



Condensed Systems of Low Dimensionality

Edited by
J. L. Beeby

with 124 illustrations

Series in Physics Vol. 202

Condensed Systems Of Low Dimensionality

Stig Lundqvist, Nils Robert Nilsson



Condensed Systems Of Low Dimensionality:

Condensed Systems of Low Dimensionality J.L. Beeby, P.K. Bhattacharya, P.Ch. Gravelle, F. Koch, D.J.

Lockwood, 2012-12-06 The NATO Special Programme Panel on Condensed Systems of Low Dimensionality began its work in 1985 at a time of considerable activity in the field. The Panel has since funded many Advanced Research Workshops, Advanced Study Institutes, Cooperative Research Grants and Research Visits across the breadth of its remit which stretches from self-organizing organic molecules to semiconductor structures having two, one and zero dimensions. The funded activities, especially the workshops, have allowed researchers from within NATO countries to exchange ideas and work together at a period of development of the field when such interactions are most valuable. Such timely support has undoubtedly assisted the development of national programs, particularly in the countries of the alliance wishing to strengthen their science base. A closing Workshop to mark the end of the Panel's activities was organized in Marmaris, Turkey, from April 23-27, 1990, with the same title as the Panel. Condensed systems of Low Dimensionality. This volume contains papers presented at that meeting which sought to bring together chemists, physicists and engineers from across the spectrum of the Panel's activities to discuss topics of current interest in their special fields and to exchange ideas about the effects of low dimensionality. As the following pages show, this is a topic of extraordinary interest and challenge which produces entirely new scientific phenomena and at the same time offers the possibility of novel technological applications. *Lower-Dimensional Systems*

and Molecular Electronics Robert M. Metzger, Peter R. Day, George C. Papavassiliou, 2013-11-11 This volume represents the written account of the NATO Advanced Study Institute Lower Dimensional Systems and Molecular Electronics held at Hotel Spetses, Spetses Island, Greece, from 12 June to 23 June 1989. The goal of the Institute was to demonstrate the breadth of chemical and physical knowledge that has been acquired in the last 20 years in inorganic and organic crystals, polymers and thin films which exhibit phenomena of reduced dimensionality. The interest in these systems started in the late 1960s with lower dimensional inorganic conductors; in the early 1970s with quasi one-dimensional crystalline organic conductors which by 1979 led to the first organic superconductors; and in 1977 to the first conducting polymers. The study of monolayer films, Langmuir-Blodgett films, had progressed since the 1930s but reached a great upsurge in the early 1980s. The pursuit of non-linear optical phenomena became increasingly popular in the early 1980s as the attention turned from inorganic crystals to organic films and polymers. And in the last few years the term molecular electronics has gained ever increasing acceptance although it is used in several contexts. We now have organic superconductors with critical temperatures in excess of 10 K, conducting polymers that are soluble and processable and used commercially, we have films of a few monolayers that have high in-plane electrical conductivity and polymers that show great promise in photonics; we even have a few devices that function almost at the molecular level. Optical Switching in Low-Dimensional Systems Hartmut Haug, L.

Banyai, 2012-12-06 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 polydiacetylene 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 *Science and Engineering of One- and Zero-Dimensional Semiconductors* Steven P. Beaumont, Clivia M. Sotomayor Torres, 2012-12-06 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 μm 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 Point and Extended Defects in Semiconductors Giorgio Benedek, 2013-06-29 The systematic study of defects in semiconductors began in the early fifties From that time on many questions about the defect structure and properties have been answered but many others are still a matter of investigation and discussion Moreover during these years new problems arose in connection with the identification and characterization of defects their role in determining transport and optical properties of semiconductor materials and devices as well as from the technology of the ever increasing scale of integration This book

presents to the reader a view into both basic concepts of defect physics and recent developments of high resolution experimental techniques The book does not aim at an exhaustive presentation of modern defect physics rather it gathers a number of topics which represent the present time research in this field The volume collects the contributions to the Advanced Research Workshop Point Extended and Surface Defects in Semiconductors held at the Ettore Majorana Centre at Erice Italy from 2 to 7 November 1988 in the framework of the International School of Materials Science and Technology The workshop has brought together scientists from thirteen countries Most participants are currently working on defect problems in either silicon submicron technology or in quantum wells and superlattices where point defects dislocations interfaces and surfaces are closely packed together

Light Scattering in Semiconductor Structures and Superlattices D.J.

Lockwood, Jeff F. Young, 2013-12-20 Just over 25 years ago the first laser excited Raman spectrum of any crystal was obtained In November 1964 Hobden and Russell reported the Raman spectrum of GaP and later in June 1965 Russell published the Si spectrum Then in July 1965 the forerunner of a series of meetings on light scattering in solids was held in Paris Laser Raman spectroscopy of semiconductors was at the forefront in new developments at this meeting Similar meetings were held in 1968 New York 1971 Paris and 1975 Campinas Since then and apart from the multidisciplinary biennial International Conference on Raman Spectroscopy there has been no special forum for experts in light scattering spectroscopy of semiconductors to meet and discuss latest developments Meanwhile technological advances in semiconductor growth have given rise to a veritable renaissance in the field of semiconductor physics Light scattering spectroscopy has played a crucial role in the advancement of this field providing valuable information about the electronic vibrational and structural properties both of the host materials and of heterogeneous composite structures On entering a new decade one in which technological advances in lithography promise to open even broader horizons for semiconductor physics it seemed to us to be an ideal time to reflect on the achievements of the past decade to be brought up to date on the current state of the art and to catch some glimpses of where the field might be headed in the 1990s

Excitations in Two-Dimensional and Three-Dimensional Quantum Fluids A.F.G. Wyatt, H.J. Lauter, 2012-12-06 The study of quantum fluids in three dimensions has been an important area for many years as it embraces Bose Einstein condensation superfluidity and macroscopic quantisation These are fundamental aspects of physics which can be studied in liquid ^4He In contrast quantum fluids in two dimension is more recent and less developed Nevertheless it has shown many interesting phenomena including a rich variety of phases and the Kosterlitz Thouless transition Intermediate between these dimensions are the restricted geometries of micro porous materials into which He may be introduced The main quantum materials considered are ^4He ^3He D_2 H_2 H and electrons on the surface of ^4He The superfluid phases of ^3He were excluded except for superfluid film flow as ^3He involves a separate set of problems These proceedings arise from a lively Advanced Research Workshop on Excitations in Two Dimensional and Three Dimensional Quantum Fluids held in Exeter 10-15 August 1990 Fifty scientists took part and each provided a written

contribution Perhaps it is a testimony to the discussions that several papers were revised by the authors after the meeting The order of the chapters is the same as the presentations at the workshop This arrangement starts with 4He in three dimensions which establishes a base from which the two dimensional properties can be viewed At the end of each section there is a report on the discussion session These are interesting and useful chapters as they clarify points made in the papers and define the boundary of current understanding

Low-Dimensional Systems Tobias Brandes, 2008-01-11 Experimental progress over the past few years has made it possible to test a number of fundamental physical concepts related to the motion of electrons in low dimensions The production and experimental control of novel structures with typical sizes in the sub micrometer regime has now become possible In particular semiconductors are widely used in order to confine the motion of electrons in two dimensional heterostructures The quantum Hall effect was one of the first highlights of the new physics that is revealed by this confinement In a further step of the technological development in semiconductor heterostructures other artificial devices such as quasi one dimensional quantum wires and quantum dots artificial atoms have also been produced These structures again differ very markedly from three and two dimensional systems especially in relation to the transport of electrons and the interaction with light Although the technological advances and the experimental skills connected with these new structures are progressing extremely fast our theoretical understanding of the physical effects such as the quantum Hall effect is still at a very rudimentary level In low dimensional structures the interaction of electrons with one another and with other degrees of freedom such as lattice vibrations or light gives rise to new phenomena that are very different from those familiar in the bulk material The theoretical formulation of the electronic transport properties of small devices may be considered well established provided interaction processes are neglected

Resonant Tunneling in Semiconductors L.L. Chang, E.E. Mendez, C. Tejedor, 2012-12-06 This book contains the proceedings of the NATO Advanced Research Workshop on Resonant Tunneling in Semiconductors Physics and Applications held at Escorial Spain on May 14-18 1990 The tremendous growth in the past two decades in the field of resonant tunneling in semiconductor heterostructures has followed if not outpaced the expansion witnessed in quantum structures in general Resonant tunneling shares also the multidisciplinary nature of that broad area with an emphasis on the underlying physics but with a coverage of material systems on the one end and device applications on the other Indeed that resonant tunneling provides great flexibility in terms of materials and configurations and that it is inherently a fast process with obvious device implications by the presence of a negative differential resistance have contributed to the unrelenting interest in this field These proceedings consist of 49 refereed articles they correspond to both invited and contributed talks at the workshop Because of the intertwining nature of the subject matter it has been difficult to subdivide them in well defined sections Instead they are arranged in several broad categories meant to serve only as guidelines of emphasis on different topics and aspects The book starts with an introduction to resonant tunneling by providing a perspective of the field in the first article This is followed by discussions of different

material systems with various band structure effects

Interacting Electrons in Reduced Dimensions Dionys

Baeriswyl, David K. Campbell, 2012-12-06 As its name suggests the 1988 workshop on Interacting Electrons in Reduced Dimensions the wide variety of physical effects that are associated with possibly systems focused on strongly correlated electrons interacting in quasi one and quasi two dimensional materials Among the phenomena discussed were superconductivity magnetic ordering the metal insulator transition localization the fractional Quantum Hall effect QHE Peierls and spin Peierls transitions conductance fluctuations and sliding charge density CDW and spin density SDW waves That these effects appear most pronounced in systems of reduced dimensionality was amply demonstrated at the meeting Indeed when concrete illustrations were presented they typically involved chain like materials such as conjugated polymers inorganic CDW systems and organic conductors or layered materials such as high temperature copper oxide superconductors certain of the organic superconductors and the QHE samples or devices where the electrons are confined to a restricted region of sample e.g. the depletion layer of a MOSFET To enable this broad subject to be covered in thirty five lectures and about half as many posters the workshop was deliberately focused on theoretical models for these phenomena and on methods for describing as faithfully as possible the true behavior of these models This latter emphasis was especially important since the inherently many body nature of problems involving interacting electrons renders conventional effective single particle mean field methods e.g. Hartree Fock or the local density approximation in density functional theory highly suspect Again this is particularly true in reduced dimensions where strong quantum fluctuations can invalidate mean field results

Mechanisms of Reactions of Organometallic Compounds with Surfaces D.J. Cole-Hamilton, J.O.

Williams, 2013-11-11 A NATO Advanced Research Workshop on the Mechanisms of Reactions of Organometallic Compounds with Surfaces was held in St Andrews Scotland in June 1988 Many of the leading international researchers in this area were present at the workshop and all made oral presentations of their results In addition significant amounts of time were set aside for Round Table discussions in which smaller groups considered the current status of mechanistic knowledge identified areas of dispute or disagreement and proposed experiments that need to be carried out to resolve such disputes so as to advance our understanding of this important research area All the papers presented at the workshop are collected in this volume together with summaries of the conclusions reached at the Round Table discussions The workshop could not have taken place without financial support from NATO and donations were also received from Associated Octel Ltd STC Ltd and Epichem Ltd for which the organisers are very grateful The organisation of the meeting was greatly assisted by Mrs G MacArthur and Mr L R Dunley of the Chemistry Department St Andrews University

Evaluation of Advanced Semiconductor Materials by Electron Microscopy David Cherns, 2012-12-06

The last few years have seen rapid improvements in semiconductor growth techniques which have produced an expanding range of high quality heterostructures for new semiconductor devices As the dimensions of such structures approach the nanometer level it

becomes increasingly important to characterise materials properties such as composition uniformity strain interface sharpness and roughness and the nature of defects as well as their influence on electrical and optical properties Much of this information is being obtained by electron microscopy and this is also an area of rapid progress There have been advances for thin film studies across a wide range of techniques including for example convergent beam electron diffraction X ray and electron energy loss microanalysis and high spatial resolution cathodoluminescence as well as by conventional and high resolution methods Important developments have also occurred in the study of surfaces and film growth phenomena by both microscopy and diffraction techniques With these developments in mind an application was made to the NATO Science Committee in late summer 1987 to fund an Advanced Research Workshop to review the electron microscopy of advanced semiconductors This was subsequently accepted for the 1988 programme and became the NATO Advanced Research Workshop on the Evaluation of Advanced Semiconductor Materials by Electron Microscopy The Workshop took place in the pleasant and intimate surroundings of Wills Hall Bristol UK during the week 11-17 September 1988 and was attended by fifty five participants from fourteen countries

Excitons in Low-Dimensional Semiconductors Stephan Glutsch, 2013-04-17 Low dimensional semiconductors have become a vital part of today's semiconductor physics and excitons in these systems are ideal objects that bring textbook quantum mechanics to life Furthermore their theoretical understanding is important for experiments and optoelectronic devices 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

Dynamics of Magnetic Fluctuations in High-Temperature Superconductors George Reiter, Peter Horsch, Gregory C. Psaltakis, 2012-12-06 This NATO Advanced Research Workshop was held at a time when there was little consensus as to the mechanism for high temperature superconductivity in the context of a world undergoing major changes in its political alignments and sense of the possibility for the future It was characterized by generosity in the sharing of our uncertainties and speculations as was appropriate for both the subject matter and the context The workshop was organized of necessity around the experimental work as is this volume Where the theoretical work is directly relevant to particular experiments it is included in the appropriate sections with them Most of the participants felt strongly that magnetic fluctuations played an important role in the mechanism for high T_c although with the exception of the ILS R work reported by Luke showing results inconsistent with the anyon picture and the work on flux phases by Lederer the mechanism remained an issue in the background A major focus was the phenomenological interpretation of the NMR data

Physics Of

Low-dimensional Systems - Proceedings Of Nobel Symposium 73 Stig Lundqvist, Nils Robert Nilsson, 1989-07-01 List of Contributors P W Anderson S Tanaka C W Chu Y H Kim T V Ramakrishnan G Wendin G Baskaran H Fukuyama Y Hasegawa A Zawadowski A A Abrikosov A I Buzdin V L Ginzburg S Barisic I Batistic E J Mele L Dzyaloshinskii L A Falkovsky J R Schrieffer D J Scalapino A I Larkin K W Becker P Fulde S A Trugman F C Zhang K A Chao G Z Wei D J Rome et al J Bardeen M Sinclair S M Girvin D P Arovas P B Wiegmann and others Spectroscopy of Semiconductor Microstructures Gerhard Fasol, Annalisa Fasolino, Paolo Lugli, 2013-06-29 Proceedings of a NATO ARW held in Venice Italy May 9 13 1989 Basic Properties of Semiconductors P.T. Landsberg, 2016-04-19 Since Volume 1 was published in 1982 the centres of interest in the basic physics of semiconductors have shifted Volume 1 was called Band Theory and Transport Properties in the first edition but the subject has broadened to such an extent that Basic Properties is now a more suitable title Seven chapters have been rewritten by the original authors However twelve chapters are essentially new with the bulk of this work being devoted to important current topics which give this volume an almost encyclopaedic form The first three chapters discuss various aspects of modern band theory and the next two analyze impurities in semiconductors Then follow chapters on semiconductor statistics and on surfaces interfaces and band offsets as they occur in heterojunctions Chapters 8 to 19 report on newer topics though a survey of transport properties of carriers is also included Among these are transport of hot electrons and thermoelectric effects including here and elsewhere properties of low dimensional and mesoscopic structures The electron hole liquid the quantum Hall effect localisation ballistic transport coherence in superlattices current ideas on tunnelling and on quantum confinement and scattering processes are also covered **Science and Technology of Fast Ion Conductors** Harry L. Tuller, M. Balkanski, 2012-12-06 The rediscovery of fast ion conduction in solids in the 1960 s stimulated interest both in the scientific community in which the fundamentals of diffusion order disorder phenomena and crystal structure evaluation required re examination and in the technical community in which novel approaches to energy conversion and chemical sensing became possible with the introduction of the new field of Solid State Ionics Because of both the novelty and the vitality of this field it has grown rapidly in many directions This growth has included the discovery of many new crystalline fast ion conductors and the extension to the fields of organic and amorphous compounds The growth has involved the extension of classical diffusion theory in an attempt to account for carrier interactions and the development of sophisticated computer models Diffraction techniques have been refined to detect carrier distributions and anharmonic vibrations Similar advances in the application of other techniques such as NMR Raman IR and Impedance Spectroscopies to this field have also occurred The applications of fast ion conducting solid electrolytes have also developed in many directions High energy density Na S batteries are now reaching the last stages of development Li batteries are being implanted in humans for heart pacemakers and solid state fuel cells are again being considered for future power plants The proliferation of inexpensive microcomputers has stimulated the need for improved chemical sensors a major application now being the zirconia auto

exhaust sensor being sold by the millions each year Quantum Theory of Real Materials James R. Chelikowsky, Steven G. Louie, 1996-02-29 A Festschrift in honor of Professor Marvin L Cohen This volume is a Festschrift in honor of Professor Marvin L Cohen The articles contributed by leading researchers in condensed matter physics highlight recent advances in the use of quantum theory to explain and predict properties of real materials The invention of quantum mechanics in the 1920 s provided detailed descriptions of the electronic structure of atoms However a similar understanding of solids has been achieved only in the past 30 years owing to the complex electron ion and electron electron interactions in these systems Professor Cohen is a central figure in this achievement His development of the pseudopotential and total energy methods provided an alternate route using computers for the exploration of solids and new materials even when they have not yet been synthesized Professor Cohen s contributions to materials theory have been both fundamental and encompassing The corpus of his work consists of over 500 papers and a textbook His band structures for semiconductors are used worldwide by researchers in solid state physics and chemistry and by device engineers Professor Cohen s own use of his theories has resulted in the determination of the electronic structure optical properties structural and vibrational properties and superconducting properties of numerous condensed matter systems including semiconductors metals surfaces interfaces defects in solids clusters and novel materials such as the fullerenes and nanotubes **Metallization and**

Metal-Semiconductor Interfaces Inder P. Batra, 2012-12-06 This book represents the work presented at a NATO Advanced Research Workshop on Metallization and Metal Semiconductor Interfaces held at the Technical University of Munich Garching W Germany from 22-26 August 1988 The major focus of the workshop was to evaluate critically the progress made in the area of metal semiconductor interfaces The underlying theme was the mechanism of Schottky barrier formation and a serious assessment of the various models A significant fraction of the workshop time was also spent in discussing the interaction of alkali metals with semiconductors Alkali metals on semiconductors form ordered overlayers and the resulting system often exhibits one dimensional metallic properties The nature of their interaction has introduced new and exciting complexities and this was pursued at length during the lively discussions at the workshop A half a day was devoted to Scanning Tunneling Microscopy the emphasis being on its utility in providing structural and electronic character of low coverage regime The book should provide readers with the most current status of the research activity in the general area of metal semiconductor interfaces at an international level It should also serve as an excellent introduction to the field since sufficient review type of material has also been included The workshop organizers Dr I P Batra Director mM Almaden Research Center San Jose Prof S Ciraci Bilkent University Ankara Prof C Y Pong University of California Davis Prof Dr F Koch Local Chairman Technical University Munich Garching Dr H

Unveiling the Energy of Verbal Artistry: An Emotional Sojourn through **Condensed Systems Of Low Dimensionality**

In a world inundated with monitors and the cacophony of fast communication, the profound energy and mental resonance of verbal artistry frequently fade in to obscurity, eclipsed by the constant barrage of sound and distractions. Yet, situated within the lyrical pages of **Condensed Systems Of Low Dimensionality**, a captivating perform of fictional splendor that pulses with organic feelings, lies an wonderful trip waiting to be embarked upon. Published by way of a virtuoso wordsmith, this interesting opus instructions visitors on an emotional odyssey, softly exposing the latent possible and profound impact stuck within the intricate web of language. Within the heart-wrenching expanse of the evocative evaluation, we can embark upon an introspective exploration of the book is central themes, dissect its charming writing style, and immerse ourselves in the indelible effect it leaves upon the depths of readers souls.

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