

# **Hot Carriers In Semiconductor Nanostructures**

Fritz Henneberger, Oliver Benson

#### **Hot Carriers In Semiconductor Nanostructures:**

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 Hot Electrons in Semiconductors N. Balkan, 1998 Since the arrival of the transistor in 1947 research in hot electrons like any field in semiconductor research has grown at a stunning rate From a physicist s point of view the understanding of hot electrons and their interactions with the lattice has always been a challenging problem of condensed matter physics Recently with the advent of novel fabrication techniques such as electron beam or plasma etching and the advanced growth techniques such as the molecular beam epitaxy MBE and metallo organic chemical vapour deposition MOCVD it has become possible to fabricate semiconductor devices with sub micron dimensions where the electrons are confined to two quantum well one quantum wire or zero quantum dot dimensions. In devices of such dimensions a few volts applied to the device result in the setting up of very high electric fields hence a substantial heating of electrons Thus electronic transport in the device becomes non linear and can no longer be described using the simple equations of Ohm's law The understanding of the operations of such devices and the realisations of more advanced ones make it necessary to understand the dynamics of hot electrons There is an obvious lack of good reference books on hot electrons in semiconductors The few that exist either cover a very narrow field or are becoming quite outdated This book is therefore written with the aim of filling the vacuum in an area where there is much demand for a comprehensive reference book The book is intended for both established researchers and graduate students and gives a complete account of the historical development of the subject together with current research interests and future trends. The contributions are written by leading scientists in the field They cover the physics of hot electrons in bulk and low dimensional device technology The material is organised into subject area that can be classified broadly into five groups 1 introduction and overview 2 hot electron phonon interactions and the ultra fast phenomena in bulk and two dimensional structures 3 hot electrons in both long and short quantum wires and quantum dots 4 hot electron tunnelling and hot electron transport in superlattices and 5 novel devices based on hot electron transport The chapters are grouped according to subject matter as far as possible However although there is much overlap of ideas and concepts each chapter is essentially independent of the others 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 <u>Ultrafast Spectroscopy of</u> 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

Advanced Semiconductor Heterostructures: Novel Devices, Potential Device Applications And Basic Properties
Michael A Stroscio, Mitra Dutta, 2003-09-12 This volume provides valuable summaries on many aspects of advanced
semiconductor heterostructures and highlights the great variety of semiconductor heterostructures that has emerged since
their original conception As exemplified by the chapters in this book recent progress on advanced semiconductor
heterostructures spans a truly remarkable range of scientific fields with an associated diversity of applications Some of these
applications will undoubtedly revolutionize critically important facets of modern technology At the heart of these advances is
the ability to design and control the properties of semiconductor devices on the nanoscale As an example the intersubband
lasers discussed in this book have a broad range of previously unobtainable characteristics and associated applications as a
result of the nanoscale dimensional control of the underlying semiconductor heterostructures As this book illustrates an
astounding variety of heterostructures can be fabricated with current technology the potentially widespread use of layered
quantum dots fabricated with nanoscale precision in biological applications opens up exciting advances in medicine In

addition many more excellent examples of the remarkable impact being made through the use of semiconductor heterostructures are given The summaries in this volume provide timely insights into what we know now about selected areas of advanced semiconductor heterostructures and also provide foundations for further developments Quantum Bits Fritz Henneberger, Oliver Benson, 2016-04-19 This book highlights state of the art qubit implementations in semiconductors and provides an extensive overview of this newly emerging field Semiconductor nanostructures have huge potential as future quantum information devices as they provide various ways of qubit implementation electron spin electronic excitation as well as a way to transfer Handbook of Self Assembled Semiconductor Nanostructures for **Novel Devices in Photonics and Electronics** Mohamed Henini, 2011-07-28 The self assembled nanostructured materials described in this book offer a number of advantages over conventional material technologies in a wide range of sectors World leaders in the field of self organisation of nanostructures review the current status of research and development in the field and give an account of the formation properties and self organisation of semiconductor nanostructures Chapters on structural electronic and optical properties and devices based on self organised nanostructures are also included Future research work on self assembled nanostructures will connect diverse areas of material science physics chemistry electronics and optoelectronics. This book will provide an excellent starting point for workers entering the field and a useful reference to the nanostructured materials research community It will be useful to any scientist who is involved in nanotechnology and those wishing to gain a view of what is possible with modern fabrication technology Mohamed Henini is a Professor of Applied Physics at the University of Nottingham He has authored and co authored over 750 papers in international journals and conference proceedings and is the founder of two international conferences He is the Editor in Chief of Microelectronics Journal and has edited three previous Elsevier books Contributors are world leaders in the field Brings together all the factors which are essential in self organisation of quantum nanostructures Reviews the current status of research and development in self organised nanostructured materials Provides a ready source of information on a wide range of topics Useful to any scientist who is involved in nanotechnology Excellent starting point for workers entering the field Serves as an excellent reference manual Quantum Heterostructures Vladimir Vasil'evich Mitin, Viacheslav Kochelap, Michael A. Stroscio, 1999-07-13 Quantum Heterostructures provides a detailed description of the key physical and engineering principles of quantum semiconductor heterostructures Blending important concepts from physics materials science and electrical engineering it also explains clearly the behavior and operating features of modern microelectronic and optoelectronic devices The authors begin by outlining the trends that have driven development in this field most importantly the need for high performance devices in computer information and communications technologies. They then describe the basics of quantum nanoelectronics including various transport mechanisms In the latter part of the book they cover novel microelectronic devices and optical devices based on quantum heterostructures The book contains many homework problems and is suitable

as a textbook for undergraduate and graduate courses in electrical engineering physics or materials science It will also be of great interest to those involved in research or development in microelectronic or optoelectronic devices Coherent Optical Interactions in Semiconductors R.T. Phillips, 2013-06-29 The NATO Advanced Research Workshop on Coherent Optical Processes in Semiconductors was held in Cambridge England on August 11 14 1993 The idea of holding this Workshop grew from the recent upsurge in activity on coherent transient effects in semiconductors. The development of this field reflects advances in both light sources and the quality of semiconductor structures such that tunable optical pulses are now routinely available whose duration is shorter than the dephasing time for excitonic states in quantum wells It was therefore no surprise to the organisers that as the programme developed there emerged a heavy emphasis on time resolved four wave mixing particularly in quantum wells Nevertheless other issues concerned with coherent effects ensured that several papers on related problems contributed some variety. The topics discussed at the workshop centred on what is a rather new field of study and benefited enormously by having participants representing many of the principal groups working in this area Several themes emerged through the invited contributions at the Workshop One important development has been the careful examination of the two level model of excitonic effects a model which has been remarkably successful despite the expected complexities arising from the semiconductor band structure Indeed modest extensions to the two level model have been able to offer a useful account for some of the complicated polarisation dependence of four wave mixing signals from GaAs quantum wells This work clearly is leading to an improved understanding of excitons in confined systems

Characterization of Semiconductor Heterostructures and Nanostructures Giovanni Agostini, Carlo Lamberti, 2011-08-11 In the last couple of decades high performance electronic and optoelectronic devices based on semiconductor heterostructures have been required to obtain increasingly strict and well defined performances needing a detailed control at the atomic level of the structural composition of the buried interfaces This goal has been achieved by an improvement of the epitaxial growth techniques and by the parallel use of increasingly sophisticated characterization techniques and of refined theoretical models based on ab initio approaches This book deals with description of both characterization techniques and theoretical models needed to understand and predict the structural and electronic properties of semiconductor heterostructures and nanostructures Comprehensive collection of the most powerful characterization techniques for semiconductor heterostructures and nanostructures Most of the chapters are authored by scientists that are among the top 10 worldwide in publication ranking of the specific field Each chapter starts with a didactic introduction on the technique The second part of each chapter deals with a selection of top examples highlighting the power of the specific technique to analyze the properties of semiconductors Semiconductor Physics Karl W. Böer, Udo W. Pohl, 2023-02-02 This handbook gives a complete and detailed survey of the field of semiconductor physics It addresses every fundamental principle the most important research topics and results as well as conventional and emerging new areas of

application Additionally it provides all essential reference material on crystalline bulk low dimensional and amorphous semiconductors including valuable data on their optical transport and dynamic properties. This updated and extended second edition includes essential coverage of rapidly advancing areas in semiconductor physics such as topological insulators quantum optics magnetic nanostructures and spintronic systems Richly illustrated and authored by a duo of internationally acclaimed experts in solar energy and semiconductor physics this handbook delivers in depth treatment of the field reflecting a combined experience spanning several decades as both researchers and educators Offering a unique perspective on many issues Semiconductor Physics is an invaluable reference for physicists materials scientists and engineers throughout academia and industry Tunneling And Its Implications: Proceedings Of The Adriatico Research Conference D Mugnai, Anedio Ranfagni, Lawrence S Schulman, 1997-04-19 The motion of a particle undergoing quantum tunneling has long been an open and debated problem in several aspects One of the most discussed is the determination of the time spent in such processes but many other features deserve consideration In this volume both theoretical and experimental aspects such as quantum measurement optical analogy experimental tests solid state devices and time scale for anomalies quantum Zeno effect and superluminal evanescence are explored **Tunneling And Its Implications** Adriatico Research Conference on Tunneling and Its Implications 1996, Trieste, Italy, D. Mugnai, 1997 The motion of a particle undergoing quantum tunneling has long been an open and debated problem in several aspects One of the most discussed is the determination of the time spent in such processes but many other features deserve consideration In this volume both theoretical and experimental aspects such as quantum measurement optical analogy experimental tests solid state devices and time scale for anomalies quantum Zeno effect and superluminal evanescence are explored Publisher's website **Quantum Processes in Semiconductors** B. K. Ridley, 2013-08-08 This book sets out the fundamental quantum processes that are important in the physics and technology of semiconductors The fifth edition includes three new chapters that expand the coverage of semiconductor physics relevant to its accompanying technology Quantum Coherence And Reality: In Celebration Of The 60th Birthday Of Yakir Aharonov - Proceedings Of The International Conference On Fundamental Aspects Of Quantum Theory Jeeva Anandan, John Safko, 1995-02-23 This volume constitutes the proceedings of the above conference held to celebrate the 60th birthday of Yakir Aharonov Two Nobel laureates Norman Ramsey and Charles Townes members of the National Academy of Sciences and Cresson Medal winners were among the speakers Among the topics discussed are quantum reality geometric phases and the Aharonov Bohm effect spin and statistics black holes and quantum gravity All of these are fundamental to our understanding of quantum theory and are related by being aspects of quantum theory on subjects that Yakir Aharonov has considered Superlattice to Nanoelectronics Raphael Tsu, 2005-04-04 Superlattice to Nanoelectronics provides a historical overview of the early work performed by Tsu and Esaki to orient those who want to enter into this nanoscience It describes the fundamental concepts and goes on to answer many questions about todays

Nanoelectronics It covers the applications and types of devices which have been produced many of which are still in use today This historical perspective is important as a guide to what and how technology and new fundamental ideas are introduced and developed The author communicates a basic understanding of the physics involved from first principles whilst adding new depth using simple mathematics and explanation of the background essentials Topics covered include Introductory materials Superlattice Bloch oscillations and transport Tunneling in QWs to QDs Optical properties optical transitions size dependent dielectric constant capacitance and doping Quantum devices New approaches without doping and heterojunctions quantum confinement via geometry and multipole electrodes Issues of robustness redundancy and I O Researchers course students and research establishments should read this book written by the leading expert in nanoelectronics and superlattices The Author is one of the founders of the field of superlattices The FIRST historical overview of the field Provides a basic understanding of the physics involved from first principles whilst adding new depth using simple mathematics and explanation of the background essentials GaAs and Related Materials Sadao Adachi, 1994 This book covers the various material properties of bulk GaAs and related materials and aspects of the physics of artificial semiconductor microstructures such as quantum wells and superlattices made of these materials A complete set of the material properties are considered in this book They are structural properties thermal properties elastic and lattice vibronic properties collective effects and some response characteristics electronic energy band structure and consequences optical elasto optic and electro optic properties and carrier transport properties This book attempts to summarize in graphical and tabular forms most of the important theoretical and experimental results on these material properties It contains a large number of references useful for further study Timely topics are discussed as well This book will be of interest to graduate students scientists and engineers working on semiconductors **Surface- and Tip-Enhanced Raman Scattering** Spectroscopy Marek Procházka, Janina Kneipp, Bing Zhao, Yukihiro Ozaki, 2024-10-18 This book describes recent progress in the mechanistic studies and applications of surface enhanced Raman scattering SERS and tip enhanced Raman scattering TERS In this book various novel techniques in SERS and TERS such as UV resonance TERS electrochemical TERS and three dimensional SERS imaging are outlined A number of new applications of SERS and TERS such as those to photonics nanotechnology microfluidics and medical diagnosis along with future perspectives are also discussed Finally the applications of new data analysis models and machine learning in SERS and TERS studies are reviewed The novelty of this book is the forming of a new bridge between the theory and applications Also the importance of chemical mechanism and that of semiconductor enhanced Raman scattering is emphasized The main audiences are researchers in academia research institutes companies and graduate students looking for a comprehensive book on the latest studies of SERS and TERS

**Ultrafast Phenomena in Semiconductors** Kong-Thon Tsen,2012-12-06 There are many books in the market devoted to the review of certain fields This book is different from those in that authors not only provide reviews of the fields but also

present their own important contributions to the fields in a tutorial way As a result researchers who are already in the field of ultrafast dynamics in semicon ductors and its device applications as well as researchers and graduate students just entering the field will benefit from it This book is made up of recent new developments in the field of ultrafast dynamics in semiconductors It consists of nine chapters Chapter 1 reviews a mi croscopic many body theory which allows one to compute the linear and non linear optical properties of semiconductor superlattices in the presence of homogeneous electric fields Chapter 2 deals with ultrafast intersubband dynamics in quantum wells and device structures Chapter 3 is devoted to Bloch oscillations in semicon ductors and their applications Chapter 4 discusses transient electron transport phe nomena such as electron ballistic transport and electron velocity overshoot phe nomena as well as non equilibrium phonon dynamics in nanostructure semicon ductors Chapter 5 reviews experimental and theoretical work on the use of the phase properties of one or more ultrashort optical pulses to generate and control electrical currents in semiconductors Nonequilibrium Green's Functions Ii - Proceedings Of The Conference Michael Bonitz, Dirk Semkat, 2003-05-28 Equilibrium and nonequilibrium properties of correlated many body systems are of growing interest in many areas of physics including condensed matter dense plasmas nuclear matter and particles The most powerful and general method which is equally applied to all these areas is given by quantum field theory. This book provides an overview of the basic ideas and concepts of the method of nonequilibrium Green's functions written by the leading experts and presented in a way accessible to non specialists and graduate students It is complemented by invited review papers on modern applications of the method to a variety of topics such as optics and quantum transport in semiconductors superconductivity strong field effects QCD and state of the art computational concepts from Green's functions to quantum Monte Carlo and time dependent density functional theory The proceedings have been selected for coverage in Index to Scientific Technical Proceedings ISTP CDROM version ISI Proceedings

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