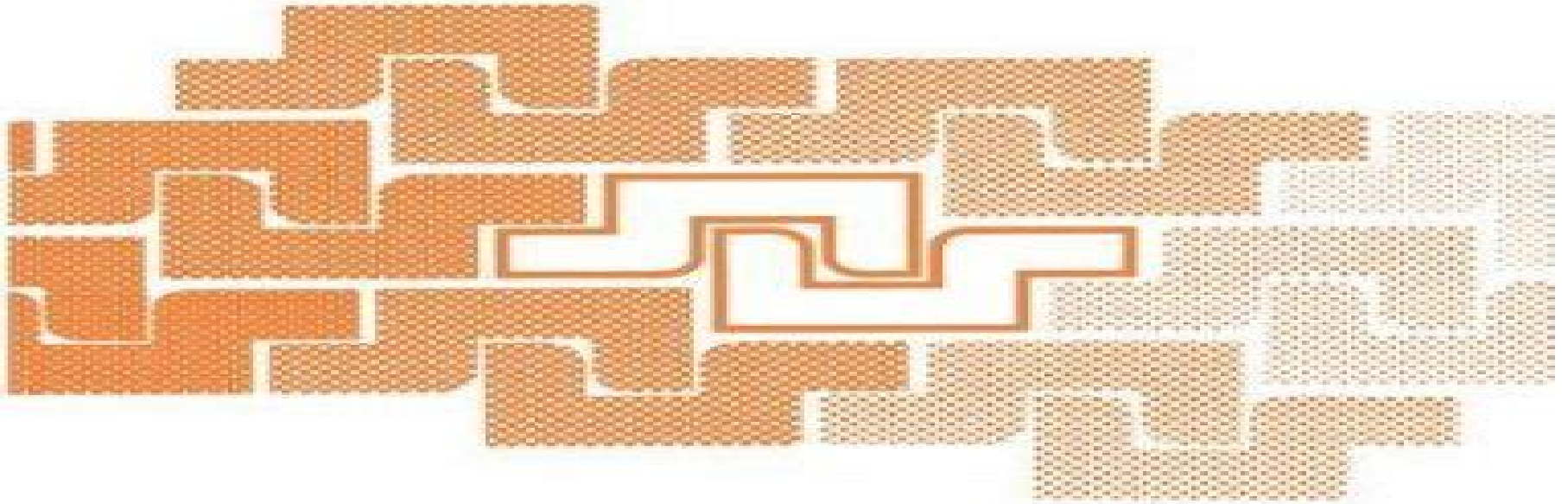

Phonons in Semiconductor Nanostructures

Edited by
Jean-Pierre Leburton, Jordi Pascual
and Clivia Sotomayor Torres

NATO ASI Series

Series E: Applied Sciences - Vol. 236

Phonons In Semiconductor Nanostructures

Vasilios N. Stavrou

Phonons In Semiconductor Nanostructures:

Phonons in Semiconductor Nanostructures J.P. Leburton,J. Pascual,Clivia M. Sotomayor Torres,2012-12-06 In the last ten years the physics and technology of low dimensional structures has experienced a tremendous development Quantum structures with vertical and lateral confinements are now routinely fabricated with feature sizes below 100 run While quantization of the electron states in mesoscopic systems has been the subject of intense investigation the effect of confinement on lattice vibrations and its influence on the electron phonon interaction and energy dissipation in nanostructures received atten tion only recently This NATO Advanced Research Workshop on Phonons in Sem iconductor Nanostructures was a forum for discussion on the latest developments in the physics of phonons and their impact on the electronic properties of low dimensional structures Our goal was to bring together specialists in lattice dynamics and nanos tructure physics to assess the increasing importance of phonon effects on the physical properties of one lD and zero dimensional OD structures The Workshop addressed various issues related to phonon physics in III V II VI and IV semiconductor nanostructures The following topics were successively covered Models for confined phonons in semiconductor nanostructures latest experimental observations of confined phonons and electron phonon interaction in two dimensional systems elementary excitations in nanostructures phonons and optical processes in reduced dimensionality systems phonon limited transport phenomena hot electron effects in quasi ID structures carrier relaxation and phonon bottleneck in quantum dots **Electron-phonon Interactions in Low-dimensional Structures** Lawrence John Challis,2003 The study of electrons and holes confined to two one and even zero dimensions has uncovered a rich variety of new physics and applications This book describes the interaction between these confined carriers and the optic and acoustic phonons within and around the confined regions Phonons provide the principal channel of energy transfer between the carriers and their surroundings and also the main restriction to their room temperature mobility But they have many other roles they provide for example an essential feature of the operation of the quantum cascade laser Since their momenta at relevant energies are well matched to those of electrons they can also be used to probe electronic properties such as the confinement width of 2D electron gases and the dispersion curve of quasiparticles in the fractional quantum Hall effect The book describes both the physics of the electron phonon interaction in the different confined systems and the experimental and theoretical techniques that have been used in its investigation The experimental methods include optical and transport techniques as well as techniques in which phonons are used as the experimental probe The aim of the book is to provide an up to date review of the physics and its significance in device performance It is also written to be explanatory and accessible to graduate students and others new to the field **Modeling Phonons in Semiconductor Nanostructures** ,2007 *Phonons in Nanostructures* Michael A. Stroscio,Mitra Dutta,2001-08-23 This book focuses on the theory of phonon interactions in nanoscale structures with particular emphasis on modern electronic and optoelectronic devices The continuing progress in

the fabrication of semiconductor nanostructures with lower dimensional features has led to devices with enhanced functionality and even novel devices with new operating principles The critical role of phonon effects in such semiconductor devices is well known There is therefore a great need for a greater awareness and understanding of confined phonon effects A key goal of this book is to describe tractable models of confined phonons and how these are applied to calculations of basic properties and phenomena of semiconductor heterostructures The level of presentation is appropriate for undergraduate and graduate students in physics and engineering with some background in quantum mechanics and solid state physics or devices A basic understanding of electromagnetism and classical acoustics is assumed Confined Electrons and Photons Elias Burstein,Claude Weisbuch,2012-12-06 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 **Hot Carriers in Semiconductor Nanostructures** Jagdeep Shah,2012-12-02 Nonequilibrium hot charge carriers play a crucial role in the physics and technology of semiconductor nanostructure devices This book one of the first on the topic discusses fundamental aspects of hot carriers in quasi two dimensional systems and the impact of these carriers on semiconductor devices The work will provide scientists and device engineers with an authoritative review of the most exciting recent developments in this rapidly moving field It should be read by all those who wish to learn the fundamentals of contemporary ultra small ultra fast semiconductor devices Topics covered include Reduced dimensionality and quantum wells Carrier phonon interactions and hot phonons Femtosecond optical studies of hot carrier Ballistic transport Submicron and resonant tunneling devices **Phonon Interactions in Novel Semiconductor Nanostructures** ,1996 During this research effort numerous interactions of confined phonons in nanostructures have been modelled theoretically these include piezoelectric scattering in cylindrical quantum wires generalized piezoelectric scattering rate for elections in a two dimensional election gas Gamma X transitions driven by interface phonons interface optical modes in cylindrical quantum wires microscopic model for election optical phonon interactions in quantum wells optical phonons in quantum dots electron acoustic phonon scattering in both rectangular and cylindrical quantum wires and acoustic modes in

quantum wires and dots Physics of Semiconductors and Nanostructures Jyoti Prasad Banerjee,Suranjana Banerjee,2019-06-11 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

Hybrid Phonons in Nanostructures B. K. Ridley,2017 The book provides a technical account of the basic physics of nanostructures which are the foundation of the hardware found in all manner of computers It will be of interest to semiconductor physicists and electronic engineers and advanced research students Crystalline nanostructures have special properties associated with electrons and lattice vibrations and their interaction The result of spatial confinement of electrons is indicated in the nomenclature of nanostructures quantum wells quantum wires quantum dots Confinement also has a profound effect on lattice vibrations The documentation of the confinement of acoustic modes goes back to Lord Rayleigh s work in the late nineteenth century but no such documentation exists for optical modes It is only comparatively recently that any theory of the elastic properties of optical modes exists and a comprehensive account is given in this book A model of the lattice dynamics of the diamond lattice is given that reveals the quantitative distinction between acoustic and optical modes and the difference of connection rules that must apply at an interface The presence of interfaces in nanostructures forces the hybridization of longitudinally and transversely polarized modes along with in polar material electromagnetic modes Hybrid acoustic and optical modes are described with an emphasis on polar optical phonons and their interaction with electrons Scattering rates in single heterostructures quantum wells and quantum wires are described and the anharmonic interaction in quantum dots discussed A description is given of the effects of dynamic screening of hybrid polar modes and the production of hot phonons *Electron and Photon Confinement in Semiconductor Nanostructures* Benoît Deveaud,Antonio Quattropani,Paolo Schwendimann,Società italiana di fisica,2003 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 Semiconductor Nanocrystal Quantum Dots Andrey Rogach,2008-09-02 When investigations on semiconductor nanocrystal quantum dots started more than a quarter of a century ago no one ever believed that nanoparticle research would develop into one of the major fields in modern science The basis was laid by studies of photocatalysis and artificial water splitting driven by the former oil crisis These euphorically started activities ebbed away more and more when on one side oil brimmed over again and the scientists on the other did not succeed in the concomitant formation of hydrogen and oxygen At the same time size quantisation was discovered in nanocrystals initiating a fruitful research field on scaling laws of physical and chemical properties of quantum dots Especially optical investigations of semiconductor nanocrystals led to fas nating scientific results and to applications in optoelectronics and biolabeling Advances in spectroscopic measurements were always correlated with advances in synthesis The better the size shape and surface control of the particles was developed the more detailed and precise was the spectroscopic information tained Applications of nanocrystal quantum dots often require asssembly processes for the formation of polymer hybrids or thin films For this as well as for the use in biomedical applications new ligand chemistry needed to be developed during the recent past This book gives a very competent view on all these facets of nanocrystal quantum dot research Twelve chapters are written by experts in the fields in a way introducing the respective concepts and providing comprehensive overview on the current state of the art *Ultrafast Dynamical Processes in Semiconductors* Kong-Thon Tsen,2004-02-25 An international team of experts describes the optical and electronic properties of semiconductors and semiconductor nanostructures at picosecond and femtosecond time scales The contributions cover the latest research on a wide range of topics In particular they include novel experimental techniques for studying and characterizing nanostructure materials The contributions are written in a tutorial way so that not only researchers in the field but also researchers and graduate students outside the field can benefit *Electron Phonon Interactions in Semiconductor Nanostructures* Segi Yu,1997 *Fundamentals of Semiconductors* Peter YU,Manuel Cardona,2010-04-07 Excellent bridge between general solid state physics textbook and research articles packed with providing detailed explanations of the electronic vibrational transport and optical properties of semiconductors The most striking feature of the book is its modern outlook provides a wonderful foundation The most wonderful feature is its efficient style of exposition an excellent book Physics Today Presents the theoretical derivations carefully and in detail and gives thorough discussions of the experimental results it presents This makes it an excellent textbook both for learners and for more experienced researchers wishing to check facts I have enjoyed reading it and strongly recommend it as a text for anyone working with semiconductors I know of no better text I am sure most semiconductor physicists will find this book useful and I recommend

it to them Contemporary Physics Offers much new material an extensive appendix about the important and by now well established deep center known as the DX center additional problems and the solutions to over fifty of the problems at the end of the various chapters *Phonons in Low Dimensional Structures* Vasilios N. Stavrou,2018-12-12 The field of low dimensional structures has been experiencing rapid development in both theoretical and experimental research Phonons in Low Dimensional Structures is a collection of chapters related to the properties of solid state structures dependent on lattice vibrations The book is divided into two parts In the first part research topics such as interface phonons and polaron states carrier phonon non equilibrium dynamics directional projection of elastic waves in parallel array of N elastically coupled waveguides collective dynamics for longitudinal and transverse phonon modes and elastic properties for bulk metallic glasses are related to semiconductor devices and metallic glasses devices The second part of the book contains among others topics related to superconductor phononic crystal carbon nanotube devices such as phonon dispersion calculations using density functional theory for a range of superconducting materials phononic crystal based MEMS resonators absorption of acoustic phonons in the hyper sound regime in fluorine modified carbon nanotubes and single walled nanotubes phonon transport in carbon nanotubes quantization of phonon thermal conductance and phonon Anderson localization **Predicting Phonon Transport in Semiconductor Nanostructures Using Atomistic Calculations and the Boltzmann Transport Equation** Daniel P. Sellan,2012 **Raman Scattering on Emerging Semiconductors and Oxides** Zhe Feng,2024-09-16 Raman Scattering on Emerging Semiconductors and Oxides presents Raman scattering studies It describes the key fundamental elements in applying Raman spectroscopies to various semiconductors and oxides without complicated and deep Raman theories Across nine chapters it covers SiC and IV IV semiconductors III GaN and nitride semiconductors III V and II VI semiconductors ZnO based and GaO based semiconducting oxides Graphene ferroelectric oxides and other emerging materials Wide bandgap semiconductors of SiC GaN and ZnO and Ultra wide gap semiconductors of AlN Ga2O3 and graphene Key achievements from the author and collaborators in the above fields are referred to and cited with typical Raman spectral graphs and analyses Written for engineers scientists and academics this comprehensive book will be fundamental for newcomers in Raman spectroscopy Zhe Chuan Feng has had an impressive career spanning many years of important work in engineering and tech including as a professor at the Graduate Institute of Photonics establishing the Science Exploring Lab joining Kennesaw State University as an adjunct professor part time and at the Department of Electrical and Computer Engineering Southern Polytechnic College of Engineering and Engineering Technology Currently he is focusing on materials research for LED III nitrides SiC ZnO other semiconductors oxides and nanostructures and has devoted time to materials research and growth of III V and II VI compounds LED III nitrides SiC ZnO GaO and other semiconductors oxides Professor Feng has also edited and published multiple review books in his field alongside authoring scientific journal papers and conference proceeding papers He has organized symposiums and been an invited speaker at

different international conferences and universities He has also served as a guest editor for special journal issues

Ultrafast Spectroscopy of Semiconductors and Semiconductor Nanostructures Jagdeep Shah,1999-06 Ultrafast spectroscopy of semiconductors and semiconductor nanostructures is currently one of the most exciting areas of research in condensed matter physics Remarkable recent progress in the generation of tunable femtosecond pulses has allowed direct investigation of the most fundamental dynamical processes in semiconductors This second edition presents the most striking recent advances in the techniques of ultrashort pulse generation and ultrafast spectroscopy it discusses the physics of relaxation tunneling and transport dynamics in semiconductors and semiconductor nanostructures following excitation by femtosecond laser pulses **Hot Carriers in Semiconductors** Karl Hess,J.P. Leburton,U. Ravaioli,2012-12-06 This volume contains invited and contributed papers of the Ninth International Conference on Hot Carriers in Semiconductors HCIS 9 held July 3 I August 4 1995 in Chicago Illinois In all the conference featured 15 invited oral presentations 60 contributed oral presentations and 105 poster presentations and an international contingent of 170 scientists As in recent conferences the main themes of the conference were related to nonlinear transport in semiconductor heterojunctions and included Bloch oscillations laser diode structures and femtosecond spectroscopy Interesting questions related to nonlinear transport size quantization and intersubband scattering were addressed that are relevant to the new quantum cascade laser Many lectures were geared toward quantum wires and dots and toward nanostructures and mesoscopic systems in general It is expected that such research will open new horizons to nonlinear transport studies An attempt was made by the program committee to increase the number of presen tations related directly to devices The richness of nonlocal hot electron effects that were discussed as a result in our opinion suggests that future conferences should further encourage reports on such device research On behalf of the Program and International Advisory Committees we thank the participants who made the conference a successful and pleasant experience and the support of the Army Research Office the Office of Naval Research and the Beckman Institute of the University of Illinois at Urbana Champaign We are also indebted to Mrs Sara Starkey and Mrs *Nanoscale Science and Technology* Robert Kelsall,Ian W. Hamley,Mark Geoghegan,2005-04-15 Nanotechnology is a vital new area of research and development addressing the control modification and fabrication of materials structures and devices with nanometre precision and the synthesis of such structures into systems of micro and macroscopic dimensions Future applications of nanoscale science and technology include motors smaller than the diameter of a human hair and single celled organisms programmed to fabricate materials with nanometer precision Miniaturisation has revolutionised the semiconductor industry by making possible inexpensive integrated electronic circuits comprised of devices and wires with sub micrometer dimensions These integrated circuits are now ubiquitous controlling everything from cars to toasters The next level of miniaturisation beyond sub micrometer dimensions into nanoscale dimensions invisible to the unaided human eye is a booming area of research and development This is a very hot area of research with large amounts of venture capital

and government funding being invested worldwide as such Nanoscale Science and Technology has a broad appeal based upon an interdisciplinary approach covering aspects of physics chemistry biology materials science and electronic engineering Kelsall et al present a coherent approach to nanoscale sciences which will be invaluable to graduate level students and researchers and practising engineers and product designers

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Phonons In Semiconductor Nanostructures Introduction

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