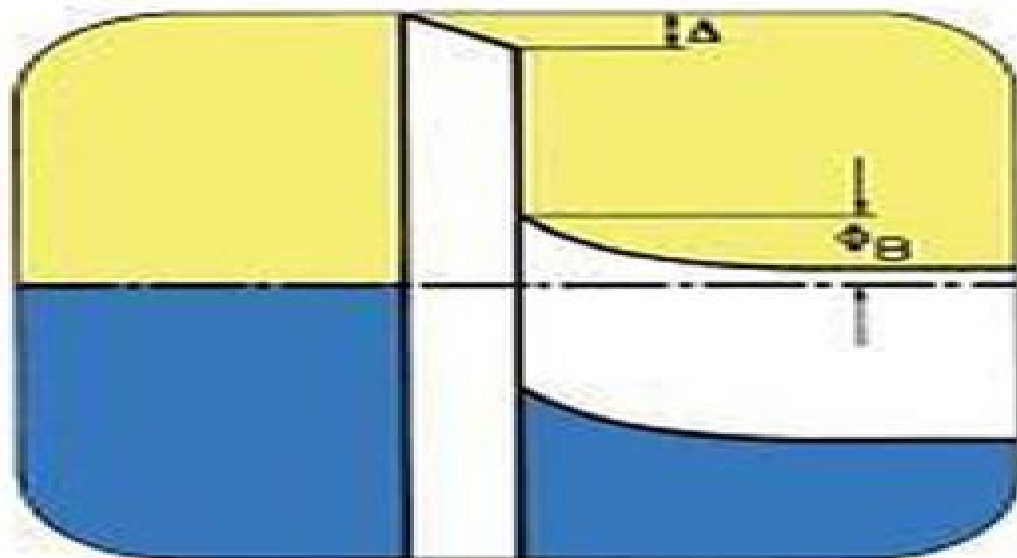


# ELECTRONIC STRUCTURE OF METAL-SEMICONDUCTOR CONTACTS

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WINFRIED MÖNCH



PERSPECTIVES IN CONDENSED MATTER PHYSICS



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# Electronic Structure Of Metal Semiconductor Contacts

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## **Electronic Structure Of Metal Semiconductor Contacts:**

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 charge layer. *Electronic Structure of Metal-Semiconductor Contacts* Winfried Mönch, 1990-11-30 The electronic structure of metal semiconductor contacts

Regina Mach, 1979 **Electronic Structure of Semiconductor Heterojunctions** Giorgio Margaritondo, 2012-12-06 E se non che di cid son vere prove. And were it not for the true evidence. Per piti e piti autori che sa ranno. Of many authors who will be. Per i miei versi nominati altrove. Mentioned elsewhere in my rhyme. Non presterei alla penna 10 mana. I would not lend my hand to the pen. Per nota 1 cid ch io vidi can temenza. And describe my observations for fear ehe non fosse do altri casso e van 0. That they would be rejected and in vane. Mala lor chiara e vera esperienza. But these authors clear and true experience. Mi assicura nel dir come persone. Encourages me to report since they. Degne di fede ad ogni gra n sentenza. Should always be trusted for their word. From Dittamondo by Fazio degli Uberti. Heterojunction interfaces: the interfaces between different semiconducting materials have been extensively explored for over a quarter of a century. The justification for this effort is 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.

**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 IFIGS 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

**Contact-Electrification of Matter** Zhong Lin Wang, 2025-05-20 This book provides a comprehensive exploration of contact electrification across solid solid solid liquid and gas solid interfaces It looks into the underlying physics mechanisms offering theoretical models and experimental methods to quantify and understand this ubiquitous yet complex phenomenon Covering fundamental concepts such as triboelectricity energy band models and tribovoltaic effects the book discusses the interactions and charge transfer processes that occur at various interfaces Special attention is given to the role of material properties electron transfer dynamics and external factors such as surface roughness and environmental conditions Each chapter builds upon foundational principles to provide a cohesive framework for understanding both the beneficial applications and potential drawbacks of contact electrification In addition to theoretical insights this book highlights cutting edge technological applications related to contact electrification including triboelectric nanogenerators TENGs self powered sensors and contact electro catalysis Practical implementations span fields such as sustainable energy harvesting biomedical applications environmental sensing and advanced materials design Written and edited by experts in the field this book serves as an essential resource for researchers engineers and advanced students in materials science physics chemistry and electrical engineering With its rigorous treatment of the subject and focus on both foundational science and applied technologies this book is poised to set the standard for research in contact electrification for years to come

*Semiconductor Microchips and Fabrication* Yaguang Lian, 2022-10-18 Semiconductor Microchips and Fabrication Advanced and highly illustrated guide to semiconductor manufacturing from an experienced industry insider Semiconductor Microchips and Fabrication is a practical yet advanced book on the theory design and manufacturing of semiconductor microchips that describes the process using the principles of physics and chemistry fills in the knowledge gaps for professionals and students who need to know how manufacturing equipment works and provides valuable suggestions and solutions to many problems that students or engineers often encounter in semiconductor processing including useful experiment results to help in process work The explanation of the semiconductor manufacturing process and the equipment needed is carried out based on the machines that are used in clean rooms over the world so readers understand how they can use the equipment to achieve their design and manufacturing ambitions Combining theory with practice all descriptions are carried out around the actual equipment and processes by way of a highly visual text with illustrations including equipment pictures manufacturing process schematics and structures of semiconductor microchips Sample topics covered in Semiconductor Microchips and Fabrication include An introduction to basic concepts such as impedance mismatch from

plasma machines and theories such as energy bands and Clausius Clapeyron equation Basic knowledge used in semiconductor devices and manufacturing machines including DC and AC circuits electric fields magnetic fields resonant cavity and the components used in the devices and machines Transistor and integrated circuits including bipolar transistors junction field effect transistors and metal semiconductor field effect transistors The main processes used in the manufacturing of microchips including lithography metallization reactive ion etching RIE plasma enhanced chemical vapor deposition PECVD thermal oxidation and implantation and more The skills in the design and problem solving of processes such as how to design a dry etching recipe and how to solve the micro grass problems in Bosch process Through Semiconductor Microchips and Fabrication readers can obtain the fundamental knowledge and skills of semiconductor manufacturing which will help them better understand and use semiconductor technology to improve their product quality or project research Before approaching this text readers should have basic knowledge of physics chemistry and circuitry

Handbook of Conducting Polymers, 2 Volume Set Terje A. Skotheim, John Reynolds, 2007-01-16 Learn how recent advances are fueling new possibilities in textiles optics electronics and biomedicine As the field of conjugated electrically conducting and electroactive polymers has grown the Handbook of Conducting Polymers has been there to document and celebrate these changes along the way Now split into two vo 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 adatom included surfaces states and of interface states It is followed by a presentation of experimental results on clean and adatom covered 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 *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 *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

**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 **Solid State Physics**

,2000-10-18 Solid State Physics



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