This volume contains the Proceedings of the NATO Advanced Research Workshop on "Growth and Optical Properties of Wide Gap II-VI Low Dimensional Semiconductors", held from 2 - 6 August 1988 in Regensburg, Federal Republic of Germany, under the auspices of the NATO International Scientific Exchange Programme. Semiconducting compounds formed by combining an element from column II of the periodic table with an element from column VI (so called II-VI Semiconductors) have long promised many optoelectronic devices operating in the visible region of the spectrum. However, these materials have encountered numerous problems including: large number of defects and difficulties in obtaining p- and n-type doping. Advances in new methods of material preparation may hold the key to unlocking the unfulfilled promises. During the workshop a full session was taken up covering the prospects for wide-gap II-VI Semiconductor devices, particularly light emitting ones. The growth of bulk materials was reviewed with the view of considering II-VI substrates for the novel epitaxial techniques such as MOCVD, MBE, ALE, MOMBE and ALE-MBE. The controlled introduction of impurities during non-equilibrium growth to provide control of the doping type and conductivity was emphasized.

This monograph is concerned with the III-V bulk and low-dimensional semiconductors, with the emphasis on the implications of multi-valley bandstructures for the physical mechanisms essential for opto-electronic devices. The optical response of such semiconductor materials is determined by many-body effects such as screening, gap narrowing, Fermi-edge singularity, electron-hole plasma and liquid formation. Consequently, the discussion of these features reflects such interdependencies with the dynamics of excitons and carriers resulting from intervalley coupling.

Optoelectronics and electronics of the years to come are likely to change dramatically. Most of the outdoor lighting systems will be replaced by light-emitting diodes that operate in the whole visible part of the electromagnetic spectrum. Transistors operating at high frequency and with high power are under development and likely to hit the market very rapidly. Compact solid-state lasers that operate in the near-ultraviolet range are going to be utilized for such widely used applications as read-write tasks in printer and CD drives. Ultraviolet detectors will be used at a wide scale for many application, ranging from flame detectors to medical instruments. This book concerns itself with the questions why nitride semiconductors are so promising over such a wide range of applications, what the current issues are in the research laboratories, and what the prospects of new electronic devices are in the dawn of the twenty-first century.
This invaluable textbook presents the basic elements needed to understand and research into semiconductor physics. It deals with elementary excitations in bulk and low-dimensional semiconductors, including quantum wells, quantum wires and quantum dots. The basic principles underlying optical non-linearities are developed, including excitonic and many-body plasma effects. Fundamentals of optical bistability, semiconductor lasers, femtosecond excitation, the optical Stark effect, the semiconductor photon echo, magneto-optic effects, as well as bulk and quantum-confined FranzKeldysh effects, are covered. The material is presented in sufficient detail for graduate students and researchers with a general background in quantum mechanics. This fifth edition includes an additional chapter on 'Quantum Optical Effects' where the theory of quantum optical effects in semiconductors is detailed. Besides deriving the 'semiconductor luminescence equations' and the expression for the stationary luminescence spectrum, the results are presented to show the importance of Coulombic effects on the semiconductor luminescence and to elucidate the role of excitonic populations.

Photo-Excited Processes, Diagnostics and Applications covers the area of photo-excitation and processing of materials by photons from the basic principles and theories to applications, from IR to x-rays, from gas phase to liquid and solid phases. The various chapters give a wide spectral view of this developing field. Twelve leading groups worldwide set down to write this book during the past two years which include the most updated techniques used in their laboratories for investigating photo-excited processes and new applications. This book will be useful to scientists and engineers who have a strong interest in photo-assisted processes development for microelectronics and photonics.

This revised and updated edition of the well-received book by C. Klingshirn provides an introduction to and an overview of all aspects of semiconductor optics, from IR to visible and UV. It has been split into two volumes and rearranged to offer a clearer structure of the course content. Inserts on important experimental techniques as well as sections on topical research have been added to support research-oriented teaching and learning. Volume 1 provides an introduction to the linear optical properties of semiconductors. The mathematical treatment has been kept as elementary as possible to allow an intuitive approach to the understanding of results of semiconductor spectroscopy. Building on the phenomenological model of the Lorentz oscillator, the book describes the interaction of light with fundamental optical excitations in semiconductors (phonons, free carriers, excitons). It also offers a broad review of seminal research results augmented by concise descriptions of the relevant experimental techniques, e.g., Fourier transform IR spectroscopy, ellipsometry, modulation spectroscopy and spatially resolved methods, to name a few. Further, it picks up on hot topics in current research, like quantum structures, mono-layer semiconductors or Perovskites. The experimental aspects of semiconductor optics are complemented by an in-depth discussion of group theory in solid-state optics. Covering subjects ranging from physics to materials science and optoelectronics, this book provides a lively and comprehensive introduction to semiconductor optics. With over 120 problems, more than 480 figures, abstracts to each chapter, as well as boxed inserts and a detailed index, it is intended for use in graduate courses in physics and neighboring sciences like material science and electrical engineering. It is also a valuable reference resource for doctoral and advanced researchers.

This Advanced Study Institute on the Electronic Properties of Multilayers and Low Dimensional Semiconductor Structures focussed on several of the most active areas in modern semiconductor physics. These included resonant tunnelling and superlattice phenomena and the topics of ballistic transport, quantised conductance and anomalous magnetoresistance effects in laterally gated two-dimensional electron systems. Although the main emphasis was on fundamental physics, a series of supporting lectures described the underlying technology (Molecular Beam Epitaxy, Metallo-Organic Chemical Vapour Deposition, Electron Beam Lithography and other advanced processing technologies). Actual and potential applications of low dimensional structures in optoelectronic and high frequency devices were also discussed. The ASI took the form of a series of lectures of about fifty minutes' duration which were given by senior researchers from a wide range of countries. Most of the lectures are recorded in these Proceedings. The younger members of the Institute made the predominant contribution to the discussion sessions following each lecture and, in addition, provided most of the fifty-five papers that were presented in two lively poster sessions. The ASI emphasised the impressive way in which this research field has developed through the fruitful interaction of theory, experiment and semiconductor device technology. Many of the talks demonstrated both the effectiveness and limitations of semiclassical concepts in describing the quantum phenomena exhibited by electrons in low dimensional structures.

Low-dimensional semiconductor quantum structures are a major, high-technological development that has a considerable industrial potential. The field is developing extremely rapidly and
the present book represents a timely guide to the latest developments in device technology, fundamental properties, and some remarkable applications. The content is largely tutorial, and the book could be used as a textbook. The book deals with the physics, fabrication, characteristics and performance of devices based on low-dimensional semiconductor structures. It opens with fabrication procedures. The fundamentals of quantum structures and electro-optical devices are dealt with extensively. Nonlinear optical devices are discussed from the point of view of physics and applications of exciton saturation in MQW structures. Waveguide-based devices are also described in terms of linear and nonlinear coupling. The basics of pseudomorphic HEMT technology, device physics and materials layer design are presented. Each aspect is reviewed from the elementary basics up to the latest developments. Audience: Undergraduates in electrical engineering, graduates in physics and engineering schools. Useful for active scientists and engineers wishing to update their knowledge and understanding of recent developments.

The first book devoted to a systematic consideration of electronic excitations and electronic energy transfer in organic crystalline multilayers and organics based nanostructures (quantum wells, quantum wires, quantum dots, microcavities). The ingenious combination of organic with inorganic materials in one and the same hybrid structure is shown to give qualitatively new opto-electronic phenomena, potentially important for applications in nonlinear optics, light emitting devices, photovoltaic cells, lasers and so on. The book will be useful not only for physicists but also for chemists and biologists. To help the nonspecialist reader, three Chapters which contain a tutorial and updated introduction to the physics of electronic excitations in organic and inorganic solids have been included. * hybrid Frenkel-Wannier-Mott excitons * microcavities with crystalline and disordered organics * electronic excitation at donor-acceptor interfaces * cold photoconductivity at donor-acceptor interface * cumulative photovoltage * Förster transfer energy in microcavity * New concepts for LEDs

This book, Condensed Matter and Material Physics, incorporates the work of multiple authors to enhance the theoretical as well as experimental knowledge of materials. The investigation of crystalline solids is a growing need in the electronics industry. Micro and nano transistors require an in-depth understanding of semiconductors of different groups. Amorphous materials, on the other hand, as non-equilibrium materials are widely applied in sensors and other medical and industrial applications. Superconducting magnets, composite materials, lasers, and many more applications are integral parts of our daily lives. Superfluids, liquid crystals, and polymers are undergoing active research throughout the world. Hence profound information on the nature and application of various materials is in demand. This book bestows on the reader a deep knowledge of physics behind the concepts, perspectives, characteristic properties, and prospects. The book was constructed using 10 contributions from experts in diversified fields of condensed matter and material physics and its technology from over 15 research institutes across the globe.

The composition of modern semiconductor heterostructures can be controlled precisely on the atomic scale to create low-dimensional systems. These systems have revolutionised semiconductor physics, and their impact on technology, particularly for semiconductor lasers and ultrafast transistors, is widespread and burgeoning. This book provides an introduction to the general principles that underlie low-dimensional semiconductors. As far as possible, simple physical explanations are used, with reference to examples from actual devices. The author shows how, beginning with fundamental results from quantum mechanics and solid-state physics, a formalism can be developed that describes the properties of low-dimensional semiconductor systems. Among numerous examples, two key systems are studied in detail: the two-dimensional electron gas, employed in field-effect transistors, and the quantum well, whose optical properties find application in lasers and other opto-electronic devices. The book includes many exercises and will be invaluable to undergraduate and first-year graduate physics or electrical engineering students taking courses in low-dimensional systems or heterostructure device physics.

A fundamental theory of the electronic and optical properties of semiconductors shows the importance of impurities, which are often unavoidable and can alter intrinsic properties of semiconductor materials substantially. While the subject of impurity doping is well understood in bulk semiconductors, the role and impact of doping in low-dimensional materials like carbon nanotubes is still under investigation and there exists significant debate on the exact nature of electronic impurity levels in single-walled carbon nanotubes associated with adatoms. In this work, we address the role of impurities in single-walled carbon nanotubes. A simple model is developed for studying the interaction of bright (singlet) excitons in semiconducting single-wall nanotubes with charged impurities. The model reveals a red shift in the energy of excitonic states in the presence of an impurity, thus indicating binding of excitons in the impurity potential well. Signatures of several bound states were found in the
absorption spectrum below the onset of excitonic optical transitions in the bare nanotube. The dependence of the binding energy on the model parameters, such as impurity charge and position, was determined and analytical fits were derived for a number of tubes of different diameter. The nanotube family splitting is seen in the diameter dependence, gradually decreasing with the diameter. By calculating the partial absorption coefficient for a small segment of nanotube the local nature of the wave function of the bound states was derived. Our studies provide useful insights into the role of the physical environment (here, a charged impurity atom) in the manipulation of the excited states of carbon nanotubes. We performed very detailed calculations of the electronic and optical properties of carbon nanotubes in the presence of an immobile impurity atom, thus going beyond previous many-body perturbation theory (MBPT) studies in which the carbon nanotubes were considered in vacuum. This work elucidates the role of impurities in low dimensional semiconductors and provides further insights into the uniqueness of the electronic and optical properties of carbon nanotubes which are viable candidates for the next generation nanoscale optoelectronics applications.

Based on a NATO Advanced Summer Institute, this volume discusses physical models, mathematical formalisms, experimental techniques, and applications for ultrafast dynamics of quantum systems. These systems are used in laser optics, spectroscopy, and utilize monochromaticity, spectral brightness, coherence, power density, and tunability of laser sources.

Gives a comprehensive and coherent account of the basic methods to characterize a solid through its interaction with an electromagnetic field.

The author develops the effective-mass theory of excitons in low-dimensional semiconductors and describes numerical methods for calculating the optical absorption including Coulomb interaction, geometry, and external fields. The theory is applied to Fano resonances in low-dimensional semiconductors and the Zener breakdown in superlattices. Comparing theoretical results with experiments, the book is essentially self-contained; it is a hands-on approach with detailed derivations, worked examples, illustrative figures, and computer programs. The book is clearly structured and will be valuable as an advanced-level self-study or course book for graduate students, lecturers, and researchers.

A recent major development in high technology, and one which bears considerable industrial potential, is the advent of low-dimensional semiconductor quantum structures. The research and development activity in this field is moving fast and it is thus important to afford scientists and engineers the opportunity to get updated by the best experts in the field. The present book draws together the latest developments in the fabrication technology of quantum structures, as well as a competent and extensive review of their fundamental properties and some remarkable applications. The book is based on a set of lectures that introduce different aspects of the basic knowledge available, it has a tutorial content and could be used as a textbook. Each aspect is reviewed, from elementary concepts up to the latest developments. Audience: Undergraduates and graduates in electrical engineering and physics schools. Also for active scientists and engineers, updating their knowledge and understanding of the frontiers of the technology.

The workshop on "Optical Properties of Low Dimensional Silicon sL Structures" was held in Meylan, France on March, 1 yd, 1993. The workshop took place inside the facilities of France Telecom- CNET. Around 45 leading scientists working on this rapidly moving field were in attendance. Principal support was provided by the Advanced Research Workshop Program of the North Atlantic Treaty Organisation (NATO). French Delegation a l'Armement and CNET gave also a small financial grant, the organisational part being undertaken by the SEE and CNET. There is currently intense research activity worldwide devoted to the optical properties of low dimensional silicon structures. This follow the recent discovery of efficient visible photoluminescence (PL) from highly porous silicon. This workshop was intended to bring together all the leading European scientists and laboratories in order to reveal the state of the art and to open new research fields on this subject. A large number of invited talks took place (12) together with regular contribution (20). The speakers were asked to leave nearly 1/3 of the time to the discussion with the audience, and that promoted both formal and informal discussions between the participants.

Semiconductor quantum dots represent one of the fields of solid state physics that have experienced the greatest progress in the last decade. Recent years have witnessed the discovery of many striking new aspects of the optical response and electronic transport phenomena. This book surveys this progress in the physics, optical spectroscopy and application-oriented research of semiconductor quantum dots. It focuses especially on
excitons, multi-excitons, their dynamical relaxation behaviour and their interactions with
the surroundings of a semiconductor quantum dot. Recent developments in fabrication
techniques are reviewed and potential applications discussed. This book will serve not only
as an introductory textbook for graduate students but also as a concise guide for active
researchers.

This monograph assimilates new research in the field of low-dimensional metals. It provides a
detailed overview of the current status of research on quasi-one- and two-dimensional
molecular metals, describing normal-state properties, magnetic field effects,
superconductivity, and the phenomena of interacting p and d electrons. It includes a number
of findings likely to become standard material in future textbooks on solid-state physics.

A program of research was carried out in which theoretical investigations into the
simultaneous manipulation of carriers (electrons, holes, and ultimately excitons) and light
in semiconductor nanostructures such as quantum wells were conducted. The manipulation of the
carrier and optical dynamics will be achieved by the use of specially tailored ultrafast
optical pulses, multicolor laser fields, millimeter or submillimeter electromagnetic pulses,
or combinations of the above. Because the relevant time scale for the carrier dynamics may be
less than the characteristic dephasing time of the carriers, the evolution of the system can
be coherent; phase effects play a dominant role. Such shaped pulses and multicolor fields may
be used to coherently control optical excitations in semiconductors in order to access
quantum mechanical states, which are otherwise difficult to attain.

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

The many-body-theoretical basis and applications of theoretical spectroscopy of condensed
matter, e.g. crystals, nanosystems, and molecules are unified in one advanced text for
readers from graduate students to active researchers in the field. The theory is developed
from first principles including fully the electron-electron interaction and spin
interactions. It is based on the many-body perturbation theory, a quantum-field-theoretical
description, and Green's functions. The important expressions for ground states as well as
electronic single-particle and pair excitations are explained. Based on single-particle and
two-particle Green's functions, the Dyson and Bethe-Salpeter equations are derived. They are
applied to calculate spectral and response functions. Important spectra are those which can
be measured using photoemission/inverse photoemission, optical spectroscopy, and electron
energy loss/inelastic X-ray spectroscopy. Important approximations are derived and discussed
in the light of selected computational and experimental results. Some numerical
implementations available in well-known computer codes are critically discussed. The book is
divided into four parts: (i) In the first part the many-electron systems are described in the
framework of the quantum-field theory. The electron spin and the spin-orbit interaction are
taken into account. Sum rules are derived. (ii) The second part is mainly related to the
ground state of electronic systems. The total energy is treated within the density functional
theory. The most important approximations for exchange and correlation are delighted. (iii)
The third part is essentially devoted to the description of charged electronic excitations
such as electrons and holes. Central approximations as Hedin's GW and the T-matrix
approximation are discussed.(iv) The fourth part is focused on response functions measured in
optical and loss spectroscopies and neutral pair or collective excitations.

This invaluable textbook presents the basic elements needed to understand and research into
semiconductor physics. It deals with elementary excitations in bulk and low-dimensional
semiconductors, including quantum wells, quantum wires and quantum dots. The basic principles
underlying optical nonlinearities are developed, including excitonic and many-body plasma
effects. Fundamentals of optical bistability, semiconductor lasers, femtosecond excitation, the optical Stark effect, the semiconductor photon echo, magneto-optic effects, as well as bulk and quantum-confined Franz-Keldysh effects, are covered. The material is presented in sufficient detail for graduate students and researchers with a general background in quantum mechanics.

The book describes how the electrons in small "low-dimensional" structures interact with their surroundings. It contains a series of linked up to date review chapters as well as explanatory material and is written to be understandable to graduate students and newcomers to the field. All contributions come from leading scientists.

This book introduces the basic theoretical concepts required for the analysis of the optical response of semiconductor systems in the coherent regime. It is the most instructive textbook on the theory and optical effects of semiconductors. The entire presentation is based on a one-dimensional tight-binding model. Starting with discrete-level systems, increasing complexity is added gradually to the model by including band-structure and many-particle interaction. Various linear and nonlinear optical spectra and temporal phenomena are studied. The analysis of many-body effects in nonlinear optical phenomena covers a major part of the book.

This book contains all the papers presented at the NATO workshop on "Optical Switching in Low Dimensional Systems" held in Marbella, Spain from October 6th to 8th, 1988. Optical switching is a basic function for optical data processing, which is of technological interest because of its potential parallelism and its potential speed. Semiconductors which exhibit resonance enhanced optical nonlinearities in the frequency range close to the band edge are the most intensively studied materials for optical bistability and fast gate operation. Modern crystal growth techniques, particularly molecular beam epitaxy, allow the manufacture of semiconductor microstructures such as quantum wells, quantum wires and quantum dots in which the electrons are only free to move in two, one or zero dimensions, of the optically excited electron-hole pairs in these low respectively. The spatial confinement dimensional structures gives rise to an enhancement of the excitonic nonlinearities. Furthermore, the variations of the microstructure extensions, of the compositions, and of the doping offer great new flexibility in engineering the desired optical properties. Recently, organic chain molecules (such as polydiacetilene) which are different realizations of one dimensional electronic systems, have been shown also to have interesting optical nonlinearities. Both the development and study of optical and electro-optical devices, as well as experimental and theoretical investigations of the underlying optical nonlinearities, are contained in this book.

This volume investigates the theory of the effect of static electric fields on one-electron states in. nanocylindrical and nanospherical heterolayers and quantized semiconductor films. Homogeneous external electrostatic field for all these structures has been considered as a "universal" modulating factor. For structures with radial symmetry, a study on the influence of radial static field and the electric field of a charged ring on one-electron states is presented. Chapters focusing on homogeneous field effect on low-dimensional excitonic states in the quantized films and quantum wires - in both wide bandgap and narrowband semiconductors - are also included. Other contents include calculations weak, moderate and strong electric fields, quantum-mechanical approximation and perturbation theory, the quasi-classical approximation (WKB method). Readers will benefit from the varied methodological to the subject which gives them a concrete analytical framework to solve problems related to nanoscale semiconductor design. The reference should prove to be useful to academics and professionals working in semiconductor nanoelectronics research and development.

This report presents an account of the course "Nonlinear Spectroscopy of Solids: Advances and Applications" held in Erice, Italy, from June 16 to 30, 1993. This meeting was organized by the International School of Atomic and Molecular Spectroscopy of the "Ettore Majorana" Centre for Scientific Culture. The purpose of this course was to present and discuss physical models, mathematical formalisms, experimental techniques, and applications relevant to the subject of nonlinear spectroscopy of solid state materials. The universal availability and application of lasers in spectroscopy has led to the widespread observation of nonlinear effects in the spectroscopy of materials. Nonlinear spectroscopy encompasses many physical phenomena which have their origin in the monochromaticity, spectral brightness, coherence, power density and tunability of laser sources. Conventional spectroscopy assumes a linear dependence between the applied electromagnetic field and the induced polarization of atoms and molecules. The validity of this assumption rests on the fact that even the most powerful conventional sources of light produce a light intensity which is not strong enough to
equalize the rate of stimulated emission and that of the experimentally observed decay. A
different situation may arise when laser light sources are used, particularly pulsed lasers.
The use of such light sources can make the probability of induced emission comparable to, or
even greater than, the probability of the observed decay; in such cases the nonlinearity of
the response of the system is revealed by the experimental data and new properties, not
detectable by conventional spectroscopy, will emerge.

Nonlinear optics is a topic of much current interest that exhibits a great diversity. Some
publications on the subject are clearly physics, while others reveal an engineering bias;
some appear to be accessible to the chemist, while others may appeal to biological
understanding. Yet all purport to be non-linear optics so where is the underlying unity? The
answer is that the unity lies in the phenomena and the devices that exploit them, while the
diversity lies in the materials used to express the phenomena. This book is an attempt to
show this unity in diversity by bringing together contributions covering an unusually wide
range of materials, preceded by accounts of the main phenomena and important devices. Because
of the diversity, individual materials are treated in separate chapters by different expert
authors, while as editors we have shouldered the task of providing the unifying initial
chapters. Most main classes of nonlinear optical solids are treated: semiconductors, glasses,
ferroelectrics, molecular crystals, polymers, and Langmuir-Blodgett films. (However, liquid
crystals are not covered.) Each class of material is enough for a monograph in itself, and
this book is designed to be an introduction suitable for graduate students and those in
industry entering the area of nonlinear optics. It is also suitable in parts for final-year
undergraduates on project work. It aims to provide a bridge between traditional fields of
expertise and the broader field of nonlinear optics.

This coherent monograph describes and explains quantum phenomena in two-dimensional (2D)
electron systems with extremely strong internal interactions, which cannot be described by
the conventional Fermi-liquid approach. The central physical objects considered are the 2D
Coulomb liquid, of which the average Coulomb interaction energy per electron is much higher
than the mean kinetic energy, and the Wigner solid. The text provides a new and comprehensive
review of the remarkable properties of Coulomb liquids and solids formed on the free surface
of liquid helium and other interfaces. This book is intended for graduate students and
researchers in the fields of quantum liquids, electronic properties of 2D systems, and solid-
state physics. It includes different levels of sophistication so as to be useful for both
theorists and experimentalists. The presentation is largely self-contained, and also
describes some instructive examples that will be of general interest to solid-state
physicists.

Beginning graduate introduction to low-dimensional systems and their applications.

This book fills a gap between many of the basic solid state physics and materials
science books that are currently available. It is written for a mixed audience of
electrical engineering and applied physics students who have some knowledge of
elementary undergraduate quantum mechanics and statistical mechanics. This book, based on
an successful course taught at MIT, is divided pedagogically into three parts: (I)
Electronic Structure, (II) Transport Properties, and (III) Optical Properties. Each topic is
explained in the context of bulk materials and then extended to low-dimensional materials
where applicable. Problem sets review the content of each chapter to help students to
understand the material described in each of the chapters more deeply and to prepare them to
master the next chapters.

Less than a decade ago, lead halide perovskite semiconductors caused a sensation: Solar cells
exhibiting astonishingly high levels of efficiency. Recently, it became possible to
synthesize nanocrystals of this material as well. Interestingly, simply by controlling the
size and shape of these crystals, new aspects of this material literally came to light. These
nanocrystals have proven to be interesting candidates for light emission. In this thesis, the
recombination, dephasing and diffusion of excitons in perovskite nanocrystals is investigated
using time-resolved spectroscopy. All these dynamic processes have a direct impact on the
light-emitting device performance from a technology point of view. However, most importantly,
the insights gained from the measurements allowed the author to modify the nanocrystals such
that they emitted with an unprecedented quantum yield in the blue spectral range, resulting
in the successful implementation of this material as the active layer in an LED. This
represents a technological breakthrough, because efficient perovskite light emitters in this
wavelength range did not exist before.

The optical properties of semiconductors have played an important role since the
identification of semiconductors as "small" bandgap materials in the 1960s, due both to
their fundamental interest as a class of solids having specific optical propenies and to their many important applications. On the former aspect we can cite the fundamental edge absorption and its assignment to direct or indirect transitions, many-body effects as revealed by exciton formation and photoconductivity. On the latter aspect, large-scale applications such as LEDs and lasers, photovoltaic converters, photodetectors, electro-optics and non-linear optic devices, come to mind. The eighties saw a revitalization of the whole field due to the advent of heterostructures of lower-dimensionality, mainly two-dimensional quantum wells, which through their enhanced photon-matter interaction yielded new devices with unsurpassed performance. Although many of the basic phenomena were evidenced through the seventies, it was this impact on applications which in turn led to such a massive investment in fabrication tools, thanks to which many new structures and materials were studied, yielding further advances in fundamental physics.

The theory of electronic states in the traditionally solid state physics is essentially a theory of electronic states in crystals of infinite size. However, any real crystal always has a finite size. This book presents an analytical theory on the electronic states in ideal low-dimensional systems and finite crystals recently developed by the author based on a differential equation theory approach. It gives some exact and general fundamental understandings on the electronic states in ideal low-dimensional systems and finite crystals and provides new insights on some fundamental problems in low-dimensional systems such as the surface states, quantum confinement effects etc, some of them are quite different from what are traditionally believed in the solid state physics community.

This volume comprises the proceedings of the NATO Advanced Research Workshop on the Science and Engineering of 1- and 0-dimensional semiconductors held at the University of Cadiz from 29th March to 1st April 1989, under the auspices of the NATO International Scientific Exchange Program. There is a wealth of scientific activity on the properties of two-dimensional semiconductors arising largely from the ease with which such structures can now be grown by precision epitaxy techniques or created by inversion at the silicon-silicon dioxide interface. Only recently, however, has there burgeoned an interest in the properties of structures in which carriers are further confined with only one or, in the extreme, zero degrees of freedom. This workshop was one of the first meetings to concentrate almost exclusively on this subject: that the attendance of some forty researchers only represented the community of researchers in the field testifies to its rapid expansion, which has arisen from the increasing availability of technologies for fabricating structures with small enough (sub - 0. 1/\mu m) dimensions. Part I of this volume is a short section on important topics in nanofabrication. It should not be assumed from the brevity of this section that there is little new to be said on this issue: rather that to have done justice to it would have diverted attention from the main purpose of the meeting which was to highlight experimental and theoretical research on the structures themselves.

The conference "Nonlinear Optics and Optical Computing" was held May 11-19, 1988 in Erice, Sicily. This was the 13th conference organized by the International School of Quantum Electronics, under the auspices of the "Ettore Majorana" Center for Scientific Culture. This volume contains both the invited and contributed papers presented at the conference, providing tutorial background, the latest research results, and future directions for the devices, structures and architectures of optical computing. The invention of the transistor and the integrated circuit were followed by another explosion of application as ever faster and more complex microelectronics chips became available. The information revolution occurred by digital computers and optical communications is now reaching the limits of silicon semiconductor technology, but the demand for faster computation is still accelerating. The fundamental limitations of information processing today derive from the performance and cost of three technical factors: speed, density, and software. Optical computation offers the potential for improvements in all three of these critical areas: Speed is provided by the transmission of impulses at optical velocities, without the delays caused by parasitic capacitance in the case of conventional electrical interconnects. Speed can also be achieved through the massive parallelism characteristic of many optical computing architectures; Density can be provided in optical computers in two ways: by high spatial resolution, on the order of wavelengths of light, and by computation or interconnection in three dimensions.

This Briefs volume describes the properties and structure of elementary excitations in isotope low-dimensional structures. Without assuming prior knowledge of quantum physics, the present book provides the basic knowledge needed to understand the recent developments in the sub-disciplines of nanoscience isotopetronics, novel device concepts and materials for nanotechnology. It is the first and comprehensive interdisciplinary account of the newly developed scientific discipline isotopetronics.