Method for Nanoelectronic Devices* Damien Querlioz, Philippe Dollfus, 2013-03-01 The emergence of nanoelectronics has led us to renew the concepts of transport theory used in semiconductor device physics and the engineering community It has become crucial to question the traditional semi

classical view of charge carrier transport and to adequately take into account the wave like nature of electrons by considering not only their coherent evolution but also the out of equilibrium states and the scattering effects This book gives an overview of the quantum transport approaches for nanodevices and focuses on the Wigner formalism It details the implementation of a particle based Monte Carlo solution of the Wigner transport equation and how the technique is applied to typical devices exhibiting quantum phenomena such as the resonant tunnelling diode the ultra short silicon MOSFET and the carbon nanotube transistor In the final part decoherence theory is used to explain the emergence of the semi classical transport in nanodevices

**Electronic Properties of Materials** H. Thayne Johnson, 2013-11-27 HIS FIRST EDITION OF Electronic Properties of Force Materials Laboratory where Air Force respon T Materials A Guide to the Literature initiates a sibility for these contracts has resided Mr John W plan for making available the indexing work of the Atwood is Project Manager at Hughes Aircraft Electronic Properties Information Center Since the Company inception of EPIC in June 1961 a basic objective has Professional members of EPIC are Charles L M been to use techniques and procedures that would Blocher Donald L Grigsby Dana H Johnson allow maximum distribution and use of EPIC output Thomas J Lyndon John T Milek Meta S Neu Accordingly data processing and reproduction tech berger and Emil Schafer All have ably contributed niques were established to reproduce and distribute to this work Mr Johnson and Mrs Neuberger have easily and economically a few copies of what was been primarily responsible for the indexing effort then a card index Mr Lyndon has supervised the classical library pro As the program advanced it became apparent that cedures and the clerical effort Mr Blocher and Mr a few copies of the index were not enough The index Grigsby have controlled the indexing vocabulary the should be available to all instead of just a select few cross references and the data processing input and However this would have meant so many copies that Mr Schafer has prepared the very excellent glossary the cost would have drained funds from the program with the assistance of Mr Milek

**Nondestructive Evaluation of Semiconductor Materials and Devices** J.

Zemel, 2013-11-11 From September 19 29 a NATO Advanced Study Institute on Non destructive Evaluation of Semiconductor Materials and Devices was held at the Villa Tuscolano in Frascati Italy A total of 80 attendees and lecturers participated in the program which covered many of the important topics in this field The subject matter was divided to emphasize the following different types of problems electrical measurements acoustic measurements scanning techniques optical methods backscatter methods x ray observations accele rated life tests It would be difficult to give a full discussion of such an Institute without going through the major points of each speaker Clearly this is the proper task of the eventual readers of these Proceedings Instead it would be preferable to stress some general issues What came through very clearly is that the measurements of the basic scientists in materials and device phenomena are of sub stantial immediate concern to the device technologies and end users

**Simulation of Semiconductor Processes and Devices 2001** Dimitris Tsoukalas, Christos Tsamis, 2012-12-06 This volume contains the Proceedings of the International Conference on Simulation of Semiconductor

Devices and Processes SISPAD 01 held on September 5-7 2001 in Athens. The conference provided an open forum for the presentation of the latest results and trends in process and device simulation. The trend towards shrinking device dimensions and increasing complexity in process technology demands the continuous development of advanced models describing basic physical phenomena involved. New simulation tools are developed to complete the hierarchy in the Technology Computer Aided Design simulation chain between microscopic and macroscopic approaches. The conference program featured 8 invited papers, 60 papers for oral presentation and 34 papers for poster presentation selected from a total of 165 abstracts from 30 countries around the world. These papers disclose new and interesting concepts for simulating processes and devices.

Compact Models for Integrated Circuit Design Samar K. Saha, 2018-09-03. Compact Models for Integrated Circuit Design: Conventional Transistors and Beyond provides a modern treatise on compact models for circuit computer aided design (CAD). Written by an author with more than 25 years of industry experience in semiconductor processes, devices, and circuit CAD and more than 10 years of academic experience in teaching compact modeling courses, this first of its kind book on compact SPICE models for very large scale integrated (VLSI) chip design offers a balanced presentation of compact modeling crucial for addressing current modeling challenges and understanding new models for emerging devices. Starting from basic semiconductor physics and covering state of the art device regimes from conventional micron to nanometer, this text presents industry standard models for bipolar junction transistors (BJTs), metal oxide semiconductor (MOS) field effect transistors (FETs), FinFETs, and tunnel field effect transistors (TFETs) along with statistical MOS models. It discusses the major issue of process variability which severely impacts device and circuit performance in advanced technologies and requires statistical compact models. It promotes further research of the evolution and development of compact models for VLSI circuit design and analysis. It supplies fundamental and practical knowledge necessary for efficient integrated circuit (IC) design using nanoscale devices. It includes exercise problems at the end of each chapter and extensive references at the end of the book. Compact Models for Integrated Circuit Design: Conventional Transistors and Beyond is intended for senior undergraduate and graduate courses in electrical and electronics engineering as well as for researchers and practitioners working in the area of electron devices. However, even those unfamiliar with semiconductor physics gain a solid grasp of compact modeling concepts from this book.

**Electronic Systems and Applications** R. P. Agarwal, S. Sarkar, 1994      **Compact Hierarchical Bipolar Transistor Modeling with Hicup** Michael Schröter, Anjan Chakravorty, 2010. Compact Hierarchical Bipolar Transistor Modeling with HICUP will be of great practical benefit to professionals from the process development, modeling, and circuit design community who are interested in the application of bipolar transistors which include the SiGe C HBTs fabricated with existing cutting edge process technology. The book begins with an overview on the different device designs of modern bipolar transistors along with their relevant operating conditions while the subsequent chapter on transistor theory is subdivided into a review of mostly classical theories brought into context with modern technology and a chapter on advanced theory that

is required for understanding modern device designs This book aims to provide a solid basis for the understanding of modern compact models

**Proceedings of the Third European Conference on Mathematics in Industry** J. Manley, S. McKee, D.R. Owens, 2012-12-06 The European Consortium for Mathematics in Industry ECMI was founded largely due to the driving energy of Michiel Hazewinkel on the 14th April 1986 in Neustadt Musbach in West Germany The founder signatories were A Bensoussan INRIA Paris A Fasano University of Florence M Hazewinkel CWI Amsterdam M Heilio Lappeenranta University Finland F Hodnett University of Limerick Ireland H Martens Norwegian Institute of Technology Trondheim S McKee University of Strathclyde Scotland H NeURzert University of Kaiserslautern Germany D Sundstrom The Swedish Institute of Applied Mathematics Stockholm A Tayler University of Oxford England and Hj Wacker University of Linz Austria The European Consortium for Mathematics in Industry is dedicated to a promote the use of mathematical models in Industry b educate industrial mathematicians to meet the growing demand for such experts c operate on a European scale ECMI is still a young organisation but its membership is growing fast Although it has still to persuade more industrialists to join ECMI certainly operates on a European scale and a flourishing postgraduate programme with student exchange has been underway for some time It is perhaps fitting that the first open meeting of ECMI was held at the University of Strathclyde in Glasgow Glasgow is and was the industrial capital of Scotland and was and arguably still is Britain s second city after London when this volume appears it will have rightly donned the mantle of the cultural capital of Europe

**Microelectronics Technology and Devices - SBMicro 2010** Marcelo Antonio Pavanello, Cor Claey, Joao Antonio Martino, 2010-09 Held in Sao Paulo Brazil from September 6 September 9 2010 the mission of the 25th Symposium on Microelectronics Technology and Devices SBMicro2010 was to share ideas and to point to new directions for future research and development SBMicro offers researchers and practitioners a unique opportunity to share their perspectives with those interested in the various aspects of microelectronics This issue of ECS Transactions continues the SBMicro tradition of being a premier forum for the presentation of leading edge research on process devices sensors and integrated circuit technology

**Cryogenic Microelectronic Systems for Ultra-Low Energy and Enhanced Performance** Nurzhan Zhuldassov, Eby G.

Friedman, 2025-09-18 This book explores cryogenic computers to achieve faster operation and lower energy use As computer components become smaller and generate more heat traditional cooling methods struggle to keep up By operating at cryogenic temperatures these limitations can be overcome reducing heat improving performance and opening new possibilities for important applications such as large scale data centers and quantum computers The approaches and physical models discussed in this book are valuable since these concepts offer a practical methodology for increasing computational computing power without being limited by heat and power dissipation The book explores how cryogenic temperatures can supercharge computing Novel methods for designing and optimizing computer systems that operate at extremely low temperatures improve performance reduce power consumption and tackle the fundamental physical limits faced by modern



electronics are introduced in this book From foundational physics based principles and cryogenic equipment to innovative graph theoretic design the book offers a fresh look at the future of high performance energy efficient computing Eine Integrationstechnik auf Waferebene für Millimeterwellenschaltungen unter Verwendung von Techniken aus der Mikromechanik Peter Abele,2007 **Transparent Electronics** Antonio Facchetti,Tobin Marks,2010-03-25 The challenge for producing invisible electronic circuitry and opto electronic devices is that the transistor materials must be transparent to visible light yet have good carrier mobilities This requires a special class of materials having contra indicated properties because from the band structure point of view the combination of transparency and conductivity is contradictory Structured to strike a balance between introductory and advanced topics this monograph juxtaposes fundamental science and technology application issues and essential materials characteristics versus device architecture and practical applications The first section is devoted to fundamental materials compositions and their properties including transparent conducting oxides transparent oxide semiconductors p type wide band gap semiconductors and single wall carbon nanotubes The second section deals with transparent electronic devices including thin film transistors photovoltaic cells integrated electronic circuits displays sensors solar cells and electro optic devices Describing scientific fundamentals and recent breakthroughs such as the first invisible transistor Transparent Electronics From Synthesis to Applications brings together world renowned experts from both academia national laboratories and industry Defect and Fault Tolerance in VLSI Systems Israel Koren,2012-12-06 This book contains an edited selection of papers presented at the International Workshop on Defect and Fault Tolerance in VLSI Systems held October 6 7 1988 in Springfield Massachusetts Our thanks go to all the contributors and especially the members of the program committee for the difficult and time consuming work involved in selecting the papers that were presented in the workshop and reviewing the papers included in this book Thanks are also due to the IEEE Computer Society in particular the Technical Committee on Fault Tolerant Computing and the Technical Committee on VLSI and the University of Massachusetts at Amherst for sponsoring the workshop and to the National Science Foundation for supporting under grant number MIP 8803418 the keynote address and the distribution of this book to all workshop attendees The objective of the workshop was to bring together researchers and practitioners from both industry and academia in the field of defect tolerance and enhancement in VLSI to discuss their mutual interests in defect tolerant architectures and models for integrated circuit defects faults and yield Progress in this area was slowed down by the proprietary nature of yield related data and by the lack of appropriate forums for disseminating such information The goal of this workshop was therefore to provide a forum for a dialogue and exchange of views A follow up workshop in October 1989 with C H Stapper from IBM and V K Jain from the University of South Florida as general co chairmen is being organized

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