Electron And Photon Confinement In Semiconductor Nanostructures Proceedings Of The International School Of Physics Enrico Fermi Course Cl

Since their discovery, low dimensional materials have never stopped to intrigue scientists, whether they are physicists, chemists, or biochemists. Investigations of their nature and functions have always been and still are numerous and as soon as a solution is found for a given question, another one is raised. The coupling of nano-materials with photonics, i. e. nano-photonics, has produced a boiling pot of idea, problems, discovery and applications. This statement is abundantly illustrated in the present book. The interest in nano-optoelectronic materials and systems is very widespread, what gives a really international and multicultural flavour to nano-optoelectronic meetings. One of them was organized by our-self in May 2000 in Kiev as a NATO Advanced Research Workshop and EC-Spring School. The arrival of the new millennium provides an obvious transition point at which many aspects of nano-science and nano-engineering of nano photonic systems can be assessed with respect to the research progresses made in the pre ceding decades and to the challenges that lie ahead in the coming decades. This book was planed to mark this with the objective of presenting a collection of papers from experts, which provide broad perspectives on the

state-of-the-art in the various disciplines of nano science and nano-engineering and on the directions for future research.

Nanophotonics has emerged as a major technology and applications domain, exploiting the interaction of light-emitting and light-sensing nanostructured materials. These devices are lightweight, highly efficient, low on power consumption, and are cost effective to produce. The authors of this book have been involved in pioneering work in manufacturing photonic devices from carbon nanotube (CNT) nanowires and provide a series of practical guidelines for their design and manufacture, using processes such as nano-robotic manipulation and assembly methods. They also introduce the design and operational principles of opto-electrical sensing devices at the nano scale. Thermal annealing and packaging processes are also covered, as key elements in a scalable manufacturing process. Examples of applications of different nanowire based photonic devices are presented. These include applications in the fields of electronics (e.g. FET, CNT Schotty diode) and solar energy. Discusses opto-electronic nanomaterials, characterization and properties from an engineering perspective, enabling the commercialization of key emerging technologies Provides scalable techniques for nanowire structure growth, manipulation and assembly (i.e. synthesis) Explores key application areas such as sensing, electronics and solar energy

The optical properties of semiconductors have played an important role since the identification of semiconductors as "small" bandgap materials in the thinies, due both to

their fundamental interest as a class of solids baving 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 sucb 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 funher advances in fundamental physics.

For ten days at the end of September, 1987, a group of about 75 scientists from 21 different countries gathered in a restored monastery on a 750 meter high piece of rock jutting out of the Mediterranean Sea to discuss the simulation of the transport of electrons and photons using Monte Carlo techniques. When we first had the idea for this meeting, Ralph Nelson, who had organized a previous course at the "Ettore Majorana" Centre for Scientific Culture, suggested that Erice would be the ideal place for such a meeting. Nahum, Nelson and Rogers became Co-Directors of the Course, with the

help of Alessandro Rindi, the Director of the School of Radiation Damage and Protection, and Professor Antonino Zichichi, Director of the "Ettore Majorana" Centre. The course was an outstanding success, both scientifically and socially, and those at the meeting will carry the marks of having attended, both intellectually and on a personal level where many friendships were made. The scientific content of the course was at a very high caliber, both because of the hard work done by all the lecturers in preparing their lectures (e. g. , complete copies of each lecture were available at the beginning of the course) and because of the high quality of the "students", many of whom were accomplished experts in the field. The outstanding facilities of the Centre contributed greatly to the success. This volume contains the formal record of the course lectures.

Providing a clear theoretical understanding of MEMS and NEMS, Solid-State Physics, Fluidics, and Analytical Techniques in Micro- and Nanotechnology focuses on nanotechnology and the science behind it, including solid-state physics. It provides a clear understanding of the electronic, mechanical, and optical properties of solids relied on in integrated circuits (ICs), MEMS, and NEMS. After exploring the rise of Si, MEMS, and NEMS in a historical context, the text discusses crystallography, quantum mechanics, the band theory of solids, and the silicon single crystal. It concludes with coverage of photonics, the quantum hall effect, and superconductivity. Fully illustrated in color, the text offers end-of-chapter problems, worked examples, extensive references, and a comprehensive glossary of terms.

Topics include: Crystallography and the crystalline materials used in many semiconductor devices Quantum mechanics, the band theory of solids, and the relevance of quantum mechanics in the context of ICs and NEMS Single crystal Si properties that conspire to make Si so important Optical properties of bulk 3D metals, insulators, and semiconductors Effects of electron and photon confinement in lower dimensional structures How evanescent fields on metal surfaces enable the guiding of light below the diffraction limit in plasmonics Metamaterials and how they could make for perfect lenses, changing the photonic field forever Fluidic propulsion mechanisms and the influence of miniaturization on fluid behavior Electromechanical and optical analytical processes in miniaturized components and systems The first volume in Fundamentals of Microfabrication and Nanotechnology, Third Edition, Three-Volume Set, the book presents the electronic, mechanical, and optical properties of solids that are used in integrated circuits, MEMS, and NEMS and covers quantum mechanics, electrochemistry, fluidics, and photonics. It lays the foundation for a qualitative and quantitative theoretical understanding of MEMS and NEMS.

Bulletin of the STEFAN UNIVERSITY: Semiconductor Science and Technology—1998; ISSN: 1098-1632.: Stefan Frontier Conferences (Frontier Science Research Conferences--FSRC); La Jolla, California, September 7-11, 1998; @1998, The Stefan University Press

Providing a clear theoretical understanding of MEMS and NEMS, Solid-State Physics, Fluidics, and Analytical

Techniques in Micro- and Nanotechnology focuses on nanotechnology and the science behind it, including solid-state physics. It provides a clear understanding of the electronic, mechanical, and optical properties of solids relied on in integra

The purpose of this course was to give an overview of the physics of artificial semiconductor structures confining electrons and photons. It furnishes the background for several applications in particular in the domain of optical devices, lasers, light emitting diodes or photonic crystals. The effects related to the microactivity polaritons, which are mixed electromagnetic radiation-exciton states inside a semiconconductor microactivity are covered. The study of the characteristics of such states shows strong relations with the domain of cavity quantum electrodynamics and thus with the investigation of some fundamental theoretical concepts.

This reference offers tools for engineers, scientists, biologists, and others working with the computational techniques of nanophotonics. It introduces the key concepts of computational methods in a manner that is easily digestible for newcomers to the field. The book also examines future applications of nanophotonics in the technical industry and covers new developments and interdisciplinary research in engineering, science, and medicine. It provides an overview of the key computational nanophotonics and describes the technologies with an emphasis on how they work and their key benefits.

Electron and photon confinement in semiconductor nanostructures is one of the most active areas in solid

state research. Written by leading experts in solid state physics, this book provides both a comprehensive review as well as a excellent introduction to fundamental and applied aspects of light-matter coupling in microcavities. Topics covered include parametric amplification and polariton liquids, quantum fluid and non-linear dynamical effects and parametric instabilities, polariton squeezing, Bose-Einstein condensation of microcavity polaritons, spin dynamics of exciton-polaritons, polariton correlation produced by parametric scattering, progress in III-nitride distributed Bragg reflectors using AlInN/GaN materials, high efficiency planar MCLEDs, exciton-polaritons and nanoscale cavities in photonic crystals, and MBE growth of high finesse microcavities.

This book deals with a topic of vital importance to the design and function of nanodevices. It covers combined systems of electrons and electromagnetic fields at nanometer scales. When the dimensions of an electromagnetic field reach the nanometer scale, it is impossible to determine whether it is an electromagnetic phenomenon or an excited electronic system. This volume covers this interdisciplinary field, with contributions from both the electronic system and electromagnetic areas.

This book is intended to be used by materials and device physicists and also solar cells researchers. It models the performance characteristics of nanostructured solar cells and resolves the dynamics of transitions between several levels of these devices. An outstanding insight into the physical behaviour of these devices is provided, which complements experimental work. This therefore

allows a better understanding of the results, enabling the development of new experiments and optimization of new devices. It is intended to be accessible to researchers, but also to provide engineering tools which are often only accessible to quantum physicists. Photon Absorption Models in Nanostructured Semiconductor Solar Cells and Devices is intended to provide an easy-to-handle means to calculate the light absorption in nanostructures, the final goal being the ability to model operational behaviour of nanostructured solar cells. It allows researchers to design new experiments and improve solar cell performances, and offers a means for the easy approximate calculation of the energy spectrum and photon absorption coefficients of nanostructures. This calculation is based on the effective mass model and uses a new Hamiltonian called the Empirical kp Hamiltonian, which is based on a four band kp model. Nanoscale Science and Technology summarizes six years of active research sponsored by NATO with the participation of the leading experts. The book provides an interdisciplinary view of several aspects of physics at the atomic scale. It contains an overview of the latest findings on the transport of electrons in nanowires and nanoconstrictions, the role of forces in probe microscopy, the control of structures and properties in the nanometer range, aspects of magnetization in nanometric structures, and local probes for nondestructive measurement as provided by light and metal clusters near atomic scales.

The only comprehensive treatment of nanophotonics currently available Photonics is an all-encompassing optical science and technology which has impacted a diverse range of fields, from information technology to health care. Nanophotonics is photonic science and technology that utilizes light-matter interactions on the nanoscale, where researchers are discovering new phenomena and developing technologies that go well beyond what is possible with conventional photonics and electronics. These new technologies could include efficient solar power generation, high-bandwidth and high-speed communications, high-capacity data storage, and flexible- and high-contrast displays. In addition, nanophotonics will continue to impact biomedical technologies by providing new and powerful diagnostic techniques, as well as light-guided and activated therapies. Nanophotonics provides the only available comprehensive treatment of this exciting, multidisciplinary field, offering a wide range of topics covering: * Foundations * Materials * Applications * Theory * Fabrication Nanophotonics introduces students to important and timely concepts and provides scientists and engineers with a cutting-edge reference. The book is intended for anyone who wishes to learn about light-matter interactions on the nanoscale, as well as applications of photonics for nanotechnology and nanobiotechnology. Written by an acknowledged leader in the field, this text

provides an essential resource for those interested in the future of materials science and engineering, nanotechnology, and photonics.

Foreword by Charles H Townes This volume includes highlights of the theories underlying the essential phenomena occurring in novel semiconductor lasers as well as the principles of operation of selected heterostructure lasers. To understand scattering processes in heterostructure lasers and related optoelectronic devices, it is essential to consider the role of dimensional confinement of charge carriers as well as acoustical and optical phonons in quantum structures. Indeed, it is important to consider the confinement of both phonons and carriers in the design and modeling of novel semiconductor lasers such as the tunnel injection laser, quantum well intersubband lasers, and quantum dot lasers. The full exploitation of dimensional confinement leads to the exciting new capability of scattering time engineering in novel semiconductor lasers.As a result of continuing advances in techniques for growing quantum heterostructures, recent developments are likely to be followed in coming years by many more advances in semiconductor lasers and optoelectronics. As our understanding of these devices and the ability to fabricate them grow, so does our need for more sophisticated theories and simulation methods bridging the gap between

quantum and classical transport.
A comprehensive survey of recent theoretical and experimental progress in the area of electron-photon interaction and dense media. A state-of-the-art discussion of radiation production, with descriptions of new ideas and technologies that enhance the production of X-rays in the form of channelling, transition and parametric X-ray production. Progress in electron beam physics to produce sub-picosecond electron bunches from low-energy linear accelerators make it possible to produce coherent, high brightness, submillimeter radiation and sub-picosecond X-ray pulses. Micro-undulators in the form of bent crystalline structures hold great promise as future X-ray sources.
This book proposes and reviews comprehensive strategies based on optical electronics for constructing optoelectronic systems with minimized optics excess. It describes the core technologies such as self-organized optical waveguides based on self-organized lightwave network (SOLNET), three-dimensional optical circuits, material-saving heterogeneous thin-film device integration process (PL-Pack with SORT), and high-speed/small-size light modulators and optical switches. The book also presents applications of optical electronics, including integrated optical interconnects within computers and massive optical switching systems utilizing three-dimensional self-organized optical circuits, solar

energy conversion systems, and bio/medical photonics such as cancer therapy.

This book provides a comprehensive view of the contemporary methods for quantum-light engineering. In particular, it addresses different technological branches and therefore allows the reader to quickly identify the best technology - application match. Non-classical light is a versatile tool, proven to be an intrinsic part of various quantum technologies. Its historical significance has made it the subject of many text books written both from theoretical and experimental point of view. This book takes another perspective by giving an insight to modern technologies used to generate and manipulate quantum light.

With full color throughout, this unique text provides an accessible yet rigorous introduction to the basic principles, technology, and applications of nanophotonics. It explains key physical concepts such as quantum confinement in semiconductors, light confinement in metal and dielectric nanostructures, and wave coupling in nanostructures, and describes how they can be applied in lighting sources, lasers, photonic circuitry, and photovoltaic systems. Readers will gain an intuitive insight into the commercial implementation of nanophotonic components, in both current and potential future devices, as well as challenges facing the field. The fundamentals of semiconductor optics,

optical material properties, and light propagation are included, and new and emerging fields such as colloidal photonics, Si-based photonics, nanoplasmonics, and bioinspired photonics are all discussed. This is the 'go-to' guide for graduate students and researchers in electrical engineering who are interested in nanophotonics, and students taking nanophotonics courses.

Terahertz physics covers one of the least explored but richest regions of the electromagnetic spectrum. Designed for independent learning, this is the first book to open up this exciting new field to students of science and engineering. Written in a clear and consistent style, the textbook focuses on an understanding of fundamental physical principles at terahertz frequencies and their applications. Part I outlines the foundations of terahertz science, starting with the mathematical representation of oscillations before exploring terahertz-frequency light, terahertz phenomena in matter and the terahertz interactions between light and matter. Part II covers components of terahertz technology, from sources of terahertz frequency radiation, through the manipulation of the radiation, to its detection. Part III deals with applications, including time-domain spectroscopy. Highlighting modern developments and concepts, the book is ideal for self-study. It features precise definitions, clear explanations, instructive illustrations, fully worked examples, numerous

exercises and a comprehensive glossary.
As the proceedings of the most important and prestigious conference in the field of semiconductor physics, this book contains the latest information on the progress of semiconductor physics. Almost 1000 contributed papers address the full range of current topics. The special symposium deals with the interface between the fundamentals and device applications and tries to predict the developments in semiconductor physics, semiconductor materials and device applications in the 21st century. A wide range of contributions represent the forefront of academic and industrial research.
These three volumes are intended to shape the field of nanoscience and technology and will serve as anessential point of reference for cutting-edge research in the field.
Bringing together widely scattered information, Nanosensors: Physical, Chemical, and Biological explores sensor development in the nanotechnology age. This easy-to-read book presents a critical appraisal of the new opportunities in the area of sensors provided by nanotechnologies and nanotechnology-enabled advancements. After introducing nanosensor classification and fundamental terms, the book outlines the properties of important nanomaterials and nanotechnologies used in nanosensor fabrication. Subsequent chapters are organized according to nanosensor

type: physical (mechanical and acoustical, thermal and radiation, optical, and magnetic); chemical (atomic and molecular energies); and biological. The final chapter summarizes the current state of the field and discusses future trends. A complete and authoritative guide to nanosensors, this book offers up-to-date information on the fabrication, properties, and operating mechanisms of these fast and reliable sensors. It addresses progress in the field, fundamental issues and challenges facing researchers, and prospects for future development. Semiconductor Quantum Dots presents an overview of the background and recent developments in the rapidly growing field of ultrasmall semiconductor microcrystallites, in which the carrier confinement is sufficiently strong to allow only quantized states of the electrons and holes. The main emphasis of this book is the theoretical analysis of the confinement induced modifications of the optical and electronic properties of quantum dots in comparison with extended materials. The book develops the theoretical background material for the analysis of carrier quantum-confinement effects, introduces the different confinement regimes for relative or center-of-mass motion quantization of the electron-hole-pairs, and gives an overview of the best approximation schemes for each regime. A detailed discussion of the carrier states in quantum dots is presented and surface polarization instabilities are

analyzed, leading to the self-trapping of carriers near the surface of the dots. The influence of spin-orbit coupling on the quantum-confined carrier states is discussed. The linear and nonlinear optical properties of small and large quantum dots are studied in detail and the influence of the quantum-dot size distribution in many realistic samples is outlined. Phonons in quantum dots as well as the influence of external electric or magnetic fields are also discussed. Last but not least the recent developments dealing with regular systems of quantum dots are also reviewed. All things included, this is an important piece of work on semiconductor quantum dots not to be dismissed by serious researchers and physicists. Contents: IntroductionTheoretical Concepts, Quantum Confinement RegimesElectron-Hole-Pair StatesOptical Properties of Small DotsOptical Properties of Large DotsPhonons and External FieldsCoupled Quantum DotsAppendix: Asymptotic Cluster Growth Laws Readership: Condensed matter physicists, researchers in laser and optical science. keywords:Absorption;Configuration Interaction;Confinement Energy;Excitons;Biexcitons;Confinement Regime;Spin-Orbit Coupling;Angular Momentum Fiber Optic Measurement Techniques is an indispensable collection of key optical measurement techniques essential for developing and

characterizing today's photonic devices and fiber optic systems. The book gives comprehensive and systematic descriptions of various fiber optic measurement methods with the emphasis on the understanding of optoelectronic signal processing methodologies, helping the reader to weigh up the pros and cons of each technique and establish their suitability for the task at hand. Carefully balancing descriptions of principle, operations and optoelectronic circuit implementation, this indispensable resource will enable the engineer to: Understand the implications of various measurement results and system performance qualifications Characterize modern optical systems and devices Select optical devices and subsystems in optical network design and implementation Design innovative instrumentations for fiber optic systems This book brings together in one volume the fundamental principles with the latest techniques, making it a complete resource for the optical and communications engineer developing future optical devices and fiber optic systems. "Optical fiber communication systems and networks constitute the core of the telecom infrastructure of the information society worldwide. Accurate knowledge of the properties of the contituent components, and of the performance of the subsystems and systems must be obtained in order to ensure reliable transmission, distribution, and delivery of information. This book is

an authoritative and comprehensive treatment of fiber-optic measurement techniques, including not only fundamental principles and methodologies but also various instrumentations and practical implementations. It is an excellent up-to-date resource and reference for the academic and industrial researcher as well as the field engineer in manufacturing and network operations." –Dr. Tingye Li, AT&T Labs (retired) Rongqing Hui received his PhD in Electrical Engineering from Politecnico di Torino, Italy in 1993. He is currently a tenured professor in the department of Electrical Engineering and Computer Science at the University of Kansas. He has published more than 90 refereed technical papers in the area of fiber-optic communications and holds 13 patents. Dr. Hui currently serves as an Associate Editor of IEEE Transactions on Communications. Maurice O'Sullivan has worked for Nortel for a score of years, at first in the optical cable business, developing factory-tailored metrology for optical fiber, but, in the main, in the optical transmission business developing, modeling and verifying physical layer designs & performance of Nortel's line and highest rate transmission product including OC-192, MOR, MOR+, LH1600G, eDCO and eDC40G. He holds a Ph.D. in physics (high resolution spectroscopy) from the University of Toronto, is a Nortel Fellow and has been granted more than 30 patents. The only book to combine

explanations of the basic principles with latest techniques to enable the engineer to develop photonic systems of the future Careful and systematic presentation of measurement methods to help engineers to choose the most appropriate for their application The latest methods covered, such as real-time optical monitoring and phase coded systems and subsystems, making this the most up-to-date guide to fiber optic measurement on the market The physics of strong light-matter coupling has been addressed in different scientific communities over the last three decades. Since the early eighties, atoms coupled to optical and microwave cavities have led to pioneering demonstrations of cavity quantum electrodynamics, Gedanken experiments, and building blocks for quantum information processing, for which the Nobel Prize in Physics was awarded in 2012. In the framework of semiconducting devices, strong coupling has allowed investigations into the physics of Bose gases in solid-state environments, and the latter holds promise for exploiting light-matter interaction at the single-photon level in scalable architectures. More recently, impressive developments in the so-called superconducting circuit QED have opened another fundamental playground to revisit cavity quantum electrodynamics for practical and fundamental purposes. This book aims at developing the necessary interface between these communities,

by providing future researchers with a robust conceptual, theoretical and experimental basis on strong light-matter coupling, both in the classical and in the quantum regimes. In addition, the emphasis is on new forefront research topics currently developed around the physics of strong light-matter interaction in the atomic and solid-state scenarios.

This book reviews a range of quantum phenomena in novel nanoscale transistors called FinFETs, including quantized conductance of 1D transport, single electron effect, tunneling transport, etc. The goal is to create a fundamental bridge between quantum FinFET and nanotechnology to stimulate readers' interest in developing new types of semiconductor technology. Although the rapid development of micro-nano fabrication is driving the MOSFET downscaling trend that is evolving from planar channel to nonplanar FinFET, silicon-based CMOS technology is expected to face fundamental limits in the near future. Therefore, new types of nanoscale devices are being investigated aggressively to take advantage of the quantum effect in carrier transport. The quantum confinement effect of FinFET at room temperatures was reported following the breakthrough to sub-10nm scale technology in silicon nanowires. With chapters written by leading scientists throughout the world, Toward Quantum FinFET provides a comprehensive introduction to the field as well as a platform for

knowledge sharing and dissemination of the latest advances. As a roadmap to guide further research in an area of increasing importance for the future development of materials science, nanofabrication technology, and nano-electronic devices, the book can be recommended for Physics, Electrical Engineering, and Materials Science departments, and as a reference on micro-nano electronic science and device design. Offers comprehensive coverage of novel nanoscale transistors with quantum confinement effect Provides the keys to understanding the emerging area of the quantum FinFET Written by leading experts in each research area Describes a key enabling technology for research and development of nanofabrication and nanoelectronic devices

Quantum dots (QDs) are luminescent semiconductor nanocrystals with unique chemical and physical properties due to their size and highly compact structure. QDs were first proposed for use in luminescent concentrators to replace organic dye molecules. In this book, the interest is in taking advantage of the emission properties of QDS, which can be tuned by their size, resulting from quantum confinement. In addition, the book discusses the potential of QDs as contrast and therapeutic agents in the field of medicine.

This volume contains the papers presented at the 7th International Conference on Object Oriented

Information Systems - OOIS 2001. The conference was hosted by the University of Calgary, Calgary, Canada on 27 - 29 August 2001. The theme of OOIS1 was Object-Oriented and Web-Based Frameworks for Information Systems. The papers published in this volume highlight the contributions of leading researchers and practitioners in the field of Object Technology and Information Systems. The topics covered include: OO foundations, OO modeling and analysis, OOIS processes, XML-based IS, OO-based reuse, OO frameworks, OO and web testing, Use case for requirement analysis, OO CASE tools, OO virtual environments and real-time systems, IT process assessment and improvement, Industrial experience and case studies, Web-based IS, Component-based OOIS, Software engineering metrics and analysis, Production line and requirements engineering, GRIDs: the next generation technologies for the Internet, E-Business Enterprise Frameworks, and Perspectives on future development.

Hype, hope, or horror? A vivid look at nanotechnology, written by an insider and experienced science writer. The variety of new products and technologies that will spin out of nanoscience is limited only by the imagination of the scientists, engineers and entrepreneurs drawn to this new field. Steve Edwards concentrates on the reader's self interest: no military gadgets, wild

fantasies of horror nanobot predators and other sci-fi stuff, but presents a realistic view of how this new field of technology will affect people in the near future. He is in close contact with many pioneers in nanotechnology, and includes their backgrounds to allow readers, especially college students considering a career in the field, to better imagine themselves in such positions. However, technology does not develop in a vacuum, and this book also looks at the social, political and economic changes attendant upon the development of nanotechnology. For the science-interested general public as well as chemists, students, lecturers, chemical organizations, materials scientists, journalists, politicians, industry, physicists, and biologists.