Heterostructure And Quantum Well Physics William R

The book is a history of Molecular Beam Epitaxy (MBE) as applied to the growth of semiconductor thin films (note that it does not cover the subject of metal thin films). It begins by examining the origins of MBE, first of all looking at the nature of molecular beams and considering their application to fundamental physics, to the development of nuclear magnetic resonance and to the invention of the microwave MASER. It shows how molecular beams of silane (SiH4) were used to study the nucleation of silicon films on a silicon substrate and how such studies were extended to compound semiconductors such as GaAs. From such surface studies in ultra-high vacuum the technique developed into a method of growing high quality single crystal films of a wide range of semiconductors. Comparing this with earlier evaporation methods of deposition and with other epitaxial deposition methods such as liquid phase and vapour phase epitaxy (LPE and VPE). The text describes the development of MBE machines from the early âhome-madeâ variety to that of commercial equipment and show how MBE was gradually refined to produce high quality films with atomic dimensions. This was much aided by the use of various in-situ surface analysis techniques, such as reflection high energy electron diffraction (RHEED) and mass spectrometry, a feature unique to MBE. It looks at various modified versions of the basic MBE process, then proceed to describe their application to the growth of so-called âlow-dimensional structuresâ (LDS) based on ultra-thin heterostructure films with thickness of order a few molecular monolayers. Further chapters cover the growth of a wide range of different compounds and describe their application to fundamental physics and to the fabrication of electronic and opto-electronic devices. The authors study the historical development of all these aspects and emphasise both the (often unexpected) manner of their discovery and development and the unique features which MBE brings to the growth of extremely complex structures with monolayer accuracy.

This book primarily covers the fundamental science, synthesis, characterization, optoelectronic properties, and applications of metal oxide nanomaterials. It discusses the basic aspects of synthetic procedures and fabrication technologies, explains the related experimental techniques and also elaborates on the current status of nanostructured oxide materials and related devices. Two major aspects of metal oxide nanostructures – their optical and electrical properties – are described in detail. The first five chapters focus on the optical characteristics of semiconducting materials, especially metal oxides at the nanoscale. The following five chapters discuss the electrical properties observed in metal oxide-based semiconductors and the status quo of device-level developments in a variety of applications such as sensors, transistors, dilute magnetic semiconductors, and dielectric materials. The basic science and mechanism behind the optoelectronic phenomena are explained in detail, to aid readers interested in the structure–property symbiosis in semiconducting nanomaterials. In short, the book offers a valuable reference guide for researchers and academics in the areas of material science and semiconductor technology, especially nanophotonics and electronics.

This book surveys semiconductor superlattices, in particular their growth and electronic properties in an applied electric field perpendicular to the layers. The main developments in this field, which were achieved in the last five to seven years, are summarized. The electronic properties include transport through minibands at low electric field strengths, the Wannier–Stark localization and Bloch oscillations at intermediate electric field strengths, resonant tunneling of electrons and holes between different subbands, and the formation of electric field domains for large carrier densities at high electric field strengths. Contents: Growth and Characterization (K Fujiwara)Miniband Transport (A Sibille)Wannier–Stark Localization and Bloch Oscillations (F Agulló-Rueda & J Feldmann)Resonant Tunneling (H Grahn)Electric Field Domains (H Grahn). Readership: Physicists and materials scientists. keywords:Semiconductor Superlattices;Nanostructures;Fabrication;Miniband Transport;Bloch Oscillations;Wannierâ€“Stark Localization;Resonant Tunneling;Electric-Field Domains;Non-Linear Transport;Optical Properties

This volume is a collection of the Nobel Lectures delivered by the prizewinners, together with their biographies, portraits and the presentation speeches for the period 1996 ? 2000. Each Nobel Lecture is based on the work that won the prize. This volume of inspiring lectures by outstanding physicists should be on the bookshelf of every keen student, teacher and professor of physics as well as of those in related fields.Below is a list of the prizewinners during the period 1996 ? 2000 with a description of the works which won them their prizes.(1996) D M LEE, D D OSHEROFF & R C RICHARDSON ? for their discovery of superfluidity in helium-3; (1997) S CHU, C COHEN-TANNOUDJI & W D PHILLIPS ? for development of methods to cool and trap atoms with laser light; (1998) R B LAUGHLIN, H L ST™RMER & D C TSUI ? for their discovery of a new form of quantum fluid with fractionally charged excitations; (1999) G 't HOOFT & M J G VELTMAN ? for elucidating the quantum structure of electroweak interactions in physics; (2000) Z I ALFEROV & H KROEMER ? for developing semiconductor heterostructures used in high-speed and opto-electronics and; J S KILBY ? for his part in the invention of the integrated circuit.

Superlattices and Other Heterostructures deals with optical properties of superlattices and quantum-well structures with emphasis on phenomena governed by crystal symmetries. After a brief introduction to group theory and symmetries, methods to calculate spectra of electrons, excitions and phonons in heterostructures are discussed. Further chapters cover absorption and reflection of light under interband transitions, cyclotron and electron spin-resoncance, light scattering by free and bound carriers as well as by optical and acoustic phonons, polarized photoluminescence, optical spin orientation of electrons and excitions, and nonlinear optical and photogalvanic effects.

This book provides the information necessary for the reader to achieve a thorough understanding of all aspects of QW lasers - from the basic mechanism of optical gain, through the current technolgoical state of the art, to the future technologies of quantum wires and quantum dots. In view of the growing importance of QW lasers, this book should be read by all those with an active interest in laser science and technology, from the advanced student to the experienced laser scientist. * The first comprehensive book-length treatment of quantum well lasers * Provides a detailed treatment of quantum well laser basics * Covers strained quantum well lasers * Explores the different state-of-the-art quantum well laser types * Provides key information on future laser technologies

This book contains the lectures delivered at the NATO Advanced Study Institute on "Physics and Applications of Quantum Wells and Superlattices", held in Erice, Italy, on April 21-May 1, 1987. This course was the fourth one of the International School of Solid-State Device Research, which is under the auspices of the Ettore Majorana Center for Scientific Culture. In the last ten years, we have seen an enormous increase in re search in the field of Semiconductor Heterostructures, as evidenced by the large percentage of papers presented in recent international conferences on semiconductor physics. Undoubtfully, this expansion has been made possible by dramatic advances in materials preparation, mostly by molecular beam epitaxy and organometallic chemical vapor deposition. The emphasis on epitaxial growth that was prevalent at the beginning of the decade (thus, the second course of the School, held in 1983, was devoted to Molecular Beam Epitaxy and Heterostructures) has given way to a strong interest in new physical phenomena and new material structures, and to practical applications that are already emerging from them.

Characterization of Semiconductor Heterostructures and Nanostructures is structured so that each chapter is devoted to a specific characterization technique used in the understanding of the properties (structural, physical, chemical, electrical etc..) of semiconductor quantum wells and superlattices. An additional chapter is devoted to ab initio modeling. The book has two basic aims. The first is educational, providing the basic concepts of each of the selected techniques with an approach understandable by advanced students in Physics, Chemistry, Material Science, Engineering, Nanotechnology. The second aim is to provide a selected set of examples from the recent literature of the TOP results obtained with the specific technique in understanding the properties of semiconductor heterostructures and nanostructures. Each chapter has this double structure: the first part devoted to explain the basic concepts, and the second to the discussion of the most peculiar and innovative examples. The topic of quantum wells, wires and dots should be seen as a pretext of applying top level characterization techniques in understanding the structural, electronic etc properties of matter at the nanometer (and even sub-nanometer) scale. In this respect it is an essential reference in the much broader, and extremely hot, field of Nanotechnology. Comprehensive collection of the most powerful characterization techniques for semiconductors heterostructures and nanostructures Most of the chapters are authored by scientists that are world-wide among the top-ten in publication ranking of the specific field Each chapter starts with a didactic introduction on the technique The second part of each chapters deals with a selection of top examples highlighting the power of the specific technique to analyse the properties of semiconductors heterostructures and nanostructures

Quantum Wells, Wires and Dots Second Edition: Theoretical and Computational Physics of Semiconductor Nanostructures provides all the essential information, both theoretical and computational, for complete beginners to develop an understanding of how the electronic, optical and transport properties of quantum wells, wires and dots are calculated. Readers are lead through a series of simple theoretical and computational examples giving solid foundations from which they will gain the confidence to initiate theoretical investigations or explanations of their own. Emphasis on combining the analysis and interpretation of experimental data with the development of theoretical ideas Complementary to the more standard texts Aimed at the physics community at large, rather than just the low-dimensional semiconductor expert The text present solutions for a large number of real situations Presented in a lucid style with easy to follow steps related to accompanying illustrative examples

The present level of experimental sophistication in quantum physics allows physicists to explore domains unimaginable just a decade ago and to test the most fundamental laws of quantum mechanics. This has led to renewed interest in devising new tests, experiments, and devices where it is possible to observe the interaction and localization of just a few atoms or photons. These techniques have been used to reveal new nonclassical effects, to question the limit of the principle of correspondence, and to force quantum behavior in semiconductors. With contributions from leading experts in quantum systems, Quantum Dynamics of Simple Systems provides an overview of the present range of quantum dynamics, exploring their use and exotic behaviors. It covers specific subjects of quantum dynamics in a competent and detailed way with emphasis on simple systems where few atoms or electrons are involved. This volume will prove to be a useful tool for graduate students as well as experienced physicists.

These proceedings review the progress in most aspects of semiconductor physics, including those related to materials, processing and devices. The conference continues the tradition of the ICPS series and these volumes include state-of-the-art lectures. The plenary and invited papers address areas of major interest.These volumes will serve as excellent material for researchers in semiconductor physics and related fields.

Physics of Quantum Well DevicesSpringer Science & Business Media

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.

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.

Quantum Heterostructures provides a detailed description of the key physical and engineering principles of quantum semiconductor heterostructures. Blending important concepts from physics, materials science, and electrical engineering, it also explains clearly the behavior and operating features of modern microelectronic and optoelectronic devices. The authors begin by outlining the trends that have driven development in this field, most importantly the need for high-performance devices in computer, information, and communications technologies. They then describe the basics of quantum nanoelectronics, including various transport mechanisms. In the latter part of the book, they cover novel microelectronic devices, and optical devices based on quantum heterostructures. The book contains many homework problems and is suitable as a textbook for undergraduate and graduate courses in electrical engineering, physics, or materials science. It will also be of great interest to those involved in research or development in microelectronic or optoelectronic devices.

This volume provides valuable summaries on many aspects of advanced semiconductor heterostructures and highlights the great variety of semiconductor heterostructures that has emerged since their original conception. As exemplified by the chapters in this book, recent progress on advanced semiconductor heterostructures spans a truly remarkable range of scientific fields with an associated diversity of applications.

Some of these applications will undoubtedly revolutionize critically important facets of modern technology. At the heart of these advances is the ability to design and control the properties of semiconductor devices on the nanoscale. As an example, the intersubband lasers discussed in this book have a broad range of previously unobtainable characteristics and associated applications as a result of the nanoscale dimensional control of the underlying semi-conductor heterostructures. As this book illustrates, an astounding variety of heterostructures can be fabricated with current technology; the potentially widespread use of layered quantum dots fabricated with nanoscale precision in biological applications opens up exciting advances in medicine. In addition, many more excellent examples of the remarkable impact being made through the use of semi-conductor heterostructures are given. The summaries in this volume provide timely insights into what we know now about selected areas of advanced semiconductor heterostructures and also provide foundations for further developments. Contents: Novel Heterostructure Devices: Electron-Phonon Wave Interactions in Inter-subband Laser Heterostructures (M Kisin et al.); Quantum Dot Infrared Detectors and Sources (P Bhattacharya et al.);Generation of Terahertz Emission Based on Intersubband Transitions (Q Hu); Midinfrared GaSb-Based Lasers with Type I Heterointerfaces (D V Donetsky et al.); Advances in Quantum Dot Research and Technology: The Path to Applications

Optoelectronics ranks one of the highest increasing rates among the different industrial branches. This activity is closely related to devices which are themselves extremely dependent on materials. Indeed, the history of optoelectronic devices has been following closely that of the materials. KLUWER Academic Publishers has thus rightly identified "Materials for Optoelectronics" as a good opportunity for a book in the series entitled "Electronic Materials; Science and Technology". Although a sound background in solid state physics is recommended, the authors have confined their contribution to a graduate student level, and tried to define any concept they use, to render the book as a whole as self-consistent as possible. In the first section the basic aspects are developed. Here, three chapters consider semiconductor materials for optoelectronics under various aspects. Prof. G. E. Stillman begins with an introduction to the field from the point of view of the optoelectronic market. Then he describes how III-V materials, especially the Multi Quantum Structures meet the requirements of optoelectronic functions, including the support of microelectronics for optoelectronic integrated circuits. In chapter 2, Prof.

The development of integrated silicon photonic circuits has recently been driven by the Internet and the push for high bandwidth as well as the need to reduce power dissipation induced by high data-rate signal transmission. To reach these goals, efficient passive and active silicon photonic devices, including waveguide, modulators, photodetectors,

Heterostructure and quantum-mechanical devices promise significant improvement in the performance of electronic and optoelectronic integrated circuits (ICs). Though these devices are the subject of a vigorous research effort, the current literature is often either highly technical or narrowly focused. This book presents heterostructure and quantum devices to the nonspecialist, especially electrical engineers working with high-performance semiconductor devices. It focuses on a broad base of technical applications using semiconductor physics theory to develop the next generation of electrical engineering devices. The text covers existing technologies and future possibilities within a common framework of high-performance devices, which will have a more immediate impact on advanced semiconductor physics-particularly quantum effects-and will thus form the basis for longer-term technology development.

This invaluable book is devoted to the physics, technology and device applications of semiconductor structures with ultrathin layers where the electronic properties are governed by the quantum-mechanical laws. Such structures called quantum wells or structures with the two-dimensional electron gas, have become one of the most actively investigated objects in modern solid state physics. Electronic properties of quantum wells differ dramatically from those of bulk semiconductors, which allows one to observe new types of physical phenomena, such as the quantum Hall effect and many other so-far-unknown kinetic and optical effects. This, in turn, offers wide opportunities for creating semiconductor devices based on new principles, and it has give birth to the new branch of electronics called nanoelectronics. Contents: General IdeasStructures with Two-Dimensional Electron GasEnergy Spectrum and Carrier StatisticsOptical Properties of Two-Dimensional SystemsKinetic Phenomena in Two-Dimensional SystemsHigh Magnetic Field PhenomenaVertical Transport in a System of Quantum WellsDevice Applications of Two-Dimensional Systems Readership: Students, engineers and solid state physicists. keywords:Quantum Wells;Nanostructures;Superlattices;Heterojunctions;Size Quantization;Quantum Hall Effect;Delta-Layers;Subbands

Quantum Wells, Wires and Dots provides all the essential information, both theoretical and computational, to develop an understanding of the electronic, optical and transport properties of these semiconductor nanostructures. The book will lead the reader through comprehensive explanations and mathematical derivations to the point where they can design semiconductor nanostructures with the required electronic and optical properties for exploitation in these technologies. This fully revised and updated 4th edition features new sections that incorporate modern techniques and extensive new material including: Properties of non-parabolic energy bands Matrix solutions of the Poisson and Schrödinger equations Critical thickness of strained materials Carrier scattering by interface roughness, alloy disorder and impurities Density matrix transport modelling Thermal modelling Written by well-known authors in the field of semiconductor nanostructures and quantum optoelectronics, this user-friendly guide is presented in a lucid style with easy to follow steps, illustrative examples and questions and computational problems in each chapter to help the reader build solid foundations of understanding to a level where they can initiate their own theoretical investigations. Suitable for postgraduate students of semiconductor and condensed matter physics, the book is essential to all those researching in academic and industrial laboratories worldwide. Instructors can contact the authors directly (p.harrison@shu.ac.uk / a.valavanis@leeds.ac.uk) for Solutions to the problems.

The Workshop Heterostructure Epitaxy and Devices HEAD'97 was held from October 12 to 16, 1997 at Smolenice Castle, the House of Scientists of the Slovak Academy of Sciences and was co-organized by the Institute of Electrical Engineering, Slovak Academy of Sciences, Bratislava and the Institute of Thin Film and Ion Technology, Research Centre, Iiilich. It was the third in a series of workshops devoted to topics related to heterostructure epitaxy and devices and the second included into the category of Advanced Research Workshops (ARW) under sponsorship of the NATO. More than 70 participants from 15 countries attended (Austria, Belarus, Belgium, Czech Republic, Finland, Germany, Greece, Hungary, Italy, Poland, Russia, Slovakia, Ukraine, the United Kingdom and the USA). Novel microelectronic and optoelectronic devices are based on semiconductor heterostructures. The goal of the ARW HEAD'97 was to discuss various questions related to the use of new materials (e.g. compound semiconductors based on high band-gap nitrides and low band-gap antimonides) and new procedures (low-temperature epitaxial growth), as well as new principles (nanostructures, quantum wires and dots, etc.) aimed at realizing high-performance heterostructure based electronic devices. Almost 70 papers (invited and contributed oral presentations as well as posters) were presented at the ARW HEAD'97 and the main part of them is included into these Proceedings.

Quantum dash based laser diodes have attracted the focus of study and research in the very recent years due to what they possess of myriad advantages that make them ideal for several applications. Atop said advantages is their peculiar ultra-broadband emission as a result of the inherent inhomogeneous nature of the growth process of quantum dashes. This book investigates a novel multi-stacked chirped InAs/InP quantum dash-in-well laser that introduces an extra layer of inhomogeneity. The investigation of this laser is carried out at two levels: device level and system level. In device level, the fundamental laser diode characterization experiments are performed to extract its principle parameters. Thereafter, the investigation scope is shifted towards pulsed operation modes of higher-ordered duty-cycles and continuous wave operations. The device-level characterization is concluded by investigating the temperature dependent lasing spectral profiles at different geometrical configurations, current injections, and temperatures. Finally, the obtained results are used to optimize different operation parameters that achieved a successful implementation in optical communication systems.

Starting with the first transistor in 1949, the world has experienced a technological revolution which has permeated most aspects of modern life, particularly over the last generation. Yet another such revolution looms up before us with the newly developed capability to control matter on the nanometer scale. A truly extraordinary research effort, by scientists, engineers, technologists of all disciplines, in nations large and small throughout the world, is directed and vigorously pressed to develop a full understanding of the properties of matter at the nanoscale and its possible applications, to bring to fruition the promise of nanostructures to introduce a new generation of electronic and optical devices. The physics of low dimensional semiconductor structures, including heterostructures, superlattices, quantum wells, wires and dots is reviewed and their modeling is discussed in detail. The truly exceptional material, Graphene, is reviewed; its functionalization and Van der Waals interactions are included here. Recent research on optical studies of quantum dots and on the physical properties of one-dimensional quantum wires is also reported. Chapters on fabrication of nanowire – based nanogap devices by the dielectrophoretic assembly approach. The broad spectrum of research reported here incorporates chapters on nanoengineering and nanophysics. In its presentation of tutorial chapters as well as advanced research on nanostructures, this book is ideally suited to meet the needs of newcomers to the field as well as experienced researchers interested in viewing colleagues' recent advances.

Since its inception in 1966, the series of numbered volumes known as Semiconductors and Semimetals has distinguished itself through the careful selection of well-known authors, editors, and contributors. The Willardson and Beer series, as it is widely known, has succeeded in producing numerous landmark volumes and chapters. Not only did many of these volumes make an impact at the time of their publication, but they continue to be well-cited years after their original release. Recently, Professor Eicke R. Weber of the University of California at Berkeley joined as a co-editor of the series. Professor Weber, a well-known expert in the field of semiconductor materials, will further contribute to continuing the series' tradition of publishing timely, highly relevant, and long-impacting volumes. Some of the recent volumes, such as Hydrogen in Semiconductors, Imperfections in III/V Materials, Epitaxial Microstructures, High-Speed Heterostructure Devices, Oxygen in Silicon, and others promise that this tradition will be maintained and even expanded. Reflecting the truly interdisciplinary nature of the field that the series covers, the volumes in Semiconductors and Semimetals have been and will continue to be of great interest to physicists, chemists, materials scientists, and device engineers in modern industry.

E se non che di cid son vere prove A nd 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 UbertiJ Heterojunction interfaces, the interfaces between different semiconducting materi als, have been extensively explored for over a quarter of a century. The justifica tion for this effort is clear - these interfaces could become the building blocks of lllany novel solid-state devices. Other interfaces involving semiconductors are al ready widely used in technology, These are, for example, metal-semiconductor and insulator-semiconductor junctions and hOll1ojunctions. In comparison, the present applications of heterojunction int. erfaces are limited, but they could potentially becOlne lnuch lllore ext. ensive in the neal' future. The path towards the widespread use of heterojunctions is obstructed by several obstacles.

Quantum well devices have been the objects of intensive research during the last two decades. Some of the devices have matured into commercially useful products and form part of modern electronic circuits. Some others require further dev- opment, but have the promise of being useful commercially in the near future. Study of the devices is, therefore, gradually becoming compulsory for electronics specialists. The functioning of the devices, however, involve aspects of physics which are not dealt with in the available text books on the physics of semicond- tor devices. There is, therefore, a need for a book to cover all these aspects at an introductory level. The present book has been written with the aim of meeting this need. In fact, the book grew out of introductory lectures given by the author to graduate students and researchers interested in this rapidly developing area of electron devices. The book covers the subjects of heterostructure growth techniques, band-offset theory and experiments, electron states, electron-photon interaction and related phenomena, electron transport and the operation of electronic, opto-electronic and photonic quantum well devices. The theory as well as the practical aspects of the devices are discussed at length. The aim of the book is to provide a comprehensive treatment of the physics underlying the various devices. A reader after going through the book should find himself equipped to deal with all kinds of quantum well devices.

The 4th edition of this highly successful textbook features copious material for a complete upper-level undergraduate or graduate course, guiding readers to the point where they can choose a specialized topic and begin supervised research. The textbook provides an integrated approach beginning from the essential principles of solid-state and semiconductor physics to their use in various classic and modern semiconductor devices for applications in electronics and photonics. The text highlights many practical aspects of semiconductors: alloys, strain, heterostructures, nanostructures, amorphous semiconductors, and noise, which are essential aspects of modern semiconductor research but often omitted in other textbooks. This textbook also covers advanced topics, such as Bragg mirrors, resonators, polarized and magnetic semiconductors, nanowires, quantum dots, multi-junction solar cells, thin film transistors, and transparent conductive oxides. The 4th edition includes many updates and chapters on 2D materials and aspects of topology. The text derives explicit formulas for many results to facilitate a better understanding of the topics. Having evolved from a highly regarded two-semester course on the topic, The Physics of Semiconductors requires little or no prior knowledge of solid-state physics. More than 2100 references guide the reader to historic and current literature including original papers, review articles and topical books, providing a go-to point of reference for experienced researchers as well.

Intersubband transitions in quantum wells have attracted tremendous attention in recent years, mainly due to the promise of applications in the mid and far-infrared regions (2--20 mum). Many of the papers presented in Quantum Well Intersubband Transition Physics and Devices are on the basic linear intersubband transition processes, detector physics and detector application, reflecting the current state of understanding and detector applications, where highly uniform, large focal plane arrays have been demonstrated. Other areas are still in their early stages, including infrared modulation, harmonic generation and emission.

Rapid developments in technology have led to enhanced electronic systems and applications. When utilized correctly, these can have significant impacts on communication and computer systems. Transport of Information-Carriers in Semiconductors and Nanodevices is an innovative source of academic material on transport modelling in semiconductor material and nanoscale devices. Including a range of perspectives on relevant topics such as charge carriers, semiclassical transport theory, and organic semiconductors, this is an ideal publication for engineers, researchers, academics, professionals, and practitioners interested in emerging developments on transport equations that govern information carriers.

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

Long Wave Polar Modes in Semiconductor Heterostructures is concerned with the study of polar optical modes in semiconductor heterostructures from a phenomenological approach and aims to simplify the model of lattice dynamics calculations. The book provides useful tools for performing calculations relevant to anyone who might be interested in practical applications. The main focus of Long Wave Polar Modes in Semiconductor Heterostructures is planar heterostructures (quantum wells or barriers, superlattices, double barrier structures etc) but there is also discussion on the growing field of quantum wires and dots. Also to allow anyone reading the book to apply the techniques discussed for planar heterostructures, the scope has been widened to include cylindrical and spherical geometries. The book is intended as an introductory text which guides the reader through basic questions and expands to cover state-of-the-art professional topics. The book is relevant to experimentalists wanting an instructive presentation of a simple phenomenological model and theoretical tools to work with and also to young theoreticians by providing discussion of basic issues and the basis of advanced theoretical formulations. The book also provides a brief respite on the physics of piezoelectric waves as a coupling to polar optical modes.

Terahertz (THz) electromagnetic waves, phenomena in the THz range and related technological issues have been explosively investigated during the recent two decades. However, its potential as a disruptive technology to commercial applications has yet to make any impression. The Russia-Japan-USA-Europe Symposium on Fundamental and Applied Problems of Terahertz Devices and Technologies (RJUSE-TeraTech 2016), held at Katahira Campus of Tohoku University, Sendai, Japan on October 31 – November 4, 2016, aims to bring together researchers from Russia, Japan, USA and Europe, who are working on the broad range of related problems in the terahertz devices, technologies and applications, to discuss on state-of-the-art results and future directions and collaborations in the development of THz. This is the fifth in the series of preceding successful symposiums in Terahertz Devices and Technologies. It contains 14 selected extended papers presented at the RJUSE-TeraTech 2016 symposium, addressing the variety of topics, in particular, THz detectors based on double heterojunction bipolar transistors (DHBT) and field effect transistors (FET) utilizing resonant plasma effects, quantum cascade (QCL) and HgCdTe quantum-well heterostructures, and graphene-based THz devices.

When this publisher offered me the opportunity to \\Tite a book, some six years ago, I did not hesitate to say yes. I had just spent the last four years of graduate school struggling to understand the physics of strained quantum well lasers, and it seemed to me the whole experience was much more difficult that it should have been. For although many of the results I needed were easy to locate, the underlying physical premises and intervening steps were not. If only I had a book providing the derivations, I could have absorbed them and gone on my way. Such a book lies before you. It provides a unified and self-contained descrip tion of the essential physics of strained quantum well lasers, starting from first principles whenever feasible. The presentation I have chosen requires only the standard introductory background in quantum mechanics, solid state physics, and electromagnetics expected of entering graduate students in physics or elec trical engineering. A single undergraduate course in each of these subjects should be more than sufficient to follow the text. :'Iore advanced material on quantum mechanics is developed and collected in the first chapter. \Vhen pos sible, I have presented the results in a general setting and have later applied them to specific cases of interest. I find this the most satisfying way to ap proach the subject, and it has the additional benefit of solving many problems once and for all.

Low Temperature Electronics: Physics, Devices, Circuits, and Applications summarizes the recent advances in cryoelectronics starting from the fundamentals in physics and semiconductor devices to electronic systems, hybrid superconductor-semiconductor technologies, photonic devices, cryocoolers and thermal management. Furthermore, this book provides an exploration of the currently available theory, research, and technologies related to cryoelectronics, including treatment of the solid state physical properties of the materials used in these systems. Current applications are found in infrared systems, satellite communications and medical equipment. There are opportunities to expand in newer fields such as wireless and mobile communications, computers, and measurement and scientific equipment. Low temperature operations can offer certain advantages such as higher operational speeds, lower power dissipation, shorter signal transmission times, higher semiconductor and metal thermal conductivities, and improved digital and analog circuit performance. The computer, telecommunication, and cellular phone market is pushing the semiconductor industry towards the development of very aggressive device and integrated circuit fabrication technologies. This is taking these technologies towards the physical miniaturization limit, where quantum effects and fabrication costs are becoming a technological and economical barrier for further development. In view of these limitations, operation of semiconductor devices and circuits at low temperature (cryogenic temperature) is studied in this book. * It is a book intended for a wide audience: students, scientists, technology development engineers, private companies, universities, etc. * It contains information which is for the first time available as an all-in-one source; Interdisciplinary material is arranged and made compatible in this book * It is a must as reference source