Charge Transport In Disordered Solids With Applications In Electronics

BOOTH MELANY

An Introduction Springer
Written in the perspective of an experimental chemist, this book puts together some fundamentals from chemistry, solid state physics and quantum chemistry, to help with understanding and predicting the electronic and optical properties of organic semiconductors, both polymers and small molecules. The text is intended to assist graduate students and researchers in the field of organic electronics to use theory to design more efficient materials for organic electronic devices such as organic solar cells, light emitting diodes and field effect transistors. After addressing some basic topics in solid state physics, a comprehensive introduction to molecular orbitals and band theory leads to a description of computational methods based on Hartree-Fock and density functional theory (DFT), for predicting geometry conformations, frontier levels and energy band structures. Topological defects and transport and optical properties are then addressed, and one of the most commonly used transparent conducting polymers, PEDOT:PSS, is described in some detail as a case study.
New Aspects and Solutions World Scientific
The second, updated edition of this essential reference book provides a wealth of detail on a wide range of electronic and photonic materials, starting from fundamentals and building up to advanced topics and applications. Its extensive coverage, with clear illustrations and applications, carefully selected chapter sequencing and logical flow, makes it very different from other electronic materials handbooks. It has been written by professionals in the field and instructors who teach the subject at a university or in corporate laboratories. The Springer Handbook of Electronic and Photonic Materials, second edition, includes practical applications used as examples, details of experimental techniques, useful tables that summarize equations, and,

most importantly, properties of various materials, as well as an extensive glossary. Along with significant updates to the content and the references, the second edition includes a number of new chapters such as those covering novel materials and selected applications. This handbook is a valuable resource for graduate students, researchers and practicing professionals working in the area of electronic, optoelectronic and photonic materials.

Organic Solar Cells Elsevier

Devices based on disordered semiconductors have wide applications. It is difficult to imagine modern life without printers and copiers, LCD monitors and TVs, optical disks, economical solar cells, and many other devices based on disordered semiconductors. However, nowadays books that discuss disordered (amorphous, nanocrystalline, microcrystalline)

Electronic Processes in Organic Semiconductors CRC Press

The field of organic electronics promises exciting new technologies based on inexpensive and mechanically flexible electronic devices, and is now seeing the beginning of commercial success. On the sidelines of this increasingly well-established field are several emerging technologies with innovative mechanisms and functions that utilize the mixed ionic/electronic conducting character of conjugated organic materials. Iontronics: Ionic Carriers in Organic Electronic Materials and Devices explores the potential of these materials, which can endow electronic devices with unique functionalities. Fundamental science and applications With contributions from a community of experts, the book focuses on the use of ionic functions to define the principle of operation in polymer devices. It begins by reviewing the scientific understanding and important scientific discoveries in the electrochemistry of conjugated polymers. It examines the known effects of ion incorporation, including the theory and modulation of electrochemistry in polymer films, and it explores the coupling of electronic and ionic transport in polymer films. The authors also describe applications that use this technology, including polymer electrochromic devices, artificial muscles, light-emitting electrochemical cells, and biosensors, and they discuss the fundamental technological hurdles in these areas. The changes in materials properties and device characteristics due to ionic conductivity and electrochemical doping in electrically conductive organic materials, as well as the importance of these processes in a number of different and exciting technologies, point to a large untapped potential in the development of new applications and novel device architecture. This volume captures the state of the science in this burgeoning field.

Materials, Devices and Applications Elsevier

Amorphous semiconductors are subtances in the amorphous solid state that have the properties of a semiconductor and which are either covalent or tetrahedrally bonded amorphous semiconductors or chelcogenide glasses. Developed from both a theoretical and experimental viewpoint Deals with, amongst others, preparation techniques, structural, optical and electronic properties, and light induced phenomena Explores different types of amorphous semiconductors including amorphous silicon, amorphous semiconducting oxides and chalcogenide glasses Applications include solar cells, thin film transistors, sensors, optical memory devices and flat screen devices including televisions

Simulations, Theory, and Numerical Modeling of Hopping Transport and Electron-hole Recombination John Wiley & Sons

Written by internationally recognized experts in the field with academic as well as industrial experience, this book concisely yet systematically covers all aspects of the topic. The monograph focuses on the optoelectronic behavior of organic solids and their application in new optoelectronic devices. It covers organic field-effect and organic electroluminescent materials and devices, organic photonics, materials and devices, as well as organic solids in photo absorption and energy conversion. Much emphasis is laid on the preparation of functional materials and the fabrication of devices, from materials synthesis and purification, to physicochemical properties and the basic processes and working principles of the devices. The only book to cover fundamentals, applications, and the latest research results, this is a handy reference for both researchers and those new to the field. From the contents: * Electronic process in organic solids * Organic/polymeric semiconductors for field-effect transistors * Organic/polymeric field-effect transistors * Organic circuits and organic single molecular transistors * Polymer light-emitting Diodes (PLEDs): devices and materials * Organic solids for photonics * Organic photonic devices * Organic solar cells based on small molecules * Polymer solar cells * Dye-sensitized solar cells (DSSCs) * Organic thermoelectric power devices

Solar Cells World Scientific

The field of charge conduction in disordered materials is a rapidly evolving area owing to current and potential applications of these materials in various electronic devices This text aims to cover conduction in disordered solids from fundamental physical principles and theories, through practical material development with an emphasis on applications in all areas of electronic materials. International group of contributors Presents basic physical concepts developed in this field in recent years in a uniform manner Brings up-to-date, in a one-stop source, a key evolving area in the field of electronic materials

Fractional Kinetics in Solids Elsevier

Like its predecessor this book is devoted to the materials, manufacturing and applications aspects of organic thin-film transistors. Once again authored by the most renowned experts from this fascinating and fast-moving area of research, it offers a joint perspective both broad and in-depth on the latest developments in the areas of materials chemistry, transport physics, materials characterization, manufacturing technology, and circuit integration of organic transistors. With its many figures and detailed index, this book once again also serves as a ready reference.

Electrons, Photons, Phonons World Scientific

Filling the gap in the literature currently available, this book presents an overview of our knowledge of the physics behind organic semiconductor devices. Contributions from 18 international research groups cover various aspects of this field, ranging from the growth of organic layers and crystals, their electronic properties at interfaces, their photophysics and electrical transport properties to the application of these materials in such different devices as organic field-effect transistors, photovoltaic cells and organic light-emitting diodes. From the contents: * Excitation Dynamics in Organic Semiconductors * Organic Field-Effect Transistors * Spectroscopy of Organic Semiconductors * Interfaces between Organic Semiconductors and Metals * Analysis and Modeling of Devices * Exciton Formation and Energy Transfer in Organic Light Emitting Diodes * Deposition and Characterization

Physics of Hot Electron Transport in Semiconductors World Scientific

This book covers in a textbook-like fashion the basics or organic solar cells, addressing the limits of photovoltaic

energy conversion and giving a well-illustrated introduction to molecular electronics with focus on the working principle and characterization of organic solar cells. Further chapters based on the author's dissertation focus on the electrical processes in organic solar cells by presenting a detailed drift-diffusion approach to describe exciton separation and charge-carrier transport and extraction. The results, although elaborated on small-molecule solar cells and with focus on the zinc phthalocyanine: C60 material system, are of general nature. They propose and demonstrate experimental approaches for getting a deeper understanding of the dominating processes in amorphous thin-film based solar cells in general. The main focus is on the interpretation of the current-voltage characteristics (J-V curve). This very standard measurement technique for a solar cell reflects the electrical processes in the device. Comparing experimental to simulation data, the author discusses the reasons for S-Shaped J-V curves, the role of charge carrier mobilities and energy barriers at interfaces, the dominating recombination mechanisms, the charge carrier generation profile, and other efficiency-limiting processes in organic solar cells. The book concludes with an illustrative guideline on how to identify reasons for changes in the J-V curve. This book is a suitable introduction for students in engineering, physics, material science, and chemistry starting in the field of organic or hybrid thin-film photovoltaics. It is just as valuable for professionals and experimentalists who analyze solar cell devices.

More Materials and Applications John Wiley & Sons

Quantum Transport Theory is a comprehensive account of recent achievements in the understanding of disordered conductors. Chapters cover the density matrix description of nonequilibrium statistical mechanics and newer topics in the field of condensed matter physics, including: weak localization; destruction of electronic phase coherence in disordered conductors; electron-electron and electron-phonon interaction in dirty metals; scaling theory of localization; the self-consistent theory of localization; and mesoscopic physics. The diagrammatic technique for systems out of equilibrium is developed systematically, and is used to study quantum kinetic equations and linear response theory.

Photophysics of Molecular Materials Springer Science & Business Media

In the field of organic semiconductors researchers and manufacturers are faced with a wide range of potential molecules. This work presents concepts for simulation-based predictions of material characteristics starting from chemical stuctures. The focus lies on charge transport – be it in microscopic models of amorphous morphologies, lattice models or large-scale device models. An extensive introductory review, which also includes experimental techniques, makes this work interesting for a broad readership. Contents: Organic Semiconductor Devices Experimental Techniques Charge Dynamics at Dierent Scales Computational Methods Energetics and Dispersive Transport Correlated Energetic Landscapes Microscopic, Stochastic and Device Simulations Parametrization of Lattice Models Drift–Diusion with Microscopic Link

Organic Electronics II Charge Transport in Disordered Solids with Applications in Electronics

Solid state physics continues to be the most rapidly growing subdiscipline in physics. As a result, entering graduate students wishing to pursue research in this field face the daunting task of not only mastering the old topics but also gaining competence in the problems of current interest, such as the fractional quantum Hall effect, strongly correlated electron systems, and quantum phase transitions. This book is written to serve the needs of such students. I have attempted in this book to present some of the standard topics in a way that makes it possible to move smoothly to current material. Hence, all the interesting topics are not presented at the end of the book. For example, immediately after the first 50 pages, Anderson's analysis of local magnetic moments is presented as an application of Hartree-Fock theory; this affords a discussion of the relationship with the Kondo model and how scaling ideas can be used to uncloak low-energy physics. As the key problems of current interest in solid state involve some aspects of electron-electron interactions or disorder or both, I have focused on the archetypal problems in which such physics is central. However, only those problems in which there is a consensus view are discussed extensively. In addition, I have placed the emphasis on physics rather than on techniques. Consequently, I focus on a clear presentation of the phenomenology along with a pedagogical derivation of the relevant equations. A key goal of the detailed derivations is to make it possible for the students who have read this book to immediately comprehend research papers on related topics. A key omission in this book is magnetism beyond the Stoner criterion and local magnetic moments. This omission has arisen primarily because the topic is adequately treated in the book by Assa Auerbach.

Organic Light-Emitting Diodes (OLEDs) Springer

For years, concepts and models relevant to the fields of molecular electronics and organic electronics have been invented in parallel, slowing down progress in the field. This book illustrates how synthetic chemists, materials scientists, physicists, and device engineers can work together to reach their desired, shared goals, and provides the knowledge and intellectual basis for this venture. Supramolecular Materials for Opto-Electronics covers the basic principles of building supramolecular organic systems that fulfil the requirements of the targeted opto-electronic function; specific material properties based on the fundamental synthesis and assembly processes; and provides an overview of the current uses of supramolecular materials in opto-electronic devices. To conclude, a "what's next" section provides an outlook on the future of the field, outlining the ways overarching work between research disciplines can be utilised. Postgraduate researchers and academics will appreciate the fundamental insight into concepts and practices of supramolecular systems for opto-electronic device integration.

Hopping Transport in Solids Royal Society of Chemistry

This review volume is based primarily on the balance equation approach developed since 1984. It provides a simple and analytical description about hot electron transport, particularly, in semiconductors with higher carrier density where the carrier-carrier collision is much stronger than the single particle scattering. The steady state and time-dependent hot electron transport, thermal noise, hot phonon effect, the memory effect, and other related subjects of charge carriers under strong electric fields are reviewed. The application of Zubarev's nonequilibrium statistical operator to hot electron transport and its equivalence to the balance equation method are also presented. For semiconductors with very low carrier density, the problem can be regarded as a single carrier transport which will be treated non-perturbatively by the nonequilibrium Green's function technique and the path integral theory. The last part of this book consists of a chapter on the dynamic conductivity and the shot noise suppression of a double-carrier resonant tunneling system.

Advanced Solid State Physics Linköping

University Electronic Press
This book contains the first systematic and detailed exposition of the linear theory of the stationary electron transport phenomena in semiconductors. Arbitrary isotropic and anisotropic nonparabolic bands as well as p-Ge-type bands are considered. Phonon drag effect are taken account of in an arbitrary nonquantizing magnetic field. Scattering theory is discussed in detail with account taken of the Bloch wave functions effect. Transport phenomena in the quantizing magnetic field are studied as well as the size effects in thin films. Band structures of the semiconductors and semiconductor compounds of interest are also considered.The main part of the book deals with the three important problems: charge carrier statistics in a semiconductor, classical and quantum theory of the electron transport phenomena. All the theoretical results considered as well as the validity conditions are presented in the form which may be directly used to interpret experimental data.

Fundamentals, Devices, and Applications John Wiley & Sons
The hopping process, which differs substantially from conventional transport processes in crystals, is the central process in the transport phenomena discussed in this book. Throughout the book the term ``hopping'' is defined as the inelastic tunneling transfer of an electron between two localized electronic states centered at different locations. Such processes do not occur in conventional electronic transport in solids, since localized states are not compatible with the translational symmetry of crystals. The rapid growth of interest in hopping transport has followed in the footsteps of the development of physics of disordered systems during the last three decades. The intense interest in disordered solids can be attributed to the technological potential of the new noncrystalline materials, as well as to new fundamental problems discovered in solid state physics when a crystal is no longer translationally symmetric. In the last decade hopping systems such as organic polymers, biological materials, many oxide glasses, mesoscopic systems, and the new high-temperature superconducting materials in their normal state have attracted much interest. New phenomena investigated recently include interference and coherent scattering in variable range hopping conduction, mesoscopic effects, relaxation processes and thermo-electric power, and thermal conductivity caused by hopping transport. This volume presents the reader with a thorough overview of these recent developments, written by leading experts in the various fields.

Electron Transport Phenomena in Semiconductors John Wiley & Sons
Alkali-doped fullerides have attracted strong interest since their production became possible about fifteen years ago. This book presents recent work which may solve intriguing problems arising from a variety of remarkable properties. For example, these solids are superconductors with high transition temperatures, although the similarity between the electronic and phonon energy scales should suppress superconductivity. Moreover, the Ioffe-Regel condition for electrical conductivity is strongly violated. The book shows why superconductivity is nevertheless possible, owing to a local pairing mechanism. The Ioffe-Regel condition is derived quantum-mechanically, and it is explained why the underlying assumptions are violated for fullerides and high-c cuprates, for example. The book treats electronic and transport properties, reviewing theoretical and experimental results. It focuses on superconductivity, electrical conductivity and metal-insulator transitions, emphasizing the electron-electron and electron-phonon interactions as well as the Jahn-Teller effect.

From Chemical Structures to Devices Academic Press
The first advanced textbook to provide a useful introduction in a brief, coherent and comprehensive way, with a focus on the fundamentals. After having read this book, students will be prepared to understand any of the many multi-authored books available in this field that discuss a particular aspect in more detail, and should also benefit from any of the textbooks in photochemistry or spectroscopy that concentrate on a particular mechanism. Based on a successful and well-proven lecture course given by one of the authors for many years, the book is clearly structured into four sections: electronic structure of organic semiconductors, charged and excited states in organic semiconductors, electronic and optical properties of organic semiconductors, and fundamentals of organic semiconductor devices.

Charge Transport in Disordered Materials John Wiley & Sons
The standard (Markovian) transport model based on the Boltzmann equation cannot describe some non-equilibrium processes called anomalous that take place in many disordered solids. Causes of anomality lie in non-uniformly scaled (fractal) spatial heterogeneities, in which particle trajectories take cluster form. Furthermore, particles can be located in some domains of small sizes (traps) for a long time. Estimations show that path length and waiting time distributions are often characterized by heavy tails of the power law type. This behavior allows the introduction of time and space derivatives of fractional orders. Distinction of path length distribution from exponential is interpreted as a consequence of media fractality, and analogous property of waiting time distribution as a presence of memory. In this book, a novel approach using equations with derivatives of fractional orders is applied to describe anomalous transport and relaxation in disordered semiconductors, dielectrics and quantum dot systems. A relationship between the self-similarity of transport, the Levy stable limiting distributions and the kinetic equations with fractional derivatives is established. It is shown that unlike the well-known Scher Montroll and Arkhipov Rudenko models, which are in a sense alternatives to the normal transport model, fractional differential equations provide a unified mathematical framework for describing normal and dispersive transport. The fractional differential formalism allows the equations of bipolar transport to be written down and transport in distributed dispersion systems to be described. The relationship between fractional transport equations and the generalized limit theorem reveals the probabilistic aspects of the phenomenon in which a dispersive to Gaussian transport transition occurs in a time-of-flight experiment as the applied voltage is decreased and/or the sample thickness increased. Recent experiments devoted to studies of transport in quantum dot arrays are discussed in the framework of dispersive transport models. The memory phenomena in systems under consideration are discussed in the analysis of fractional equations. It is shown that the approach based on the anomalous transport models and the fractional kinetic equations may be very useful in some problems that involve nano-sized systems. These are photon counting statistics of blinking single quantum dot fluorescence, relaxation of current in colloidal quantum dot arrays, and some others.