

Conduction band (CB)

(a)

Valence band (VB)

Type I

(Straddling gap)

Type II

(Staggered gap)

Type III

(Broken gap)

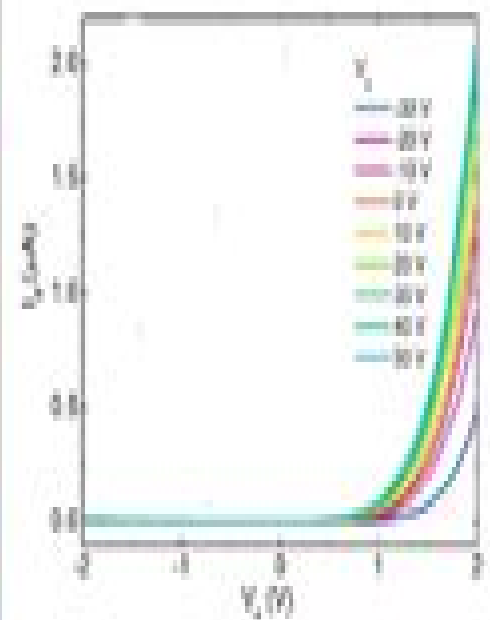
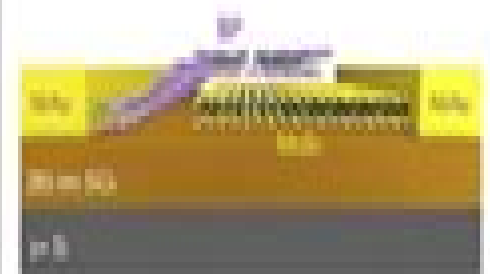
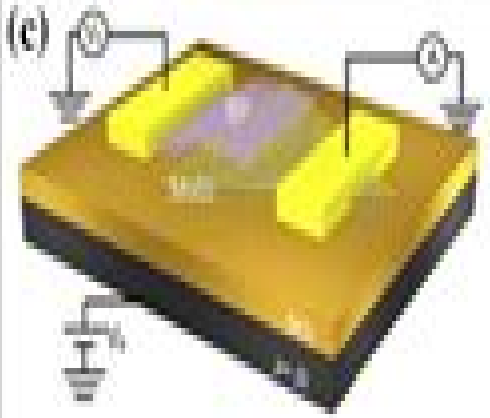
(b)

Equilibrium

Forward

Reverse

(c)



# Semiconductor Heterojunctions

**Xiaohua Yu**



## **Semiconductor Heterojunctions:**

*Semiconductor Heterojunctions* B. L. Sharma, R. K. Purohit, 2015-12-04 *Semiconductor Heterojunctions* investigates various aspects of semiconductor heterojunctions. Topics covered include the theory of heterojunctions and their energy band profiles, electrical and optoelectronic properties and methods of preparation. A number of heterojunction devices are also considered, from photovoltaic converters to photodiodes, transistors and injection lasers. Comprised of eight chapters, this volume begins with an overview of the theory of heterojunctions and a discussion on abrupt isotype and anisotype heterojunctions along with graded heterojunctions. The reader is then introduced to the energy band profiles of isotype and anisotype heterojunctions, the practical aspects of their fabrication and characterization and their electronic and optoelectronic properties. Some methods used in the preparation of heterojunctions are also described, including the chemical method, solution growth method, alloying method and sputtering method. The remaining chapters focus on the characterization of the grown layers, examples of heterojunction devices and experimental work on heterojunctions. This monograph is intended for research workers and graduate students.

### **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 ra nno 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 nota1 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.

**Introduction to Organic Semiconductor Heterojunctions** Donghang Yan, Haibo Wang, Baoxun Du, 2010-09-16 It is well known that most important electronic devices use Schottky junctions and heterojunctions. Unfortunately, there is not an advanced book introducing heterojunctions systematically. *Introduction to Organic Semiconductor Heterojunctions* fills the gap. In this book, the authors provide a comprehensive discussion and systematic introduction on the state of the art technologies as well as application of organic semiconductor heterojunctions. First book to systematically introduce organic heterojunctions. Arms readers with theoretical, experimental and applied aspects of organic heterojunctions. The Chinese edition of the book is part

of the Chinese Academy of Sciences Distinguished Young Scholar Scientific Book Series Introduction to Organic Semiconductor Heterojunctions is an ideal and valued reference for researchers and graduate students focusing on organic thin film devices like organic light emitting diodes OLEDs organic photovoltaic OPV cells and organic field effect transistors OFETs Instructors can use the book as a supplementary text for a semiconductor physics or organic electronics course giving students a better feel for the application of organic thin film devices

**Heterojunctions and Metal Semiconductor Junctions** A.G. Milnes, 2012-12-02 Heterojunctions and Metal Semiconductor Junctions discusses semiconductor semiconductor heterojunctions and metal semiconductor heterojunctions which are of significant practical importance today and also of considerable scientific interest with worthwhile problems still to be explored and understood Many classes of heterojunctions are believed to have new and valuable applications Although some aspects of heterojunction behavior remain areas for continued scientific and technological study the main outlines of the subject are clear This book comprises nine chapters and begins with an introduction to semiconductor heterojunctions Succeeding chapters then discuss semiconductor p n heterojunction models and diode behavior heterojunction transistors isotype n n p p heterojunctions optical properties of heterojunctions and heterojunction lasers metal semiconductor barriers metal semiconductor junction behavior high yield photoemissive cathodes and fabrication of heterojunctions This book will be of interest to practitioners in the fields of applied physics

*Optoelectronic Organic-Inorganic Semiconductor Heterojunctions* Ye Zhou, 2021-01-19 Optoelectronic Organic Inorganic Semiconductor Heterojunctions summarizes advances in the development of organic inorganic semiconductor heterojunctions points out challenges and possible solutions for material device design and evaluates prospects for commercial applications Introduces the concept and basic mechanism of semiconductor heterojunctions Describes a series of organic inorganic semiconductor heterojunctions with desirable electrical and optical properties for optoelectronic devices Discusses typical devices such as solar cells photo detectors and optoelectronic memories Outlines the materials and device challenges as well as possible strategies to promote the commercial translation of semiconductor heterojunctions based optoelectronic devices Aimed at graduate students and researchers working in solid state materials and electronics this book offers a comprehensive yet accessible view of the state of the art and future directions

**Organic Semiconductor Heterojunctions and Its Application in Organic Light-Emitting Diodes** Dongge Ma, Yonghua Chen, 2017-09-21 This book systematically introduces the most important aspects of organic semiconductor heterojunctions including the basic concepts and electrical properties It comprehensively discusses the application of organic semiconductor heterojunctions as charge injectors and charge generation layers in organic light emitting diodes OLEDs Semiconductor heterojunctions are the basis for constructing high performance optoelectronic devices In recent decades organic semiconductors have been increasingly used to fabricate heterojunction devices especially in OLEDs and the subject has attracted a great deal of attention and evoked many new phenomena and interpretations in the field This important application is based on the low

dielectric constant of organic semiconductors and the weak non covalent electronic interactions between them which means that they easily form accumulation heterojunctions. As we know the accumulation type space charge region is highly conductive which is an important property for highly efficient charge generation in their application as charge injector and charge generation layer in OLEDs. This book serves as a valuable reference for researchers and as a textbook for graduate students focusing on the study and development of OLED for display and lighting.

**Survey of Semiconductor Physics** Karl Wolfgang Böer, 1990 Taking up where the first volume left off this work provides coverage of the inhomogeneous semiconductor. It deals mainly with Si and GaAs but also investigates other materials of theoretical and practical interest such as Ge, other III-V and II-VI compounds and amorphous SiH. Equipped with this source, physicists, semiconductor engineers, device engineers and fabrication engineers will have access to a vast reservoir of practical information on the design, production and operations of semiconductor devices.

*Optical Semiconductor Devices* Mitsuo Fukuda, 1998-12-24 This book is devoted to optical semiconductor devices and their numerous applications in telecommunications, optoelectronics and consumer electronics areas where signal processing or the transmission of signals across fiber optic cables is paramount. It introduces a new generation of devices that includes optical modulators, quantum well QW lasers and photodiodes and explores new applications of more established devices such as semiconductor lasers, light emitting diodes and photodiodes. Mitsuo Fukuda examines the material properties, operation principles, fabrication, packaging, reliability and applications of each device and offers a unique industrial perspective discussing everything engineers and scientists need to know at different phases of research, development and production. This guide to the state of the art of optical semiconductor devices helps you choose the right device for a given application. Covers important performance data such as temperature and optical feedback, noise in lasers. Highlights epitaxial growth techniques and fabrication for each device. Features one hundred figures and an extensive bibliography. Provides a clear and concise treatment unencumbered by excessive theory. *Optical Semiconductor Devices* is an essential resource for engineers and researchers in telecommunications and optoelectronics, equipment designers and manufacturers and graduate students and scholars interested in this rapidly evolving field.

**The Materials Science of Semiconductors** Angus Rockett, 2007-11-20 This book describes semiconductors from a materials science perspective rather than from condensed matter physics or electrical engineering viewpoints. It includes discussion of current approaches to organic materials for electronic devices. It further describes the fundamental aspects of thin film nucleation and growth and the most common physical and chemical vapor deposition techniques. Examples of the application of the concepts in each chapter to specific problems or situations are included along with recommended readings and homework problems.

**Heterojunctions and Semiconductor Superlattices** Guy Allan, Gerals Bastard, Nino Boccarda, Michel Lannoo, Michel Voos, 2012-12-06 The Winter School held in Les Houches on March 12-21 1985 was devoted to Semiconductor Heterojunctions and Superlattices, a topic which is recognized as being now one of

the most interesting and active fields in semiconductor physics In fact following the pioneering work of Esaki and Tsu in 1970 the study of these two dimensional semiconductor heterostructures has developed rapidly both from the point of view of basic physics and of applications For instance modulation doped heterojunctions are nowadays currently used to investigate the quantum Hall effect and to make very fast transistors This book contains the lectures presented at this Winter School showing in particular that many aspects of semiconductor heterojunctions and super lattices were treated extending from the fabrication of these two dimensional systems to their basic properties and applications in micro and opto electron ics Among the subjects which were covered one can quote as examples molecular beam epitaxy and metallorganic chemical vapor deposition of semi conductor compounds band structure of superlattices properties of elec trons in heterojunctions including the fractional quantum Hall effect opti cal properties of two dimensional heterostructures quantum well lasers and two dimensional electron gas field effect transistors It is clear that two dimensional semiconductor systems are raising a great deal of interest in many industrial and university laboratories From the number of applications which were received and from the reactions of the participants it can certainly be asserted that this School corresponded to a need and came at the right time

*Semiconductor Physics* Karl W. Böer,Udo W. Pohl,2023-02-02 This handbook gives a complete and detailed survey of the field of semiconductor physics It addresses every fundamental principle the most important research topics and results as well as conventional and emerging new areas of application Additionally it provides all essential reference material on crystalline bulk low dimensional and amorphous semiconductors including valuable data on their optical transport and dynamic properties This updated and extended second edition includes essential coverage of rapidly advancing areas in semiconductor physics such as topological insulators quantum optics magnetic nanostructures and spintronic systems Richly illustrated and authored by a duo of internationally acclaimed experts in solar energy and semiconductor physics this handbook delivers in depth treatment of the field reflecting a combined experience spanning several decades as both researchers and educators Offering a unique perspective on many issues *Semiconductor Physics* is an invaluable reference for physicists materials scientists and engineers throughout academia and industry

*Heterojunction Photocatalytic Materials* A. Pandikumar,K. Jothivenkatachalam,S. Moscow,2022-06-30 Clean environment and green energy are the basic requirements of a sustainable human life Semiconductor materials play a crucial role in addressing the issues related to increased global energy demand and environmental remediation The development of photocatalysts has experienced almost exponential progress since their popularization in the early 1970s Therefore researchers have started to consider the diversity of photocatalysts globally by approaching this domain from a materials science perspective for applications in various areas Recently heterojunction photocatalytic materials have attracted a great amount of multidisciplinary research to face the global concerns of energy production and environmental protection The unique potential of these technologies has been the stimulus to develop heterojunction photocatalysts with improved structural morphological and electronic properties

effectively increasing their efficiency This book overviews the latest advances in this field offering insights into the materials and applications of the latest generation of photocatalytic materials It presents the challenges future directions and strategies for design within the area of heterojunction photocatalysts and will be a useful resource to enhance understanding of students researchers and academicians for promoting research in this field

**Physics of Semiconductors and Nanostructures** Jyoti Prasad Banerjee, Suranjana Banerjee, 2019-06-11 This book is a comprehensive text on the physics of semiconductors and nanostructures for a large spectrum of students at the final undergraduate level studying physics material science and electronics engineering It offers introductory and advanced courses on solid state and semiconductor physics on one hand and the physics of low dimensional semiconductor structures on the other in a single text book Key Features Presents basic concepts of quantum theory solid state physics semiconductors and quantum nanostructures such as quantum well quantum wire quantum dot and superlattice In depth description of semiconductor heterojunctions lattice strain and modulation doping technique Covers transport in nanostructures under an electric and magnetic field with the topics quantized conductance Coulomb blockade and integer and fractional quantum Hall effect Presents the optical processes in nanostructures under a magnetic field Includes illustrative problems with hints for solutions in each chapter Physics of Semiconductors and Nanostructures will be helpful to students initiating PhD work in the field of semiconductor nanostructures and devices It follows a unique tutorial approach meeting the requirements of students who find learning the concepts difficult and want to study from a physical perspective

Local Parameters of Semiconductor Heterojunctions Xiaohua Yu, 1992 Semiconductor Heterojunctions and Nanostructures Omar Manasreh, 2005-05-13 Publisher's Note Products purchased from Third Party sellers are not guaranteed by the publisher for quality authenticity or access to any online entitlements included with the product This comprehensive text is aimed at graduate level students and researchers breaking down the complexities of fabrication use and maintenance of heterojunctions Topics include introduction to quantum mechanics Potential barriers and wells electronic energy levels in periodic potentials tunneling through potential barriers distribution functions and density of states optical properties of interband and intersubband transitions electrical properties techniques and measurements growth issues devices Detectors and emitters *Microscopic Study of Semiconductor Heterojunctions* Ahmad Dauod Katnani, 1983 *The Physics and Chemistry of Semiconductor Heterojunctions and Layer Structures* International Conference on the Physics and Chemistry of Semiconductor Heterojunctions and Layer Structures, European Physical Society, International Union of Pure and Applied Physics, 1971

Photocatalysis Approach for Environmental Applications Marcio Aurélio P. Almeida, Surender Kumar Sharma, Geraldo E. Luz Jr., Elson Longo, Laécio Santos Cavalcante, 2025-09-16 Currently many of the technological advances around the world are limited by the lack of understanding about materials science and its applications Beginning researchers in materials sciences worldwide have had great difficulty developing their research This book is aimed at undergraduate students and researchers

in materials sciences It aims to provide a greater understanding of the potential of semiconductor materials for environmental applications such as renewable energy energy storage systems and remediation of degraded environments

Advanced Functional Materials Ashutosh Tiwari,Lokman Uzun,2015-05-14 Because of their unique properties size shape and surface functions functional materials are gaining significant attention in the areas of energy conversion and storage sensing electronics photonics and biomedicine Within the chapters of this book written by well known researchers one will find the range of methods that have been developed for preparation and functionalization of organic inorganic and hybrid structures which are the necessary building blocks for the architecture of various advanced functional materials The book discusses these innovative methodologies and research strategies as well as provides a comprehensive and detailed overview of the cutting edge research on the processing properties and technology developments of advanced functional materials and their applications Specifically Advanced Functional Materials Compiles the objectives related to functional materials and provides detailed reviews of fundamentals novel production methods and frontiers of functional materials including metallic oxides conducting polymers carbon nanotubes discotic liquid crystalline dimers calixarenes crown ethers chitosan and graphene Discusses the production and characterization of these materials while mentioning recent approaches developed as well as their uses and applications for sensitive chemiresistors optical and electronic materials solar hydrogen generation supercapacitors display and organic light emitting diodes functional adsorbents and antimicrobial and biocompatible layer formation This volume in the Advanced Materials Book Series includes twelve chapters divided into two main areas Part 1 Functional Metal Oxides Architecture Design and Applications and Part 2 Multifunctional Hybrid Materials Fundamentals and Frontiers **Photocatalytic Systems by Design** Mohan Sakar,R. Geetha Balakrishna,Trong-On Do,2021-08-14

Photocatalytic Systems by Design Materials Mechanisms and Applications explores various aspects of photocatalysis including the photocatalytic phenomenon and process applications and the design of photocatalysts via band gap engineering The book also covers band edge position engineering for multiple photocatalytic applications such as pollutant degradations hydrogen production CO<sub>2</sub> reduction into hydrocarbon fuels antimicrobial disinfections organic synthesis N<sub>2</sub> fixation and more This book is designed to enable beginners to learn the concepts and applications of photocatalysis Unlike conventional books on photocatalysis the book provides a 360 perspective into the field of photocatalysis and serves as an informative handbook for all audiences Addresses all concepts and applications of photocatalysis Covers the fundamentals including mechanisms of photocatalytic materials Describes the various material systems and engineering of photocatalysts Offers insight into the schemes for photocatalysis of various materials Discusses the application specific design of photocatalysts



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