



The Physics of Submicron Semiconductor Devices

Edited by
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David K. Ferry and
G. Jacoboni**

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Physics Of Submicron Semiconductor Devices

B. T. Browne, John James Henry Miller



Physics Of Submicron Semiconductor Devices:

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

Physics of Submicron Devices David K. Ferry, Robert O. Grondin, 2012-12-06 The purposes of this book are many First we must point out that it is not a device book as a proper treatment of the range of important devices would require a much larger volume even without treating the important physics for submicron devices Rather the book is written principally to pull together and present in a single place and in a hopefully uniform treatment much of the understanding on relevant physics for submicron devices Indeed the understanding that we are trying to convey through this work has existed in the literature for quite some time but has not been brought to the full attention of those whose business is the making of submicron devices It should be remarked that much of the important physics that is discussed here may not be found readily in devices at the 100 nm level but will be found to be dominant at the 0.1 μm level The range between these two is rapidly being covered as technology moves from the 256K RAM to the 16M RAM chips

The Physics of Submicron Semiconductor Devices Harold L. Grubin, David K. Ferry, C. Jacoboni, 2014-01-15 *Proceedings of the NATO Advanced Study Institute on Physics of Submicron Semiconductor Devices Held in San Miniato, Italy on July 10-23, 1983. The Physics of Submicron Semiconductor Devices. (NATO ASI Series B: Physics, Volume 180).* Harold L. Grubin, David K. Ferry, C. Jacoboni, MODENA UNIV (Italy), 1983 Contents Modelling of Sub Micron Devices Boltzmann Transport Equation Transport

and Material Considerations for Submicron Devices Epitaxial Growth for Sub Micron Structures Insulator Semiconductor Interfaces Theory of the Electronic Structure of Semiconductor Surfaces and Interfaces Deep Levels at Compound Semiconductor Interfaces Ensemble Monte Carlo Techniques Noise and Diffusion in Submicron Structures Superlattices Submicron Lithography Quantum Effects in Device Structures Due to Submicron Confinement in One Dimension Physics of Heterostructures and Heterostructure Devices Correlation Effects in Short Time Nonstationary Transport Device Device Interactions Quantum Transport and the Wigner Function Far Infrared Measurements of Velocity Overshoot and Hot Electron Dynamics in Semiconductor Devices The Influence of Contacts on the Behavior of Near and Sub Micron InP Devices Monte Carlo Simulation of Transport in Submicron Structures Two Dimensional Electron Gas Fet Hot Electron Transfer Amplifiers New Graded Band Gap and Superlattice Structures and Their Applications to Photodetectors Bipolar Transistors and High Speed Devices Metal Semiconductor Interfaces Nonequilibrium Phonons in Semiconductors Power Dissipation of Highly Laser Excited Electron Hole Plasmas and Picosecond Measurements of Device and Circuit Transient Response with Optoelectric Techniques JHD

Physics-based Modeling of Hot-electron Effects in Submicron Semiconductor Devices for CAD Applications Shiuh-Luen Wang,1992 **Frontiers of Computing Systems Research** Stuart K.

Tewksbury,2012-12-06 Computing systems researchers confront two serious problems 1 The increasingly monolithic or pseudo monolithic integration of complex computing functions and systems imposes an environment which integrates advanced principles and techniques from a broad variety of fields Researchers not only must confront the increased complexity of topics in their specialty field but also must develop a deeper general understanding of a broadening number of fields 2 There has been a proliferation of journals books workshops and conferences through which research results are reported Remaining familiar with recent advances in our specific fields is a major challenge Casually browsing through journals and conference proceedings to remain aware of developments in areas outside our specialization has become an even greater challenge Frontiers of Computing Systems Research has been established to address these two issues With the assistance of an advisory board of experts from a wide variety of specialized areas we hope to provide roughly annual volumes of invited chapters on a broad range of topics and designed for an interdisciplinary research audience No single volume can cover all the relevant topics and no single article can convey the full set of directions being pursued within a given topic For this reason a chapter listing technical reports available from universities is also included Often such unpublished reports are designed for a general research audience and provide a good informal look at trends in specialized research topics

Physics of Submicron Devices David K Ferry,Robert O Grondin,1991-11-01 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 **Quantum**

Heterostructures Vladimir Vasil'evich Mitin, Viacheslav Kochelap, Michael A. Stroscio, 1999-07-13 Quantum

Heterostructures provides a detailed description of the key physical and engineering principles of quantum semiconductor heterostructures Blending important concepts from physics materials science and electrical engineering it also explains clearly the behavior and operating features of modern microelectronic and optoelectronic devices The authors begin by outlining the trends that have driven development in this field most importantly the need for high performance devices in computer information and communications technologies They then describe the basics of quantum nanoelectronics including various transport mechanisms In the latter part of the book they cover novel microelectronic devices and optical devices based on quantum heterostructures The book contains many homework problems and is suitable as a textbook for undergraduate and graduate courses in electrical engineering physics or materials science It will also be of great interest to those involved in research or development in microelectronic or optoelectronic devices Physics and Numerical Modeling of Carrier Transport in Submicron Semiconductor Devices Robert Kimbal Cook, 1981 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

Compound Semiconductor Electronics, The Age Of Maturity T W Crowe, Tor A Fjeldly, Steve Long, Michael S Shur, R J Trew, 1996-11-26 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

Numerical Analysis of Semiconductor Devices and Integrated Circuits B. T. Browne, John James Henry Miller, 1981

Fundamentals Of Semiconductor Physics And Devices Rolf Enderlein, 1997-02-27 This book is an introduction to the principles of semiconductor physics linking its scientific aspects with practical applications It is addressed to both readers who wish to learn semiconductor physics and those seeking to understand semiconductor devices It is particularly well suited

for those who want to do both. Intended as a teaching vehicle, the book is written in an expository manner aimed at conveying a deep and coherent understanding of the field. It provides clear and complete derivations of the basic concepts of modern semiconductor physics. The mathematical arguments and physical interpretations are well balanced; they are presented in a measure designed to ensure the integrity of the delivery of the subject matter in a fully comprehensible form. Experimental procedures and measured data are included as well. The reader is generally not expected to have background in quantum mechanics and solid state physics beyond the most elementary level. Nonetheless, the presentation of this book is planned to bring the student to the point of research design capability as a scientist or engineer. Moreover, it is sufficiently well endowed with detailed knowledge of the field, including recent developments bearing on submicron semiconductor structures, that the book also constitutes a valuable reference resource.

In Chapter 1, basic features of the atomic structures, chemical nature, and the macroscopic properties of semiconductors are discussed. The band structure of ideal semiconductor crystals is treated in Chapter 2, together with the underlying one-electron picture and other fundamental concepts. Chapter 2 also provides the requisite background of the tight-binding method and the $k \cdot p$ method, which are later used extensively. The electron states of shallow and deep centers, clean semiconductor surfaces, quantum wells, and superlattices, as well as the effects of external electric and magnetic fields, are treated in Chapter 3. The one- or multi-band effective mass theory is used wherever this method is applicable. A summary of group theory for application in semiconductor physics is given in an Appendix. Chapter 4 deals with the statistical distribution of charge carriers over the band and localized states in thermodynamic equilibrium. Non-equilibrium processes in semiconductors are treated in Chapter 5. The physics of semiconductor junctions, pn hetero metal, and insulator is developed in Chapter 6 under conditions of thermodynamic equilibrium and in Chapter 7 under non-equilibrium conditions. On this basis, the most important electronic and optoelectronic semiconductor devices are treated among them: uni- and bi-polar transistors, photodetectors, solar cells, and injection lasers. A summary of group theory for applications in semiconductors is given in an Appendix.

Spin Electronics David D. Awschalom, Robert A. Buhrman, James M. Daughton, Stephan von Molnár, Michael L. Roukes, 2013-06-29. The history of scientific research and technological development is replete with examples of breakthroughs that have advanced the frontiers of knowledge, but seldom does it record events that constitute paradigm shifts in broad areas of intellectual pursuit. One notable exception, however, is that of spin electronics, also called spintronics, magnetoelectronics, or magnetronics, wherein information is carried by electron spin in addition to or in place of electron charge. It is now well established in scientific and engineering communities that Moore's Law, having been an excellent predictor of integrated circuit density and computer performance since the 1970s, now faces great challenges as the scale of electronic devices has been reduced to the level where quantum effects become significant factors in device operation. Electron spin is one such effect that offers the opportunity to continue the gains predicted by Moore's Law by taking advantage of the confluence of magnetics and semiconductor electronics in the newly emerging

discipline of spin electronics From a fundamental viewpoint spin polarization transport in a material occurs when there is an imbalance of spin populations at the Fermi energy In ferromagnetic metals this imbalance results from a shift in the energy states available to spin up and spin down electrons In practical applications a ferromagnetic metal may be used as a source of spin polarized electrons to be injected into a semiconductor a superconductor or a normal metal or to tunnel through an insulating barrier

New Technical Books New York Public Library,1989 The Physics of Submicron Lithography Kamil A. Valiev,2012-09-27 This book is devoted to the physics of electron beam ion beam optical and x ray lithography The need for this book results from the following considerations The astonishing achievements in microelectronics are in large part connected with successfully applying the relatively new technology of processing changing the properties of a material into a device whose component dimensions are submicron called photolithography In this method the device is imaged as a pattern on a metal film that has been deposited onto a transparent substrate and by means of a broad stream of light is transferred to a semiconductor wafer within which the physical structure of the devices and the integrated circuit connections are formed layer by layer The smallest dimensions of the device components are limited by the diffraction of the light when the pattern is transferred and are approximately the same as the wavelength of the light Photolithography by light having a wavelength of $\lambda = 0.4 \mu\text{m}$ has made it possible to serially produce integrated circuits having devices whose minimal size is $2.3 \mu\text{m}$ in the 4 pattern and having 10¹⁰ transistors per circuit [Russian],1989 [Russian] [Russian] [Russian] (Japan),1972 Directory of Published Proceedings,1999

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