Semiconductor Quantum Well Intermixing Material Properties And Optoelectronic

Semiconductor devices based on lattice mismatched heterostructures have been the subject of much study. This volume focuses on the physics, technology and applications of strained layer quantum wells and superlattices, featuring chapters on aspects ranging from theoretical modeling of quantum-well lasers to materials characterization and assessment by the most prominent researchers in the field. It is an essential reference for both researchers and students of semiconductor lasers, sensors and communications.

The field of materials science and engineering is rapidly evolving into a science of its own. While traditional literature in this area often concentrates primarily on property and structure, the Materials Processing Handbook provides a much needed examination from the materials processing perspective. This unique focus reflects the changing comple

Under certain conditions electrons in a semiconductor become much hotter than the surrounding crystal lattice. When this happens, Ohm's Law breaks down: current no longer increases linearly with voltage and may even decrease. Hot electrons have long been a challenging problem in condensed matter physics and remain important in semiconductor research. Recent advances in technology have led to semiconductors with submicron dimensions, where electrons can be confined to two (quantum well), one (quantum wire), or zero (quantum dot) dimensions. In these devices small voltages heat electrons rapidly, inducing complex nonlinear behavior; the study of hot electrons is central to their further development. This book is the only comprehensive and up-to-date coverage of hot electrons. Intended for both established researchers and graduate students, it gives a complete account of the historical development of the subject, together with current research and future trends, and covers the physics of hot electrons in bulk and low-dimensional device technology. The contributions are from leading scientists in the field and are grouped broadly into five categories: introduction and overview; hot electron-phonon interactions and ultra-fast phenomena in bulk and two-dimensional structures; hot electrons in quantum wires and dots; hot electron tunneling and transport in superlattices; and novel devices based on hot electron transport.

Interest in antimonide-related heterostructures is burgeoning due to their applications as light sources, diode lasers, modulators, filters, switches, nonlinear optics, and field-defect transistors. This volume, featuring contributions from leading researchers in the field, is the first book to focus on antimonide-related topics. It offers to both the beginning student and the advanced researcher a comprehensive review of the state of the art in this exciting new area of research.

InP is a key semiconductor for the production of optoelectronic and photonic devices. Its related compounds, such as InGaAsP alloy, have been realized as very important materials for communication in the 1.3 and 1.55 micron spectral regions. Furthermore, the applications on InP and related compounds have extended to other areas that include laser diodes, light emitting diodes, photodetectors, waveguides, photocathodes, solar cells, and many other applications. The topics presented in this book have been chosen to achieve a balance between the properties of bulk materials, doping, characterization, applications, and devices. This unique volume, featuring chapters written by experts in the field, provides a good starting point for those who are new to the subject and contains detailed results and in depth discussions for those who are experts in the field.

A study of materials modification by ion irradiation. The papers address topics such as: ion beam modification of polymers; nanoclusters and nonlinear optics; and photonic integrated circuits and quantum wells.

Although it took some time to establish the word, photonics is both widely accepted and used throughout the world and a major area of activity concerns nonlinear materials. In these the nonlinearity mainly arises from second-order or third-order nonlinear optical processes. A restriction is that second-order processes only occur in media that do not possess a centre of symmetry. Optical fibres, on the other hand, being made of silica glass, created by fusing SiO molecules, are made of material with a centre of z symmetry, so the bulk of all processes are governed by third-order nonlinearity. Indeed, optical fibre nonlinearities have been extensively studied for the last thirty years and can be truly hailed as a success story of nonlinear optics. In fact, the fabrication ofsuch fibres, and the exploitation oftheir nonlinearity, is in an advanced stage - not least being their capacity to sustain envelope solitons. What then ofsecond-order nonlinearity? This is also well-known for its connection to second-harmonic generation. It is an immediate concern, however, to understand how waves can mix and conserve both energy and momentum ofthe photons involved. The problem is that the wave vectors cannot be made to match without a great deal of effort, or at least some clever arrangement has to be made - a special geometry, or crystal arrangement. The whole business is called phase matching and an inspection ofthe state-of-the-art today, reveals the subject to be in an advanced state.

This second part presents a comprehensive overview of fundamental optical properties of the III Nitride Semiconductor. All optoelectronic applications based on III-nitrides are due to their unique optical properties and characterizations of III-nitrides. Much information, which is critical to the design and improvement of optoelectronic devices based on III-nitrides has been obtained in the last several years. This is the second of a two part Volume in the seriesOptoelectronic Properties of Semiconductors and Superlattices. Part II consists of chapters with emphasis on the optical spectroscopy of highly excited group III-nitrides, theoretical calculations and experimental measurements of optical constants of III-nitrides. The remaining five chapters focus on the relationships and properties of GaN and InGaN as relating to III Nitrides.

This unique volume provides a comprehensive review and introduction of the defects and structural properties of GaN and related compounds for newcomers to the field and will be a stimulus to further advances for experienced researchers. The chapters contained in this volume constitutes a representative sampling of the broad range of research on nitride semiconductor materials and defect issues currently being pursued in academic, government, and industrial laboratories worldwide.

Lead Chalcogenides remain one of the basic materials of modern infrared optoelectronics. This volume presents the [roperties of lead chalcogenides, including the basic physical features, the bulk and epitaxial growth technique, and the 2-D physics of lead chalcogenide-based structures. In addition, the theoretical appraoches for band structure and impurity state calculations are reviewed.

Defects in ion-implanted semiconductors are important and will likely gain increased importance as annealing temperatures are reduced with successive IC generations. Novel implant approaches, such as MdV implantation, create new types of defects whose origin and annealing characteristics will need to be addressed. Publications in this field mainly focus on the effects of ion implantation on the material and the modification in the implanted layer after high temperature annealing. The editors of this volume and Volume 45 focus on the physics of the annealing kinetics of the damaged layer. An overview of characterization tehniques and a critical comparison of the information on annealing kinetics is also presented. Provides basic knowledge of ion implantation-induced defects Focuses on physical mechanisms of defect annealing Utilizes electrical, physical, and optical characterization tools for processed semiconductors Provides the basis for understanding the problems caused by the defects generated by implantation and the means for their characterization and elimination

Each chapter in this book is written by a group of leading experts in one particular type of microprobe technique. They emphasize the ability of that technique to provide information about small structures (i.e. quantum dots, quantum lines), microscopic defects, strain, layer composition, and its usefulness as diagnostic technique for device degradation. Different types of probes are considered (electrons, photons and tips) and different microscopies (optical, electron microscopy and tunneling). It is an ideal reference for post-graduate and experienced researchers, as well as for crystal growers and optoelectronic device makers.

Addressing the growing demand for larger capacity in information technology, VLSI Micro- and Nanophotonics: Science, Technology, and Applications explores issues of science and technology of micro/nano-scale photonics and integration for broad-scale and chip-scale Very Large Scale Integration photonics. This book is a game-changer in the sense that it is quite possibly the first to focus on "VLSI Photonics".

Very little effort has been made to develop integration technologies for micro/nanoscale photonic devices and applications, so this reference is an important and necessary early-stage perspective on this field. New demand for VLSI photonics brings into play various technological and scientific issues, as well as evolutionary and revolutionary challenges—all of which are discussed in this book. These include topics such as miniaturization, interconnection, and integration of photonic devices at micron, submicron, and nanometer scales. With its "disruptive creativity" and unparalleled coverage of the photonics revolution in information technology, this book should greatly impact the future of micro/nano-photonics and IT as a whole. It offers a comprehensive overview of the science and engineering of micro/nanophotonics and photonic integration. Many books on micro/nanophotonics focus on understanding the properties of individual devices and their related characteristics. However, this book offers a full perspective from the point of view of integration, covering all aspects of benefits and advantages of VLSI-scale photonic integration—the key technical concept in developing a platform to make individual devices and components useful and practical for various applications.

Defects in Optoelectronic Materials bridges the gap between device process engineers and defect physicists by describing current problems in device processing and current understanding of these defects based on defect physics. The volume covers defects and their behaviors in epitaxial growth, in various processes such as plasma processing, deposition and implantation, and in device degradation. This book also provides graduate students cutting-edge information on devices and materials interaction.

Semiconductor Quantum Well Intermixing is an international collection of research results dealing with several aspects of the diffused quantum well (DFQW), ranging from Physics to materials and device applications. The material covered is the basic interdiffusion mechanisms of both cation and anion groups as well as the properties of band structure modifiations. Its comprehensive coverage of growth and pos-growth processing technologies along with its presentation of the various interesting and advanced features of the DFQW materials make this book an essential reference to the study of QW layer intermixing.

Presents views on current developments in heat and mass transfer research related to the modern development of heat exchangers. Devotes special attention to the different modes of heat and mass transfer mechanisms in relation to the new development of heat exchangers design. Dedicates particular attention to the future needs and demands for further development in heat and mass transfer. GaN and related materials are attracting tremendous interest for their applications to high-density optical data storage, blue/green diode lasers and LEDs, high-temperature electronics for high-power microwave applications, electronics for aerospace and automobiles, and stable passivation films for semiconductors. In addition, there is great scientific interest in the nitrides, because they appear to form the first semiconductor system in which extended defects do not severely affect the optical properties of devices. This series provides a forum for the latest research in this rapidly-changing field, offering readers a basic understanding of new developments in recent research. Series volumes feature a balance between original theoretical and experimental research in basic physics, device physics, novel materials and quantum structures, processing, and systems.

Be a part of the nanotechnology revolution intelecommunications This book provides a unique and thought-provoking perspective onhow nanotechnology is poised to revolutionize thetelecommunications, computing, and networking industries. Theauthor discusses emerging technologies as well as technologiesunder development that will lay the foundation for such innovationsas: * Nanomaterials with novel optical, electrical, and magneticproperties * Faster and smaller non-silicon-based chipsets, memory, andprocessors * New-science computers based on Quantum Computing * Advanced microscopy and manufacturing systems * Faster and smaller telecom switches, including opticalswitches * Higher-speed transmission phenomena based on plasmonics and otherquantum-level phenomena * Nanoscale MEMS: micro-electro-mechanical systems The author of this cutting-edge publication has played a role inthe development of actual nanotechnology-based communicationsystems. In this book, he examines a broad range of the science ofnanotechnology and how this field will affect every facet of thetelecommunications and computing industries, in both the near andfar term, including: * Basic concepts of nanotechnology and its applications * Essential physics and chemistry underlying nanotechnologyscience * Nanotubes, nanomaterials, and nanomaterial processing * Promising applications in nanophotonics, including nanocrystalsand nanocrystal fibers * Nanoelectronics, including metal nanoclusters, semiconductingnanoclusters, nanocrystals, nanowires, and quantum dots This book is written for telecommunications professionals,researchers, and students who need to discover and exploit emergingrevenue-generating opportunities to develop the next generation ofnanoscale telecommunications and network systems. Non-scientistswill find the treatment completely accessible. A detailed glossaryclarifies unfamiliar terms and concepts. Appendices are providedfor readers who want to delve further into the hard-core science,including nanoinstrumentation and quantum computing. Nanotechnology is the next industrial revolution, and thetelecommunications industry will be radically transformed by it ina few years. This is the publication that readers need tounderstand how that transformation will happen, the science behindit, and how they can be a part of it.

Quantum well intermixing (QWI), a postgrowth bandgap engineering technology, has been viewed as a promising method for semiconductor photonics integrated circuits (PICs). In this research, we investigated a novel intermixing process that yields large bandgap blueshift at low activation energy in various quantum well and dot structures using metallic impurity induced disordering technique. Large bandgap selectivity and high intermixed material quality have also been observed from GaAs-based quantum well nanostructures. Impurity-free vacancy induced disordering (IFVD), Cu:SiO2 intermixing and nitrogen (N) ion-implantation induced disordering (N-IID) have been performed to promote the efficient group-III intermixing in InP-based quantum dash laser structure. Using Cu:SiO2 and N-IID to promote universal intermixing on dash-inwell InP-based laser structure, up to a maximum bandgap shift of 208 nm (115 meV) and 193 nm (106 meV) were observed from the Cu:SiO2 and N-IIID intermixed samples, respectively.

As microprocessors shrink in size, there is a growing need to understand and combat potential radiation damage problems. Space applications are an obvious case, but, beyond that, today's device and circuit fabrication rely on an increasing number of processing steps that involve a perilous environment where inadvertent radiation damage can occur. This book is aimed at researchers seeking an overview of the field and nuclear, space, and process engineers. Background knowledge of semiconductor and device physics is assumed, but the basic concepts are all concisely summarized.

Energetic ion beam irradiation is the basis of a wide plethora of powerful research- and fabrication-techniques for materials characterisation and processing on a nanometre scale. Materials with tailored optical, magnetic and electrical properties can be fabricated by synthesis of nanocrystals by ion implantation, focused ion beams can be used to machine away and deposit material on a scale of nanometres and the scattering of energetic ions is a unique and quantitative tool for process development in high speed electronics and 3-D nanostructures with extreme aspect radios for tissue engineering and nano-fluidics lab-on-a-chip may be machined using proton beams. This book will benefit practitioners, researchers and graduate students working in the field of ion beams and application and more generally everyone concerned with the broad field of nanoscience and technology.

This book will provide useful information to material growers and evaluators, device design and processing engineers as well as potential users of SiC technologies. This book will help identify remaining challenging issues to stimulate further investigation to realize the full potential of wide band gap SiC for optoelectronic and microelectronic applications.

The concepts in this book will provide a comprehensive overview of the current state for a broad range of nitride semiconductor devices, as well as a detailed introduction to selected materials and processing issues of general relevance for these applications. This compilation is very timely given the level of interest and the current stage of research in nitride semiconductor materials and device applications. This volume consists of chapters written by a number of leading researchers in nitride materials and device technology addressing Ohmic and Schottky contacts, AIGalnN multiple quantum well laser diodes, nitride vertical cavity emitting lasers, and ultraviolet photodetectors. This unique volume provides a comprehensive review and introduction to application and devices based on GaN and related compounds for newcomers to the field and stimulus to further advances for experienced researchers.

This volume provides a comprehensive review of the experimental and theoretical aspects of the optical and transport properties of nanoporous silicon, their relation to the microscopic structure of nanocrystals, and the application of porous silicon in optical devices. As porous silicon is an ideal substance for the modelling of optical processes in nanocrystalline materials, this volume also is an excellent reference source on the more general subject of the structural and optical properties of nanocrystalline semiconductors.

SPIE Milestones are collections of seminal papers from the world literature covering important discoveries and developments in optics and photonics.

This book reviews the current status of research and development in dilute III-V nitrides. It covers major developments in this new class of materials within 24 chapters from prominent research groups. The book integrates materials science and applications in optics and electronics in a unique way. It is valuable both as a reference work for researchers and as a study text for graduate students.

This proceeding is a collection of selected papers presented at Symposium O of Compound Semiconductor Photonics in the International Conference on Materials for Advanced Technology (ICMAT), which was held in Singapore from 28 June to 3 July 2009. The symposium covers a wide range of topics from fundamental semiconductor materials study to photonic device fabrication and application. The papers collected are of recent progress in the active and wide range of semiconductor photonics research. They include materials-related papers on III-As/P, III-nitride, quantum dot/wire/dash growth, ZnO, and chalcogenide, and devices-related papers on photonic crystals, VCSEL, quantum dot/dash lasers, LEDs, waveguides, solar cells and heterogeneous integration.

Since their development in the 1990s, it has been discovered that diluted nitrides have intriguing properties that are not only distinct from those of conventional semiconductor materials, but also are conducive to various applications in optoelectronics and photonics. The book examines these applications and presents a broad and in-depth look at t

II-VI Semiconductor Materials and Their Applications deals with II-VI compound semiconductors and the status of the two areas of current optoelectronics applications: blue-green emitters and IR detectors. Specifically, the growth, charactrtization, materials and device issues for these two applications are described. Emphasis is placed on the wide bandgap emitters where much progress has occurred recently.The book also presents new directions that have potential, future applications in optoelectronics for II-VI materials. In particular, it discusses the status of dilute magnetic semiconductors for mango-optical and electromagnetic devices, nonlinear optical properties, photorefractive effects and new materials and physics phenomena, such as self-organized, low-dimensional structures.II_VI Semiconductor Materials and Their Applications is a valuable reference book for researchers in the field as well as a textbook for materials science and applied physics courses.

Complex-mediums electromagnetics (CME) describes the study of electromagnetic fields in materials with complicated response properties. This truly multidisciplinary field commands the attentions of scientists from physics and optics to electrical and electronic engineering, from chemistry to materials science, to applied mathematics, biophysics, and nanotechnology. This book is a collection of essays to explain complex mediums for optical and electromagnetic applications. All contributors were requested to write with two aims: first, to educate; second, to provide a state-of-the-art review of a particular subtopic. The vast scope of CME exemplified by the actual materials covered in the essays should provide a plethora of opportunities to the novice and the initiated alike.

A major showcase for the compound semiconductor community, Compound Semiconductors 2002 presents an overview of recent developments in compound semiconductor physics and its technological applications to devices. The topics discussed reflect the significant progress achieved in understanding and mastering compound semiconductor materials and electronic and optoelectronic devices. The book covers heteroepitaxial growth, quantum confined emitters and detectors, quantum wires and dots, ultrafast transistors, and various compound materials.

Carbon (C) and Silicon Germanium (SiGe) work like a magic sauce. At least in small concentrations, they make everything taste better. It is remarkable enough that SiGe, a new material, and the heterobipolar transistor, a new device, appear on the brink of impacting the exploding wireless market. The addition of C to SiGe, albeit in small concentrations, looks to have breakthrough potential. Here, at last, is proof that materials science can put a rocket booster on the silicon-mind, the silicon transistor. Scientific excitement arises, as always, from the new possibilities a multicomponent materials system offers. Bandgaps can be changed, strains can be tuned, and properties can be tailored. This is catnip to the materials scientist. The wide array of techniques applied here to the SiGeC system bear testimony to the ingenious approaches now available for mastering the complexities of new materials

The characterization and precisely controlled building of atomic-scale mutilayers have been the subject of intensive R&D worldwide. Nanometric structures based on III-V semiconductors have attracted particular attention. Since 1970, around 15,000 papers have been published in all, of which 10,000 have appeared in the last 6 years. The resulting improved materials control is enabling engineers to achieve major improvements in the performance of microelectronic and optoelectronic devices such as QW lasers, tunnelling devices, modulators, switches and photodetectors. In this book, the large volume of research results which have accumulated is evaluated and distilled down to a useful, manageable concentration of up-to-date knowledge for electronic engineers and solid-state physicists. This has been carried out by an invited international team of over 50 specialists under the editorship of Professor Bhattacharya with support from INSPEC, who also compiled the subject index. There are 40 individually-written, self-contained modules ("Datareviews"), each specially commissioned to fit into a pre-determined structure. Subjects reviewed in depth include historical perspective, theory, epitaxial growth and doping, structure (e.g. X-ray diffraction), electronic properties, optical properties, modulation doping and devices. Each Datareview comprises tables, text, figures and expert guidance to the literature, as appropriate. Properties of III-V quantum wells and superlattices is intended both as a look-up source of evaluated data and as a finely-structured state-of-the-art review for academic and industrial R&D workers.

Pioneered by the pharmaceutical industry and adapted for the purposes of materials science and engineering, the combinatorial method is now widely considered a watershed in the accelerated discovery, development, and optimization of new materials. Combinatorial Materials Synthesis reveals the gears behind combinatorial materials chemistry and thin-

Since first coming into existence in the early 90s, the vertical-cavity surface-emitting laser (VCSEL) has made several quantum leaps in performance. The performance of VCSELs now exceeds that of edge-emitting lasers in many respects, and offers a superior optical beam and much easier monolithic integrability. As the VCSEL technology improves further, and their number and variety multiply, their potential applications will likely expand at a rapid pace. Vertical-cavity Surface-Emitting Lasers: Technology and Applications addresses two main objectives. It provides the researcher and device engineer with a reference guide to understanding the physical principles as well as the practical design concepts of VCSELs. Furthermore, it provides the system designer or application engineer with a review of the properties of VCSELs, and an overview of some of the applications in which the VCSEL has already played an important role. This book features contributions from prominent researchers in the field.

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The first GaN and Related Materials covered topics such as a historical survey of past research, optical electrical and microstructural characterization, theory of defects, bulk crystal growth, and performance of electronic and photonic devices. This new volume updates old research where warranted and explores new areas such as UV detectors, microw

This book provides a comprehensive introduction to integrated optical waveguides for information technology and data communications. Integrated coverage ranges from advanced materials, fabrication, and characterization techniques to guidelines for design and simulation. A concluding chapter offers perspectives on likely future trends and challenges. The dramatic scaling down of feature sizes has driven exponential improvements in semiconductor productivity and performance in the past several decades. However, with the potential of gigascale integration, size reduction is approaching a physical limitation due to the negative impact on resistance and inductance of metal interconnects with current copper-trace based technology. Integrated optics provides a potentially lower-cost, higher performance alternative to electronics in optical communication systems. Optical interconnects, in which light can be generated, guided, modulated, amplified, and detected, can provide greater bandwidth, lower power consumption, decreased interconnect delays, resistance to electromagnetic interference, and reduced crosstalk when integrated into standard electronic circuits. Integrated waveguide optics represents a truly multidisciplinary field of science and engineering, with continued growth requiring new developments in modeling, further advances in materials science, and innovations in integration platforms. In addition, the processing and fabrication of these new devices must be optimized in conjunction with the development of accurate and precise characterization and testing methods. Students and professionals in materials science and engineering will find Advanced Materials for Integrated Optical Waveguides to be an invaluable reference for meeting these research and development goals.