



Semiconductor Based Heterostructures

Evgeny Y. Tsymbal, Igor Zutic



Semiconductor Based Heterostructures:

Characterization of Semiconductor Heterostructures and Nanostructures Giovanni Agostini, Carlo Lamberti, 2011-08-11 In the last couple of decades high performance electronic and optoelectronic devices based on semiconductor heterostructures have been required to obtain increasingly strict and well defined performances needing a detailed control at the atomic level of the structural composition of the buried interfaces This goal has been achieved by an improvement of the epitaxial growth techniques and by the parallel use of increasingly sophisticated characterization techniques and of refined theoretical models based on ab initio approaches This book deals with description of both characterization techniques and theoretical models needed to understand and predict the structural and electronic properties of semiconductor heterostructures and nanostructures Comprehensive collection of the most powerful characterization techniques for semiconductor heterostructures and nanostructures Most of the chapters are authored by scientists that are among the top 10 worldwide in publication ranking of the specific field Each chapter starts with a didactic introduction on the technique The second part of each chapter deals with a selection of top examples highlighting the power of the specific technique to analyze the properties of semiconductors *Handbook of II-VI Semiconductor-Based Sensors and Radiation Detectors* Ghenadii Korotcenkov, 2023-02-02 Three volumes book Handbook of II VI Semiconductor Based Sensors and Radiation Detectors is the first to cover both chemical sensors and biosensors and all types of photodetectors and radiation detectors based on II VI semiconductors It contains a comprehensive and detailed analysis of all aspects of the application of II VI semiconductors in these devices The second volume Photodetectors of a three volume set focus on the consideration of all types of optical detectors including IR detectors visible and UV photodetectors This consideration includes both the fundamentals of the operation of detectors and the peculiarities of their manufacture and use In particular describes numerous strategies for their fabrication and characterization An analysis of new trends in development of II VI semiconductors based photodetectors such as graphene HgCdTe nanowire and quantum dot based photodetectors as well as solution processed multicolor flexible and self powered photodetectors are also given **Metal Oxide-Based Heterostructures** Naveen Kumar, Bernabé Marí Soucase, 2022-11-13 Metal Oxide Based Heterostructures Fabrication and Applications provides information on synthesis strategies structural and hierarchical features morphological characteristics of metal oxide based heterostructures and their diverse applications This book begins with an introduction to the various multidimensional heterostructures synthesis aspects and techniques used to control the formation of heterostructures Then the impact of synthesis routes on the formation of mixed metal oxide heterostructures and their properties are analyzed The effect of nonmetal doping metal doping and composites of metal oxide heterostructures on the properties of heterostructures is also addressed and that also includes opportunities for optimization of the material s performance for specific applications Special attention is given to the surface characteristics of the metal oxide heterostructures and their impact on the material s

performance and the applications of metal oxide heterostructures in various fields such as environmental remediation sensing organic catalysis photovoltaics light emitting materials and hydrogen production Introduces key principles for metal oxide heterostructures their properties key characteristics and synthesis routes Emphasizes the relationship between synthesis strategies and material performance including optimization strategies such as tailoring the material's surface characteristics or structure Discusses metal oxide heterostructures and their application in lighting and displays energy environment and sensing Wave Mechanics Applied to Semiconductor Heterostructures Gerald Bastard, 1988 Examines the basic electronic and optical properties of two dimensional semiconductor heterostructures based on III V and II VI compounds Explores various consequences of one dimensional size quantization on the most basic physical properties of heterolayers Beginning with basic quantum mechanical properties of idealized quantum wells and superlattices it discusses the occurrence of bound states when the heterostructure is imperfect or when it is shone with near bandgap light

Semiconductor-based Sensors Fan Ren, Stephen J Pearton, 2016-08-26 This book provides a comprehensive summary of the status of emerging sensor technologies and provides a framework for future advances in the field Chemical sensors have gained in importance in the past decade for applications that include homeland security medical and environmental monitoring and also food safety A desirable goal is the ability to simultaneously analyze a wide variety of environmental and biological gases and liquids in the field and to be able to selectively detect a target analyte with high specificity and sensitivity The goal is to realize real time portable and inexpensive chemical and biological sensors and to use these as monitors for handheld gas environmental pollutant exhaled breath saliva urine or blood with wireless capability In the medical area frequent screening can catch the early development of diseases reduce the suffering of patients due to late diagnoses and lower the medical cost For example a 96% survival rate has been predicted in breast cancer patients if the frequency of screening is every three months This frequency cannot be achieved with current methods of mammography due to high cost to the patient and invasiveness radiation In the area of detection of medical biomarkers many different methods including enzyme linked immunosorbent assay ELISA particle based flow cytometric assays electrochemical measurements based on impedance and capacitance electrical measurement of microcantilever resonant frequency change and conductance measurement of semiconductor nanostructures gas chromatography GC ion chromatography high density peptide arrays laser scanning quantitative analysis chemiluminescence selected ion flow tube SIFT nanomechanical cantilevers bead based suspension microarrays magnetic biosensors and mass spectrometry MS have been employed Depending on the sample condition these methods may show variable results in terms of sensitivity for some applications and may not meet the requirements for a handheld biosensor **Handbook of Spin Transport and Magnetism** Evgeny Y. Tsymbal, Igor Zutic, 2016-04-19 In the past several decades the research on spin transport and magnetism has led to remarkable scientific and technological breakthroughs including Albert Fert and Peter Grunberg's Nobel Prize winning discovery of giant

magnetoresistance GMR in magnetic metallic multilayers Handbook of Spin Transport and Magnetism provides a comprehensive balance

Compound Semiconductors 1996, Proceedings of the Twenty-Third INT Symposium on Compound Semiconductors held in St Petersburg, Russia, 23-27 September 1996 M.S. Shur, 2020-10-29 Providing a comprehensive overview of developments to both the academic and industrial communities Compound Semiconductors 1996 covers all types of compound semiconducting materials and devices The book includes results on blue and green lasers heterostructure devices nanoelectronics and novel wide band gap semiconductors With invited review papers and research results in current topics of interest this volume is part of a well known series of conferences for the dissemination of research results in the field

Nanomagnetism and Spintronics Fumihiro Matsukura, Hideo Ohno, 2013-10-07 III V compound semiconductors such as GaAs and InAs alloyed with Mn exhibit ferromagnetism The magnetic electrical and optical properties of ferromagnetic III V semiconductors are first compiled along with the way to prepare the epitaxial films and the effect of postgrowth annealing Theories available to explain the magnetism in these alloys are then presented Because the ferromagnetic semiconductors are compatible with epitaxial III V heterostructures a number of device structures have been examined and shown to reveal a wide variety of phenomena that either cannot be realized or are very difficult to observe in ferromagnetic metal structures The unique properties revealed by ferromagnetic semiconductor structures ranging from reversible electric field control of ferromagnetic phase transition to generating velocity versus current density curves of current induced domain wall motion are then reviewed The prospect of realizing high transition temperature is discussed in the last section

Physics and Technology of Semiconductor Thin Film-Based Active Elements and Devices Halyna Khlyap, 2009 This well organized reference book covers the newest and most important practically applicable results in thin film based semiconductor A2B6 A4B6 and chalcogenide sensors heterojunction based active elements and other devices This book is written for

Molecular Beam Epitaxy Robin F.C. Farrow, 1995-12-31 In this volume the editor and contributors describe the use of molecular beam epitaxy MBE for a range of key materials systems that are of interest for both technological and fundamental reasons Prior books on MBE have provided an introduction to the basic concepts and techniques of MBE and emphasize growth and characterization of GaAs based structures The aim in this book is somewhat different it is to demonstrate the versatility of the technique by showing how it can be utilized to prepare and explore a range of distinct and diverse materials For each of these materials systems MBE has played a key role both in their development and application to devices

Nanomagnetism and Spintronics Teruya Shinjo, 2013-10-07 The concise and accessible chapters of Nanomagnetism and Spintronics Second Edition cover the most recent research in areas of spin current generation spin calorimetric effect voltage effects on magnetic properties spin injection phenomena giant magnetoresistance GMR and tunnel magnetoresistance TMR Spintronics is a cutting edge area in the field of magnetism that studies the interplay of magnetism and transport phenomena demonstrating how electrons not only have charge but also spin This second edition provides the

background to understand this novel physical phenomenon and focuses on the most recent developments and research relating to spintronics This exciting new edition is an essential resource for graduate students researchers and professionals in industry who want to understand the concepts of spintronics and keep up with recent research all in one volume Provides a concise thorough evaluation of current research Surveys the important findings up to 2012 Examines the future of devices and the importance of spin current

Ultrathin Two-Dimensional Semiconductors for Novel Electronic Applications
 Mohammad Karbalaee Akbari, Serge Zhuiykov, 2020-07-30 Offering perspective on both the scientific and engineering aspects of 2D semiconductors Ultrathin Two Dimensional Semiconductors for Novel Electronic Applications discusses how to successfully engineer 2D materials for practical applications It also covers several novel topics regarding 2D semiconductors which have not yet been discussed in any other publications Features Provides comprehensive information and data about wafer scale deposition of 2D semiconductors ranging from scientific discussions up to the planning of experiments and reliability testing of the fabricated samples Precisely discusses wafer scale ALD and CVD of 2D semiconductors and investigates various aspects of deposition techniques Covers the new group of 2D materials synthesized from surface oxide of liquid metals and also explains the device fabrication and post treatment of these 2D nanostructures Addresses a wide range of scientific and practical applications of 2D semiconductors and electronic and optoelectronic devices based on these nanostructures Offers novel coverage of 2D heterostructures and heterointerfaces and provides practical information about fabrication and application of these heterostructures Introduces the latest advancement in fabrication of novel memristors artificial synapses and sensorimotor devices based on 2D semiconductors This work offers practical information valuable for engineering applications that will appeal to researchers academics and scientists working with and interested in developing an array of semiconductor electronic devices

Comprehensive Semiconductor Science and Technology, 2011-01-28
 Semiconductors are at the heart of modern living Almost everything we do be it work travel communication or entertainment all depend on some feature of semiconductor technology Comprehensive Semiconductor Science and Technology Six Volume Set captures the breadth of this important field and presents it in a single source to the large audience who study make and exploit semiconductors Previous attempts at this achievement have been abbreviated and have omitted important topics Written and Edited by a truly international team of experts this work delivers an objective yet cohesive global review of the semiconductor world The work is divided into three sections The first section is concerned with the fundamental physics of semiconductors showing how the electronic features and the lattice dynamics change drastically when systems vary from bulk to a low dimensional structure and further to a nanometer size Throughout this section there is an emphasis on the full understanding of the underlying physics The second section deals largely with the transformation of the conceptual framework of solid state physics into devices and systems which require the growth of extremely high purity nearly defect free bulk and epitaxial materials The last section is devoted to exploitation of the knowledge described in the previous

sections to highlight the spectrum of devices we see all around us Provides a comprehensive global picture of the semiconductor world Each of the work s three sections presents a complete description of one aspect of the whole Written and Edited by a truly international team of experts **Materials for Electronic, Magnetic, and Spintronic**

Technologies Amodini Mishra, Virat Dixit, Divya Somvanshi, Anu Singh, Anju Mishra, 2024-08-12 This book consolidates the collective contributions of various authors presenting a diverse array of materials for systematic property assessment and their subsequent application in electronic magnetic and spintronic technologies Encompassing pure and modified polymers metals and semiconductors the book elucidates the magnetic photocatalytic thermal electrochemical and other salient characteristics inherent in these materials Delving into a broad spectrum of applications such as energy storage environmental remediation water purification and biomedical drug administration the book carefully examines these materials in the context of their distinctive attributes By elucidating the correlation between a material s functionality and its physical properties this work offers a lucid and accessible presentation that facilitates an understanding of how these materials can be judiciously employed for specific purposes Designed for researchers graduate students educators engineers industry researchers and other informed members of the public the comprehensive coverage of this book renders it an indispensable tool in the realm of materials science and technology Through its meticulous exploration of various materials and their applications this work stands as a valuable resource for those seeking a profound understanding of the intricate interplay between material properties and their functionalities *Energy Research Abstracts* ,1989 Solar Light

Harvesting with Nanocrystalline Semiconductors Oleksandr Stroyuk, 2017-11-07 This book explains the use of nanocrystalline semiconductors in the harvesting of energy from solar light It introduces promising methodology and technology which may help to increase the efficiency of light harvesting one of the major challenges on the way toward sustainable energy generation The book starts with a general introduction to the photochemistry of semiconductor nanocrystals In the introductory chapter the author also provides a frank and critical discussion on perspectives and limitations of the photocatalytic processes for solar light conversion including a historical account on semiconductor photocatalysis He discusses that and also why it is a long way from laboratory prototypes to real sustainable technologies The following chapters outline the conversion of solar light energy in semiconductor nanophotocatalysis on the one hand and to electric energy in nanocrystalline semiconductor based solar cells on the other hand Topics addressed include nanophotocatalytic hydrogen production artificial photosynthesis quantum dot sensitized liquid junction and bulk heterojunction solar cells Perspectives and opportunities but also bottlenecks and limitations are discussed and the novel systems compared with established technology such as classical silicon solar cells While readers in this way learn to understand the basics and get introduced to the current research in the field the final chapter provides them with the necessary knowledge about methodology both in synthesis and characterization of semiconductor nanophotocatalysts and semiconductor nanomaterials

including examples for the practice of photocatalytic experiments and the studies of semiconductor based solar cells

Atomic and Nano Scale Materials for Advanced Energy Conversion, 2 Volumes Zongyou Yin, 2022-04-18 Atomic and Nano Scale Materials for Advanced Energy Conversion Discover the latest advancements in energy conversion technologies used to develop modern sustainable energy techniques In Atomic and Nano Scale Materials for Advanced Energy Conversion expert interdisciplinary researcher Dr Zongyou Yin delivers a comprehensive overview of nano to atomic scale materials science the development of advanced electrochemical photochemical photoelectrochemical and photovoltaic energy conversion strategies and the applications for sustainable water splitting and other technologies The book offers readers cutting edge information of two dimensional nano mixed dimensional nano nano rare earth clusters and single atoms It constructively evaluates emerging nano to atomic scale energy conversion technologies for academic research and development R D researchers and industrial technique consultants and engineers The author sets out a systematic analysis of recent energy conversion science covering topics like adaptable manufacturing of Van der Waals heterojunctions mixed dimensional junctions tandem structures and superlattices He also discusses function oriented engineering in polymorphic phases photon absorption excitons charges conversion non noble plasmonics and solid liquid gas interactions Readers will also benefit from A thorough introduction to emerging nanomaterials for energy conversion including electrochemical photochemical photoelectrochemical and photovoltaic energy conversion An exploration of clusters for energy conversion including electrochemical photochemical and photoelectrochemical clusters Practical discussions of single atoms for energy conversion in electrochemical photochemical and photoelectrochemical energy conversion technologies A thorough analysis of future perspectives and directions in advanced energy conversion technology Perfect for materials scientists photochemists electrochemists and inorganic chemists Atomic and Nano Scale Materials for Advanced Energy Conversion is also a must read resource for catalytic chemists interested in the intersection of advanced chemistry and physics in energy conversion technologies

Multifunctional Nanocomposites for Energy and Environmental Applications Zhanhu Guo, Yuan Chen, Na Luna Lu, 2018-01-02 Dieses klar strukturierte Fachbuch legt den Schwerpunkt auf praktische Anwendungen von Nanokompositen und Nanotechnologien im Rahmen einer nachhaltigen Entwicklung Es zeigt wie Nanokomposite zur Lösung von Energie und Umweltproblemen beitragen können bietet zusätzlich einen breiten Überblick über Anwendungen im Energiebereich und behandelt eine einzigartige Auswahl an Umweltthemen Der erste Teil beschäftigt sich mit Anwendungen wie Lithium Ionen Batterien Solarzellen Katalyse Gewinnung von Wärme und Energie aus Abfällen mithilfe der Thermoelektrizität und Wasserspaltung Der zweite Teil beleuchtet in einzigartiger Weise ökologische Themen darunter Atommanagement sowie die Abscheidung und Speicherung von Kohlendioxid Dieses Fachbuch vermittelt auf erfolgreiche Weise Grundlagenwissen für Einsteiger als auch die neuesten Erkenntnisse für erfahrene Wissenschaftler Ingenieure und Forscher aus der Industrie

Polarization Effects in Semiconductors Debdeep Jena, 2008 Polarization Effects in Semiconductors

From Ab Initio Theory to Device Applications presents the latest understanding of the solid state physics electronic implications and practical applications of the unique spontaneous or pyro electric polarization charge of wurtzite compound semiconductors and associated piezo electric effects in strained thin film heterostructures These heterostructures are used in wide band gap semiconductor based sensors in addition to various electronic and opto electronic semiconductor devices The book covers the ab initio theory of polarization in cubic and hexagonal semiconductors growth of thin film GaN GaN AlGaIn GaAlN AlGaInN and other nitrides and SiC heterostructures It discusses the effects of spontaneous and piezoelectric polarization on band diagrams and electronic properties of abrupt and compositionally graded heterostructures electronic characterization of polarization induced charge distributions by scanning probe spectroscopies and gauge factors and strain effects In addition polarization in extended defects piezo electric strain charge engineering and application to device design and processing are covered The effects of polarization on the fundamental electron transport properties and on the basic optical transitions are described The crucial role of polarization in devices such as high electron mobility transistors HEMTs and light emitting diodes LEDs is covered The chapters are authored by professors and researchers in the fields of physics applied physics and electrical engineering who worked for 5 years under the Polarization Effects in Semiconductors DOD funded Multi Disciplinary University Research Initiative This book will be of interest to graduate students and researchers working in the field of wide bandgap semiconductor physics and their device applications It will also be useful for practicing engineers in the field of wide bandgap semiconductor device research and development

Polarization Effects in Semiconductors Colin Wood, Debdeep Jena, 2007-10-16 Polarization Effects in Semiconductors From Ab Initio Theory to Device Applications presents the latest understanding of the solid state physics electronic implications and practical applications of the unique spontaneous or pyro electric polarization charge of wurtzite compound semiconductors and associated piezo electric effects in strained thin film heterostructures These heterostructures are used in wide band gap semiconductor based sensors in addition to various electronic and opto electronic semiconductor devices The book covers the ab initio theory of polarization in cubic and hexagonal semiconductors growth of thin film GaN GaN AlGaIn GaAlN AlGaInN and other nitrides and SiC heterostructures It discusses the effects of spontaneous and piezoelectric polarization on band diagrams and electronic properties of abrupt and compositionally graded heterostructures electronic characterization of polarization induced charge distributions by scanning probe spectroscopies and gauge factors and strain effects In addition polarization in extended defects piezo electric strain charge engineering and application to device design and processing are covered The effects of polarization on the fundamental electron transport properties and on the basic optical transitions are described The crucial role of polarization in devices such as high electron mobility transistors HEMTs and light emitting diodes LEDs is covered The chapters are authored by professors and researchers in the fields of physics applied physics and electrical engineering who worked for 5 years under the Polarization Effects in Semiconductors DOD funded Multi

Disciplinary University Research Initiative This book will be of interest to graduate students and researchers working in the field of wide bandgap semiconductor physics and their device applications It will also be useful for practicing engineers in the field of wide bandgap semiconductor device research and development

Unveiling the Magic of Words: A Report on "**Semiconductor Based Heterostructures**"

In some sort of defined by information and interconnectivity, the enchanting power of words has acquired unparalleled significance. Their capability to kindle emotions, provoke contemplation, and ignite transformative change is actually awe-inspiring. Enter the realm of "**Semiconductor Based Heterostructures**," a mesmerizing literary masterpiece penned by way of a distinguished author, guiding readers on a profound journey to unravel the secrets and potential hidden within every word. In this critique, we shall delve into the book's central themes, examine its distinctive writing style, and assess its profound effect on the souls of its readers.

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Semiconductor Based Heterostructures Introduction

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