

Elementary Semiconductor Physics

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Elementary treatise on physics, experimental and applied, tr. and ed. by E. Atkinson
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Elementary Treatise on Physics Experimental and Applied for the Use of Colleges and Schools
Elementary solid state physics : principles and applications
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International Journal of Electrical Engineering Education
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this book by two leading experts on integrated circuit design adopts an untraditional approach to introducing semiconductor devices to beginners the authors use circuit theory to provide a digestible explanation of energy band theory and understanding of energy band diagrams after briefly summarizing the basics of semiconductors the authors describe semiconductor devices from a circuit theoretic point of view making the book especially suitable for circuit design students and engineers further to the emphasis on the circuit perspective the book then uses circuit theory to introduce readers to the famously indigestible energy bands of crystalline solids additionally the book explains how to read physics from energy band diagrams of semiconductor devices in great detail the key to appreciating the real power of energy band diagrams is shown to lie in the understanding of the concept of the quasi fermi levels introduced in 1949 by william shockley but remaining elusive to date and therefore often omitted from energy band diagrams to rectify this some of the energy band diagrams presented in this book complete with quasi fermi levels were drawn using a device simulator a k a technology computer aided design tcad offering quantitative information about device physics the book could therefore also serve as a hands on course text in tcad drawn band diagram reading because no prior exposure to quantum mechanics is required and the book does not attempt to teach it this book is ideal for students in various disciplines who may or may not be specializing in semiconductor devices the numerous practical examples of reading tcad based energy band diagrams are also invaluable to practicing semiconductor device engineers

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 modern theoretical techniques for the analysis of electron transport 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 specific area it intends to introduce the reader to the fascinating field of electron dynamics in semiconductors a field that through its applications to electronics greatly contributed to the transformation of all our lives in the second half of the twentieth century and continues to provide surprises and new challenges the field 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 five 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 possible 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 systems 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

we have reached the double conclusion that invention is choice that this choice is imperatively governed by the sense of scientific beauty hadamard 1945 princeton university press by permission the great majority of all sources and amplifiers of microwave energy and all devices for receiving or detecting microwaves use a semiconductor active element the development of microwave semiconductor devices described in this book has proceeded from the simpler two terminal devices such as gunn or impatt devices which originated in the 1960s to the sophisticated monolithic circuit mesfet three terminal active elements of the 1980s and 1990s the microwave field has experienced a renaissance in electrical engineering departments in the last few years and much of this growth has been associated with microwave semiconductor devices the university of massachusetts has recently developed a well recognized program in microwave engineering much of the momentum for this program has been provided by interaction with industrial companies and the influx of a large number of industry supported students this program had a need for a course in microwave semiconductor devices which covered the physical aspects as well as the aspects of interest to the engineer who incorporates such devices in his designs it was also felt that it would be important to introduce the most recently developed devices hfets hbt's and other advanced devices as early as possible

development of the thermionic valve historical survey of early research in semiconductors development of the transistor major technical processes used in semiconductor device fabrication review of major factors affecting the growth of the united states semiconductor industry review of the factors affecting the growth of the japanese and south korean semiconductor industries review of the european semiconductor industry

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

this volume contains the notes of lectures given at the school on nonlinear dynamics in solids held at the physikzentrum bad bonn 26 october 1989 under the patronage of the deutsche physikalische gesellschaft nonlinear dynamics has become a highly active

research area owing to many interesting developments during the last three decades in the theoretical analysis of dynamical processes in both hamiltonian and dissipative systems research has been focused on a variety of problems such as the characteristics of regular and chaotic motion in hamiltonian dynamics the problem of quantum chaos the formation and properties of solitary spatio-temporal structures the occurrence of strange attractors in dissipative systems and the bifurcation scenarios leading to complex time behaviour until recently predictions of the theory have been tested predominantly on instabilities in hydrodynamic systems where many interesting experiments have provided valuable input and have led to a fruitful interaction between experiment and theory fluid systems are certainly good candidates for performing clean experiments free from disturbing influences with fluids compared to solids it is simpler to prepare good samples the relevant length and time scales are in easily accessible ranges and it is possible to do measurements inside the fluid because it can be filled in after the construction of the apparatus further the theory describing the macroscopic dynamics of fluids is well established and contains only very few parameters all of which have well known values

this book provides a rather comprehensive presentation of the physics and modeling of high frequency bipolar transistors with particular emphasis given to silicon based devices i hope it will be found useful by those who do as well as by those who intend to work in the field as it compiles and extends material presented in numerous publications in a coherent fashion i've worked on this project for years and did my best to avoid errors despite all efforts it is possible that something has been overlooked during copy editing and proof reading if you find a mistake please let me know michael reisch kempten december 2002 notation it is intended here to use the most widely employed notation in cases where the standard textbook notation is different from the spice notation the latter is used in order to make formulas more readable model parameters represented in spice by a series of capital letters are written here as one capital letter with the rest in the form of a subscript e.g. x_{cjc} is used here instead of the $xcjc$ used in the spice input concerning the use of lower case and capital letters the following rules are applied time dependent large signal quantities are represented by lower case letters the variables t , v and p therefore denote time dependent current voltage and power values

this is perhaps the most comprehensive undergraduate textbook on the fundamental aspects of solid state electronics it presents basic and state of the art topics on materials physics device physics and basic circuit building blocks not covered by existing textbooks on the subject each topic is introduced with a historical background and motivations of device invention and circuit evolution fundamental physics is rigorously discussed with minimum need of tedious algebra and advanced mathematics another special feature is a systematic classification of fundamental mechanisms not found even in advanced texts it bridges the gap between solid state device physics covered here with what students have learnt in their first two years of study used very successfully in a one semester introductory core course for electrical and other engineering materials science and physics junior students the second part of each chapter is also used in an advanced undergraduate course on solid state devices the inclusion of previously unavailable analyses of the basic transistor digital circuit building blocks and cells makes this an excellent reference for engineers to look up fundamental concepts and data design formulae and latest devices such as the *ger* heterostructure bipolar transistors

harrison has provided a new text on the electronic structure and properties of solids it is similar in spirit to his well known 1980 text electronic structure and the properties of solids on the same subject but is otherwise entirely new it covers covalent semiconductors ionic insulators simple metals and transition metal and *f* shell metal systems it focuses on the most important aspects of each system making what approximations are necessary in order to proceed analytically and obtain formulae for the properties the book is written as a text with problems at the end of each chapter other problems can readily be generated by asking for estimates of different properties or different materials from those treated in the text in fact the ease of generating interesting problems reflects on the extraordinary utility and simplicity of the methods introduced developments since the 1980 publication have made the theory simpler than before much more accurate and allowed much wider application

this book provides a comprehensive presentation of the most advanced research results and technological developments enabling understanding qualifying and mitigating the soft errors effect in advanced electronics including the fundamental physical mechanisms of radiation induced soft errors the various steps that lead to a system failure the modelling and simulation of soft error at various levels including physical electrical netlist event driven rtl and system level modelling and simulation hardware fault injection accelerated radiation testing and natural environment testing soft error oriented test structures process level device level cell level circuit level architectural level software level and system level soft error mitigation techniques the book contains a comprehensive presentation of most recent advances on understanding qualifying and mitigating the soft error effect in advanced electronic systems presented by academia and industry experts in reliability fault tolerance eda processor soc and system design and in particular experts from industries that have faced the soft error impact in terms of product reliability and related business issues

and were in the forefront of the countermeasures taken by these companies at multiple levels in order to mitigate the soft error effects at a cost acceptable for commercial products in a fast moving field where the impact on ground level electronics is very recent and its severity is steadily increasing at each new process node impacting one after another various industry sectors as an example the automotive electronics council comes to publish qualification requirements on soft errors research and technology developments and industrial practices have evolve very fast outdated the most recent books edited at 2004

since the beginning of semiconductor era in microelectronics the methodology of reliability assessment became a well established area in most cases the reliability assessment involves statistical methods for safe operating area and long term re ability parameters at the development of semiconductor processes components and systems at the same time in case of catastrophic failures at any development phase the major practical method is failure analysis fa however fa is mainly dealing with detection of consequences of some irreversible event that already happened this book is focused on the most important and the less summarized reliability aspects among them catastrophic failures impact of local structural inhomogeneities major principles of physical limitation of safe operating area soa physical mechanisms of the current instability filamentation and conductivity modulation in particular device types and architectures specifically the similar principles and regularities are discussed for elect static discharge esd protection devices treating them as a particular case of pulsed power devices thus both the most intriguing applications and reliability problems in case of the discrete and the integrated components are covered in this book

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