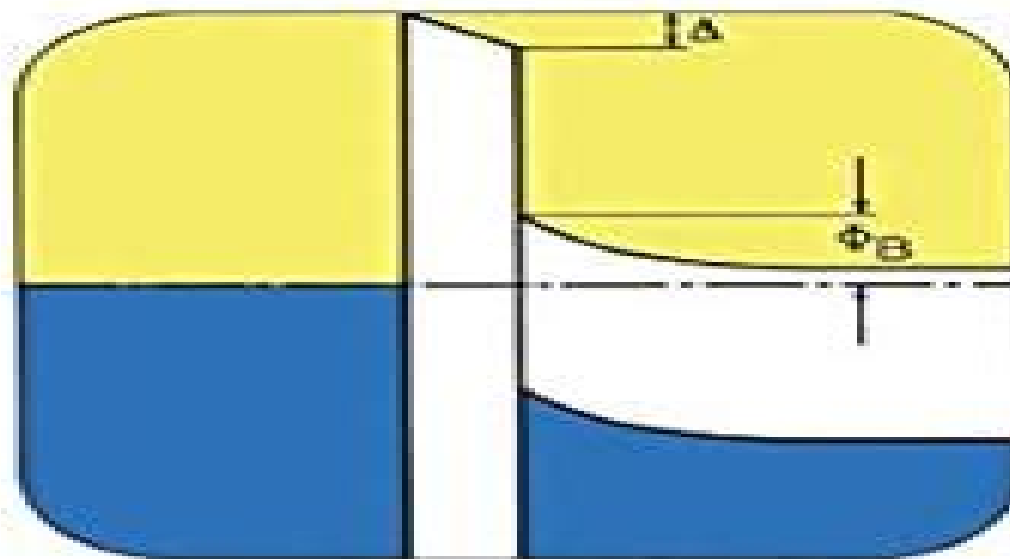


ELECTRONIC STRUCTURE OF METAL-SEMICONDUCTOR CONTACTS

edited by
WINFRIED MONCH



PERSPECTIVES IN CONDENSED MATTER PHYSICS



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Electronic Structure of Metal-Semiconductor Contacts Winfried Mönch, 2012-12-06 Interface and surface science have been important in the development of semiconductor physics right from the beginning on. Modern device concepts are not only based on p-n junctions which are interfaces between regions containing different types of dopants but take advantage of the electronic properties of semiconductor-insulator interfaces, heterojunctions between distinct semiconductors and metal-semiconductor contacts. The latter ones stood almost at the very beginning of semiconductor physics at the end of the last century. The rectifying properties of metal-semiconductor contacts were first described by Braun in 1874. A physically correct explanation of unilateral conduction as this deviation from Ohm's law was called could not be given at that time. A prerequisite was Wilson's quantum theory of electronic semiconductors which he published in 1931. A few years later in 1938 Schottky finally explained the rectification at metal-semiconductor contacts by a space Electronic Structure of Metal-Semiconductor Contacts Winfried Monch, 1990-11-30 **The electronic structure of metal**

semiconductor contacts Regina Mach, 1979 **Electronic Structure of Semiconductor Interfaces** Winfried Mönch, 2024-06-14 This concise volume examines the characteristic electronic parameters of semiconductor interfaces, namely the barrier heights of metal-semiconductor or Schottky contacts and the valence band discontinuities of semiconductor-semiconductor interfaces or heterostructures. Both are determined by the same concept, namely the wave function tails of electron states overlapping a semiconductor band gap directly at the interface. These interface-induced gap states (IFGS) result from the complex band structure of the corresponding semiconductor. The IFGS are characterized by two parameters, namely by their branch point at which their charge character changes from predominantly valence band to conduction band-like and secondly by the proportionality factor or slope parameter of the corresponding electric dipole term which varies in proportion to the difference in the electronegativities of the two solids forming the interface. This IFGS and electronegativity concept consistently and quantitatively explains the experimentally observed barrier heights of Schottky contacts as well as the valence band offsets of heterostructures. Insulators are treated as wide band gap semiconductors.

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clear these interfaces could become the building blocks of many novel solid state devices Other interfaces involving semiconductors are already widely used in technology These are for example metal semiconductor and insulator semiconductor junctions and heterojunctions In comparison the present applications of heterojunction interfaces are limited but they could potentially become much more extensive in the near future The path towards the widespread use of heterojunctions is obstructed by several obstacles

Metal - Semiconductor Contacts and Devices Simon S. Cohen, Gennady Sh. Gildenblat, 2014-12-01 VLSI Electronics Microstructure Science Volume 13 Metal Semiconductor Contacts and Devices presents the physics technology and applications of metal semiconductor barriers in digital integrated circuits The emphasis is placed on the interplay among the theory processing and characterization techniques in the development of practical metal semiconductor contacts and devices This volume contains chapters that are devoted to the discussion of the physics of metal semiconductor interfaces and its basic phenomena fabrication procedures and interface characterization techniques particularly ohmic contacts Contacts that involve polycrystalline silicon applications of the metal semiconductor barriers in MOS bipolar and MESFET digital integrated circuits and methods for measuring the barrier height are covered as well Process engineers device physicists circuit designers and students of this discipline will find the book very useful

Metal-semiconductor Interfaces Akio Hiraki, 1995 **Semiconductor Surfaces and Interfaces** Winfried Mönch, 2013-04-17 Semiconductor Surfaces and Interfaces deals with structural and electronic properties of semiconductor surfaces and interfaces The first part introduces the general aspects of space charge layers of clean surface and adsorbed surfaces states and of interface states It is followed by a presentation of experimental results on clean and adsorbed surfaces which are explained in terms of simple physical and chemical concepts and models Where available results of more refined calculations are considered A final chapter is devoted to the band lineup at semiconductor interfaces

Introduction to Semiconductor Lasers for Optical Communications David J. Klotzkin, 2020-01-07 This updated second edition textbook provides a thorough and accessible treatment of semiconductor lasers from a design and engineering perspective It includes both the physics of devices as well as the engineering designing and testing of practical lasers The material is presented clearly with many examples provided Readers of the book will come to understand the finer aspects of the theory design fabrication and test of these devices and have an excellent background for further study of optoelectronics

Physics Briefs, 1992 **Quantum Theory of Materials** Efthimios Kaxiras, John D. Joannopoulos, 2019-06-06 An accessible overview of the concepts and tools essential to the physics of materials with applications exercises and color figures

The Molecule-Metal Interface Norbert Koch, Nobuo Ueno, Andrew T. S. Wee, 2013-02-08 Reviewing recent progress in the fundamental understanding of the molecule metal interface this useful addition to the literature focuses on experimental studies and introduces the latest analytical techniques as applied to this interface The first part covers basic theory and initial principle studies while the second part introduces readers to photoemission STM and synchrotron

techniques to examine the atomic structure of the interfaces The third part presents photoelectron spectroscopy high resolution UV photoelectron spectroscopy and electron spin resonance to study the electronic structure of the molecule metal interface In the closing chapter the editors discuss future perspectives Written as a senior graduate or senior undergraduate textbook for students in physics chemistry materials science or engineering the book s interdisciplinary approach makes it equally relevant for researchers working in the field of organic and molecular electronics

Modelling of Interface Carrier Transport for Device Simulation Dietmar Schroeder, 2013-03-09 This book represents a comprehensive text devoted to charge transport at semiconductor interfaces and its consideration in device simulation by interface and boundary conditions It contains a broad review of the physics modelling and simulation of electron transport at interfaces in semiconductor devices Particular emphasis is put on the consistent derivation of interface or boundary conditions for semiconductor device simulation The book is of interest with respect to a wide range of electronic engineering activities as process design device design process characterization research in microelectronics or device simulator development It is also useful for students and lecturers in courses of electronic engineering and it supplements the library of technically oriented solid state physicists The deepest roots of this book date back to the mid seventies Being a student of electrical engineering who was exposed for the first time to the material of semiconductor device electronics I was puzzled by noticing that much emphasis was put on a thorough introduction and understanding of the basic semiconductor equations while the boundary conditions for these equations received very much less attention Until today on many occasions one could get the impression that boundary conditions are unimportant accessories they do not stand on their own besides the bulk transport equations although it is clear that they are of course a necessary complement of these

Wide-Gap Chalcopyrites Susanne Siebentritt, Uwe Rau, 2006-02-25 Chalcopyrites in particular those with a wide band gap are fascinating materials in terms of their technological potential in the next generation of thin film solar cells and in terms of their basic material properties They exhibit uniquely low defect formation energies leading to unusual doping and phase behavior and to extremely benign grain boundaries This book collects articles on a number of those basic material properties of wide gap chalcopyrites comparing them to their low gap cousins They explore the doping of the materials the electronic structure and the transport through interfaces and grain boundaries the formation of the electric field in a solar cell the mechanisms and suppression of recombination the role of inhomogeneities and the technological role of wide gap chalcopyrites

[Electronic Properties of Semiconductor Interfaces](#) Winfried Mönch, 2013-04-17 Almost all semiconductor devices contain metal semiconductor insulator semiconductor insulator metal and or semiconductor semiconductor interfaces and their electronic properties determine the device characteristics This is the first monograph that treats the electronic properties of all different types of semiconductor interfaces Using the continuum of interface induced gap states IFIGS as a unifying theme Mönch explains the band structure lineup at all types of semiconductor interfaces These intrinsic IFIGS are the wave function tails of electron

states which overlap a semiconductor band gap exactly at the interface so they originate from the quantum mechanical tunnel effect He shows that a more chemical view relates the IFIGS to the partial ionic character of the covalent interface bonds and that the charge transfer across the interface may be modeled by generalizing Pauling's electronegativity concept The IFIGS and electronegativity theory is used to quantitatively explain the barrier heights and band offsets of well characterized Schottky contacts and semiconductor heterostructures respectively

Physics and Technology of Amorphous-Crystalline Heterostructure Silicon Solar Cells Wilfried G. J. H. M. van Sark, Lars Korte, Francesco Roca, 2011-11-16 Today's solar cell multi GW market is dominated by crystalline silicon c Si wafer technology however new cell concepts are entering the market One very promising solar cell design to answer these needs is the silicon heterojunction solar cell of which the emitter and back surface field are basically produced by a low temperature growth of ultra thin layers of amorphous silicon In this design amorphous silicon a Si H constitutes both emitter and base contact back surface field on both sides of a thin crystalline silicon wafer base c Si where the electrons and holes are photogenerated at the same time a Si H passivates the c Si surface Recently cell efficiencies above 23% have been demonstrated for such solar cells In this book the editors present an overview of the state of the art in physics and technology of amorphous crystalline heterostructure silicon solar cells The heterojunction concept is introduced processes and resulting properties of the materials used in the cell and their heterointerfaces are discussed and characterization techniques and simulation tools are presented

Electric and Electronic Applications of Metal Oxides Srikanta Moharana, Bibhuti Bhusan Sahu, Santosh Kumar Satpathy, Tuan Anh Nguyen, 2025-05-23 Electric and Electronic Applications of Metal Oxides provides a comprehensive guide to the use of metal oxides in a variety of electronic and electric applications The book delivers a thorough understanding of the fundamental properties of metal oxides and their use across a wide range of electronic devices including Schottky diodes p n diodes thin film transistors field effect transistors Mott transition field effect transistors varistors high K dielectric capacitors devices with electron emission cold cathodes microelectronic technology high power and high temperature electronics transparent and flexible electronics resistive switching memory spintronics magnetic memory and piezoelectric devices In addition the book covers the latest advances and offers a glimpse of future prospects and challenges in the field The book is a valuable resource for researchers graduate students and professionals working in the field of materials science chemistry physics and engineering Provides a comprehensive overview of metal oxide fundamental properties related to electric and electronic applications Includes prospective challenges offering insights into future applications of metal oxides in electric and electronics Presents an outstanding reference for researchers material scientists engineers and students working in the fields of materials science chemistry physics and other related disciplines

Electronic Structure, 2000-07-19 This book is the second volume in the Handbook of Surface Science series and deals with aspects of the electronic structure of surfaces as investigated by means of the experimental and theoretical methods of

physics The importance of understanding surface phenomena stems from the fact that for many physical and chemical phenomena the surface plays a key role in electronic magnetic and optical devices in heterogenous catalysis in epitaxial growth and the application of protective coatings for example Therefore a better understanding and ultimately a predictive description of surface and interface properties is vital for the progress of modern technology An investigation of surface electronic structure is also central to our understanding of all aspects of surfaces from a fundamental point of view The chapters presented here review the goals achieved in the field and map out the challenges ahead both in experiment and theory

Solid State Physics, 2000-10-18 Solid State Physics **Power Semiconductors** M. Kubat, 2013-04-17 The book contains a summary of our knowledge of power semiconductor structures It presents first a short historic introduction Chap I as well as a brief selection of facts from solid state physics in particular those related to power semiconductors Chap 2 The book deals with diode structures in Chap 3 In addition to fundamental facts in pn junction theory the book covers mainly the important processes of power structures It describes the emitter efficiency and function of microleaks shunts the p p and n n junctions and in particular the recent theory of the pin pvn and p1tn junctions whose role appears to be decisive for the forward mode not only of diode structures but also of more complex ones For power diode structures the reverse mode is the decisive factor in pn junction breakdown theory The presentation given here uses engineering features the multiplication factor M and the experimentally detected laws for the volume and surface of crystals which condenses the presentation and makes the mathematical apparatus simpler The discussion of diode structures is complemented by data on the tunnel phenomenon as well as on the properties of the semiconductor metal contact which forms the outer layers of the diode or more complex structure A separate chapter Chap 4 is devoted to the two transistor equivalent of the four layer structure and the solution of the four layer structure in various modes This presentation is also directed mainly towards the power aspect and the new components

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