

Ultrafast THz Spectroscopy and Nonlinear Optical Properties of Semiconductor Nanostructures

Zhen-Yu ZHAO

17 July 2008

- ✓ Laboratoire Pierre Aigrain - Ecole Normale Supérieure, Paris
- ✓ State Laboratory of Precise Spectroscopy - East China Normal University, Shanghai

Optical Spectroscopy Of Semiconductor Nanostructures

**Marcin L. Sadowski, Marek
Potemski, Marian Grynberg**



Optical Spectroscopy Of Semiconductor Nanostructures:

Optical Spectroscopy of Semiconductor Nanostructures Eougenious L. Ivchenko, 2005 This volume looks at optical spectroscopy of semiconductor nanostructures Some of the topics it covers include quantum confinement in low dimensional systems resonant light reflection and transmission and absorption

Near Field Optical Spectroscopy of Semiconductor Nanostructures Vadim Regelman, Tekhniyon, Makhon tekhnologi le-Yisra'el. Fa'ulṭah le-fisikah, 2002

Optical Properties of Semiconductor Nanostructures Marcin L. Sadowski, Marek Potemski, Marian Grynberg, 2012-12-06 Optical methods for investigating semiconductors and the theoretical description of optical processes have always been an important part of semiconductor physics Only the emphasis placed on different materials changes with time Here a large number of papers are devoted to quantum dots presenting the theory spectroscopic investigation and methods of producing such structures Another major part of the book reflects the growing interest in diluted semiconductors and II IV nanosystems in general There are also discussions of the fascinating field of photonic crystals Classical low dimensional systems such as GaAs GaAlAs quantum wells and heterostructures still make up a significant part of the results presented and they also serve as model systems for new phenomena New materials are being sought and new experimental techniques are coming on stream in particular the combination of different spectroscopic modalities

Simulations and Optical Spectroscopy of Semiconductor Nanostructures Coupled to Surface Plasmons, 2013

Ultrafast Spectroscopy of Semiconductors and Semiconductor Nanostructures Jagdeep Shah, 2013-11-11

Self-organized Growth and Optical Spectroscopy of Semiconductor Nanostructures Markku Sopanen, 1997

Optical Spectroscopy of Carrier Dynamics in Semiconductor Nanostructures Elinore Marie-Louise Dionne Jong, 2017

Applications of Optical Spectroscopy to Studies of Electronic and Vibrational States in Semiconductor Nanostructures Jiqiang Ning, University of Hong Kong, 2007

Near Field Optical Spectroscopy of Disorder in Semiconductor Nanostructures Francesca Intonti, 2002

Nonlinear Optical Spectroscopy of Dipole and Electron Spin Coherences in Semiconductor Nanostructures Phedon Palinginis, 2004

Modelling of Semiconductor Nanostructures Boon Hon Hong, 2011 III V semiconductor nanostructures are widely used in optoelectronic devices e g lasers and detectors in the visible 0.4-0.8 μm near infrared 0.8-3 μm mid infrared 3-5 μm and far infrared 8 μm wavelength ranges with great potential for high performance and high temperature operation As well as simple designs complex structures incorporating low dimensional components e g quantum wells and quantum dots are not unusual Often the optical and electronic characteristics of these structures are altered significantly as compared to bulk material As a prerequisite to design for different applications the study of their electronic and optical properties is essential With the increasing computational power of modern personal computers computational modelling becomes viable and more efficient Indeed it has become routine to follow or to precede experimental studies with computational modelling of good interpretive and predictive power

Combined with experimental studies this is a powerful tool to provide insight into new devices This research work is primarily based on calculations of the electronic band structure of various semiconductor nanostructures followed by modelling of optical transitions and optical spectra All numerical calculations use a cost effective computational method The applicability of the model to ultra thin structures of short period InAs GaSb superlattices is investigated The work is then extended to study complex quantum dot in well structures Finally the attempt to extract the structural parameters of quantum dots by a combination of modelling and optical spectroscopy is presented

Near-field Optical Spectroscopy of Quantum Confined Semiconductor Nanostructures Pietro Giuseppe Gucciardi, 2000

Semiconductor Quantum Dots Yasuaki Masumoto, T. Takagahara, 2002-05-28

Growth of Self Organized Quantum Dots J S Lee

Excitonic Structures and Optical Properties of Quantum Dots Toshihide Takagahara

Electron Phonon Interactions in Semiconductor Quantum Dots Toshihide Takagahara

Micro Imaging and Single Dot Spectroscopy of Self Assembled Quantum Dots Mitsuru Sugisaki

Persistent Spectral Hole Burning in Semiconductor Quantum Dots Yasuaki Masumoto

Dynamics of Carrier Relaxation in Self Assembled Quantum Dots Ivan V Ignatiev Igor E Kozin

Resonant Two Photon Spectroscopy of Quantum Dots Alexander Baranov

Homogeneous Width of Confined Excitons in Quantum Dots Experimental Yasuaki Masumoto

Theory of Exciton Dephasing in Semiconductor Quantum Dots Toshihide Takagahara

Excitonic Optical Nonlinearity and Weakly Correlated Exciton Pair States Selvakumar V Nair Toshihide Takagahara

Coulomb Effects in the Optical Spectra of Highly Excited Semiconductor Quantum Dots Selvakumar V Nair

Device *Applications of Optical Spectroscopy to Studies of Electronic and Vibrational States in Semiconductor Nanostructures* Jiqiang Ning, 2017-01-27

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Abstract Abstract of thesis entitled APPLICATIONS OF OPTICAL SPECTROSCOPY TO STUDIES OF ELECTRONIC AND VIBRATIONAL STATES IN SEMICONDUCTOR NANOSTRUCTURES Submitted by Ning Jiqiang for the degree of Doctor of Philosophy at The University of Hong Kong in December 2007

Time resolved Kerr rotation TRKR spectroscopy reflectance spectroscopy and Raman spectroscopy were employed to investigate the electronic and vibrational properties of semiconductor nanostructures namely InAs GaAs ultrafine multiple quantum wells MQW s the nanosized space charge double layer formed on the surface of a ZnO bulk crystal and GaN nanowires respectively From the measured TRKR data of the InAs GaAs MQW s at 5 K the transition energies from the heavy hh and light hole lh to the conduction band were determined to be 1.4346 and 1.4475 eV respectively resulting in an energy separation of 12.9 meV Such a well separated valence band structure allows selective excitation of electrons with opposite spin orientations By selective excitation of spin

up and down electrons it was found that the spin polarized electrons with opposite spin orientations show distinctive dynamical behaviors For the electrons from the hh subband their spin polarizations experience a fast relaxation process with a time constant of tens of picoseconds In strong contrast to the hh case the spin polarizations of electrons excited from the lh subband exhibit a slow relaxation process within hundreds of picoseconds since the light holes lose their spin orientations almost immediately after the excitation Therefore the long relaxation time basically reflects the spin relaxation process of electrons resonantly excited from the lh subband Due to the long lived heavy hole spins bi excitons with defined spin orientation can form leading to the observation of quantum beats between the bi excitons and original excitons in the TRKR spectra The bi exciton binding energy of 2 72 0 02 meV was determined from the oscillation period The beating amplitudes exhibit a clear resonance effect with respect to the wavelength of the excitation light which gives a confirmative evidence of the exciton effect Regular slow oscillations were observed in the low temperature reflectance spectra measured from a bulk crystalline ZnO rod at almost normal incident The oscillations can be interpreted as Fabry Perot interfering due to the formation of a nanosized space charge double layer on the ZnO surface The oscillation periods possess a linear dependence on the wavelengths of the incident light which suggests a constant extending rate of the surface space charge double layer under illumination From the experimental data the extending rate of about 1 3 nm min was deduced Confocal micro Raman scattering measurements were carried out to identify a 1 vibrational mode at 418 cm which is commonly observed in GaN nanomaterials The spectra measured from a series of GaN nanowires systematically prepared by nitriding Ga O nanowires under different conditions show a clear evolution of the 2 3 mode which reveals that the mode most likely originates from the local octahedral Ga N bonding structures which can abundantly form in GaN nanostructures This assignment is additionally supported by the high resolution electron transmission microscopy observation DOI 10 5353 th_b3963422 Subjects

Handbook of Nanostructured Materials and Nanotechnology Hari Singh Nalwa, 2000 Nanostructured materials is one of the hottest and fastest growing areas in today s materials science field along with the related field of solid state physics Nanostructured materials and their based technologies have opened up exciting new possibilities for future applications in a number of areas including aerospace automotive x ray technology batteries sensors color imaging printing computer chips medical implants pharmacy and cosmetics The ability to change properties on the atomic level promises a revolution in many realms of science and technology Thus this book details the high level of activity and significant findings are available for those involved in research and development in the field It also covers industrial findings and corporate support This five volume set summarizes fundamentals of nano science in a comprehensive way The contributors enlisted by the editor are at elite institutions worldwide Key Features Provides comprehensive coverage of the dominant technology of the 21st century Written by 127 authors from 16 countries making this truly international First and only reference to cover all aspects of nanostructured materials and nanotechnology OCLC **Semiconductor Quantum Dots** Yasuaki

Masumoto,T. Takagahara,2014-03-12 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 *Optical Spectroscopy of Colloidal CdSe Semiconductor Nanostructures* Joseph B. Herzog,2011 *Optical Properties And Spectroscopy Of Nanomaterials* Jin Zhong Zhang,2009-07-21 Optical properties are among the most fascinating and useful properties of nanomaterials and have been extensively studied using a variety of optical spectroscopic techniques A basic understanding of the optical properties and related spectroscopic techniques is essential for anyone who is interested in learning about nanomaterials of semiconductors insulators or metal This is partly because optical properties are intimately related to other properties and functionalities e g electronic magnetic and thermal that are of fundamental importance to many technological applications such as energy conversion chemical analysis biomedicine optoelectronics communication and radiation detection Intentionally designed for upper level undergraduate students and beginning graduate students with some basic knowledge of quantum mechanics this book provides the first systematic coverage of optical properties and spectroscopic techniques of nanomaterials *Ultrafast Physical Processes in Semiconductors* ,2000-10-06 Since its inception in 1966 the series of numbered volumes known as Semiconductors and Semimetals has distinguished itself through the careful selection of well known authors editors and contributors The Willardson and Beer series as it is widely known has succeeded in producing numerous landmark volumes and chapters Not only did many of these volumes make an impact at the time of their publication but they continue to be well cited years after their original release Recently Professor Eicke R Weber of the University of California at Berkeley joined as a co editor of the series Professor Weber a well known expert in the field of semiconductor materials will further contribute to continuing the series tradition of publishing timely highly relevant and long impacting volumes Some of the recent volumes such as Hydrogen in Semiconductors Imperfections in III V Materials Epitaxial Microstructures High Speed Heterostructure Devices Oxygen in Silicon and others promise that this tradition will be maintained and even expanded Reflecting the truly interdisciplinary nature of the field that the series covers the volumes in Semiconductors and Semimetals have been and will continue to be of great interest to physicists chemists materials scientists and device engineers in modern industry **Semiconductor and Metal Nanocrystals** Victor I. Klimov,2003-11-07 The vast technological potential of nanocrystalline materials as well as current intense interest in the physics and chemistry of nanoscale phenomena has led to explosive growth in research on semiconductor nanocrystals also

known as nanocrystal quantum dots and metal nanoparticles Semiconductor and Metal Nanocrystals addresses current topics impacting the field including synthesis and assembly of nanocrystals theory and spectroscopy of interband and intraband optical transitions single nanocrystal optical and tunneling spectroscopies electrical transport in nanocrystal assemblies and physical and engineering aspects of nanocrystal based devices Written by experts who have contributed pioneering research this reference comprises key advances in the field of semiconductor nanocrystal quantum dots and metal nanoparticles over the past several years Focusing specifically on nanocrystals generated through chemical techniques Semiconductor and Metal Nanocrystals Merges investigative frontiers in physics chemistry and engineering Documents advances in nanocrystal synthesis and assembly Explores the theory of electronic excitations in nanoscale particles Presents comprehensive information on optical spectroscopy of interband and intraband optical transitions Reviews data on single nanocrystal optical and tunneling spectroscopies Weighs controversies related to carrier relaxation dynamics in ultrasmall nanoparticles Discusses charge carrier transport in nanocrystal assemblies Provides examples of lasing and photovoltaic nanocrystal based devices Semiconductor and Metal Nanocrystals is a must read for scientists engineers and upper level undergraduate and graduate students interested in the physics and chemistry of nanoscale semiconductor and metal particles as well as general nanoscale science

Unveiling the Magic of Words: A Overview of "**Optical Spectroscopy Of Semiconductor Nanostructures**"

In some sort of defined by information and interconnectivity, the enchanting power of words has acquired unparalleled significance. Their power to kindle emotions, provoke contemplation, and ignite transformative change is truly awe-inspiring. Enter the realm of "**Optical Spectroscopy Of Semiconductor Nanostructures**," a mesmerizing literary masterpiece penned with a distinguished author, guiding readers on a profound journey to unravel the secrets and potential hidden within every word. In this critique, we shall delve to the book is central themes, examine its distinctive writing style, and assess its profound impact on the souls of its readers.

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