Nanoelectronics Principles and Devices

The Artech House Nanoscale Science and Engineering

Nanoelectronics and Information Technology

First Principles Simulations of Nanoelectronic Devices

The book allows the reader to have a basic understanding of the structure and properties of nanoscale materials routinely used in nanotechnology-based research and industries. To add, the book describes the operation of nanoscale transistors and the processes used to fabricate the devices. Additionally, it presents research involving the use of carbon nanotubes, graphene, and molecules to create non-silicon based electronic devices. It aims to provide an understanding of the operation of the most frequently used fabrication and characterization procedures, such as scanning electron microscopy, atomic force microscopy, etch, e-beam lithography, and photolithography.

Principles of Production of New Devices for Micro- and Nanoelectronics on the Base of Materials with Ion Tracks

In three handy volumes, this ready reference provides a detailed overview of nanotechnology as it is applied to energy sustainability. Clearly structured, following an introduction, the first part of the book is dedicated to energy production, renewable energy, energy storage, energy distribution, and energy conversion and harvesting. The second part then goes on to discuss nano-enabled materials, energy conservation and management, technological and intellectual property-related issues and markets and environmental remediation. The text concludes with a look at and recommendations for future technology advances. An essential handbook for all experts in the field - from academic researchers to developers in industry.

Nanoelectronic Materials

This book presents synthesis techniques for the preparation of low-dimensional nanomaterials including 0D (quantum dots), 1D (nanowires, nanotubes) and 2D (thin films, few layers), as well as their potential applications in nanoelectronic systems. It focuses on the size effects involved in the transition from bulk materials to nanomaterials; the electronic properties of nanoscale devices; and different classes of nanomaterials from microelectronics to nanoelectronics, to molecular electronics. Furthermore, it demonstrates the structural stability, physical, chemical, magnetic, optical, electrical, thermal, electronic and mechanical properties of the nanomaterials. Subsequent chapters address their characterization, fabrication techniques from lab-scale to mass production, and functionality. In turn, the book considers the environmental impact of nanoelectronics and novel applications in the chemical industries, energy harvesting, clean energy, manufacturing materials, electronics, transistors, health and medical technology. In closing, it addresses the combination of biological systems with nanoelectronics and highlights examples of nanoelectronic- cell interfaces and other advanced medical applications. The book answers the following questions: What is different at the nanoscale? What is new about nanoscience? What are the fundamental issues in nanomaterials? Where are nanomaterials found? What nanomaterials exist in nature? What is the importance of NMs in our lives? Why so much interest in nanomaterials? What is at nanoscale in nanomaterials? What is graphene? Are pure low-dimensional systems interesting and worth pursuing? Are nanotechnology products currently available? What are sensors? How can Artificial Intelligence (AI) and nanotechnology work together? What are the recent advances in nanoelectronic materials? What are the latest applications of NMs?

Nanotechnology: Principles and Practices

This book is focused on recent advances in the development of thin films for photovoltaic applications. It covers thin-film applications with enhanced photo-catalytic properties, nanometer oxide and hydroxide films for anticorrosive coatings, surface passivation in chemical industries, micro- and nanoelectronics, bialayers and bilayers and lead free piezoelectrics for magnetic field sensors, current sensors, spintronics, microwave and read/write devices. Diluted ferromagnetic alloy films are also considered for superconducting spintronics based on superconducting spin-valves. Thermal properties of segmented nanowires are analyzed with respect to thermoelectric applications. Recent advances in template production of nanocomposites are also reviewed with particular focus on technologies for template assisted formation of metal nanotubes. Some elements related to abrasive flow machining (AFM), specifically state of the art elements of technological and photolithography. The book is written for researchers in materials science, nanotechnologies, PhD students and graduate students.

Non-Linear Transport Properties of Hybrid Nanoelectronic Devices

In-depth analysis of the theory, properties and description of the most potential technological applications of metamaterials for the realization of novel devices such as subwavelength lenses, invisibility cloaks, dipole and reflector antennas, high frequency telecommunications, new designs of bandpass filters, absorbers and...
concentrators of EM waves etc. In order to create a new device, it is necessary to know the main electrodynamical characteristics of metamaterial structures on the basis of which the device is supposed to be created. The electromagnetic wave scattering surfaces built with metamaterials are primarily based on the ability of metamaterials to control the surrounded electromagnetic fields by varying their permeability and permittivity characteristics. The book covers some solutions for micro- and nanoscale wavelength scales as well as exploitation of nanoscale EM wavelength such as visible spector using recent advances of nanotechnology, for instance in the field of nanowires, nanopolymers, carbon nanotubes and graphene. Metamaterial is suitable for scholars from extremely large scientific domains and therefore given to engineers, scientists, graduates and other interested professionals from photonics to nanoscience and from material science to antenna engineering as a comprehensive reference on this artificial materials of tomorrow.

**Introductory Nanoelectronics**

Introducing up-to-date coverage of research in electron field emission from nanostructures, Vacuum Nanoelectronic Devices outlines the physics of quantum nanostructures, basic principles of electron field emission, and vacuum nanoelectronic devices operation, and offers insight state-of-the-art and future researches and developments. This book also evaluates the results of research and development of novel quantum electron sources that will determine the future development of vacuum nanoelectronics. Further to this, the influence of quantum mechanical effects on high frequency vacuum nanoelectronic devices is also assessed. Key features: • In-depth description and analysis of the fundamentals of Quantum Electron effects in novel electron sources. • Comprehensive and up-to-date summary of the physics and technologies for THz sources for students of physical and engineering specialties and electronics engineers. • Unique coverage of quantum physical results for electron field emission and novel electron sources with quantum effects, relevant for many applications such as electron microscopy, electron lithography, imaging and communication systems and signal processing. • New approaches for realization of electron sources with required and optimal parameters in electronic devices such as vacuum micro and nanoelectronics. This is an essential reference for researchers working in terahertz technology wanting to expand their knowledge of electron beam generation in vacuum and electron source quantum concepts. It is also valuable to advanced students in electronics engineering and physics who want to deepen their understanding of this topic. Ultimately, the progress of the quantum nanostructure theory and technology will promote the progress and development of electron sources as main part of vacuum micro-, micro- and nanoelectronics.

**Nanoelectronics**

**Nanodevices Principle and Applications**

Offering first-hand insights by top scientists and industry experts at the forefront of R&D into nanoelectronics, this book neatly links the underlying technological principles with present and future applications. A brief introduction is followed by an overview of present and emerging logic devices, memories and power technologies. Specific chapters are dedicated to the enabling factors, such as new materials, characterization techniques, smart manufacturing and advanced circuit design. The second part of the book provides detailed coverage of the current state and showcases real future applications in a wide range of fields: safety, transport, medicine, environment, manufacturing, and social life, including an analysis of emerging trends in the internet of things and cyber-physical systems. A survey of main economic factors and trends concludes the book. Highlighting the importance of nanoelectronics in the core fields of communication and information technology, this is essential reading for materials scientists, electronics and electrical engineers, as well as those working in the semiconductor and sensor industries.

**Electrical Atomic Force Microscopy for Nanoelectronics**

Maintaining and improving energy security is one of the biggest challenges worldwide. The NATO ARW conference in Tallent, October 2012, was devoted to discussing visions and concepts that are currently discussed in different research fields. Leading scientists have written concise contributions to introduce the reader to this exciting topic. The present volume summarizes the discussions at the conference.

**Introductory Nanoelectronics**

Emerging Nanoelectronic Devices focuses on the future direction of semiconductor and emerging nanoscale device technology. As the dimensional scaling of CMOS approaches limits, alternative exploitation processing devices and architectures are being explored to sustain increasing functionality at decreasing cost into the indefinite future. This includes the paradigm shifts in information processing enabled by innovative new devices, circuits, and architectures, necessary to support an increasingly interconnected world through a rapidly evolving internet. This original title provides a fresh perspective on emerging research devices in 26 up-to-date chapters written by the leading researchers in their respective areas. It supplements and extends the work performed by the Emerging Research Devices working group of the International Technology Roadmap for Semiconductors (ITRS). Key features: • Serves as an authoritative tutorial on innovative devices and architectures that populate the dynamic worlds of “Beyond CMOS” technologies. • Provides a realistic assessment of the strengths, weaknesses and key unknowns associated with each technology. • Suggests guidelines for the directions of future development of each technology. • Emphasizes physical concepts over mathematical development. • Provides an essential resource for students, researchers and practicing engineers.

**Emerging Nanoelectronic Devices**

This outstanding textbook provides an introduction to electronic materials and device concepts for the major areas of current and future information technology. On about 1,000 pages, it collects the fundamental concepts and key technologies related to advanced electronic materials and devices. The obvious strength of the book is its encyclopedic character, providing an adequate background material instead of just reviewing current trends. It focuses on the underlying principles which are illustrated by current examples. The third edition now holds 47 chapters grouped into eight sections. The first two sections are devoted to principles, materials processing and characterization methods. Following sections hold contributions to relevant materials and various devices, computational concepts, storage systems, data transmission, imaging systems and displays. Each subject area is opened by a tutorial introduction, written by the editor and giving an rich list of references. The following chapters provide a concise yet in-depth description in a given topic. Primarily aimed at graduate students of physics, electrical engineering and information technology as well as material science, this book is equally of interest to professionals looking for a broader overview. Experts might appreciate the book for having quick access to principles as well as a source for getting insight into related fields.

**Nanotechnology**

Nanoelectronic Devices and Their Applications helps readers acquire a thorough understanding of the fundamentals of solids at the nanoscale level in addition to their applications including operation and properties of recent nanoscale devices. This book includes seven chapters that give an overview of electronics in solids, carbon nanotube devices and their applications, doping techniques, construction and operational details of channel-engineered MOSFETs, and spintronic devices and their applications. Structural and operational features of phase-change memory (PCM), memristor, and resistive random-access memory (ReRAM) are also discussed. In addition, some applications of these phase-change devices to logic designs have been presented. Aimed at senior undergraduate
This book presents the achievements in bionanoelectronics in a coherent manner. It deals with nanodevices applied to biostructures, molecular motors, molecular pumps, molecular nanoelectromotors and electronic biodiodes, including nanodevices for sensing and imaging biomolecules. The book describes bionanoelectronics, detection of biomolecules and targets various biological applications such as detection and sequencing of DNA and early detection of various diseases and nanomedicine. Further important topics of the book are biomimetics and bioinspired electronics. The book also deals with biomolecules as building blocks of nanodevices for nanoelectronics or future computing architecture. The application of scanning probe techniques to biological samples is described.

**Metamaterial**

This introductory text develops the reader’s fundamental understanding of core principles and experimental aspects underlying the operation of nanoelectronic devices. The author makes a thorough and systematic presentation of electron transport in quantum-confined systems such as quantum dots, quantum wires, and quantum wells together with Landauer–Büttiker formalism and non-equilibrium Green’s function approach. The coverage encompasses nanofabrication techniques and characterization tools followed by a comprehensive exposition of nanoelectronic devices including resonant tunneling diodes, nanoscale MOSFETs, carbon nanotube FETs, high-electron-mobility transistors, single-electron transistors, and heterostructure optoelectronic devices. The writing throughout is simple and straightforward, with clearly drawn illustrations and extensive self-study exercises for each chapter. It introduces the basic concepts underlying the operation of nanoelectronic devices. Offers a broad overview of the field, including state-of-the-art developments. Covers the relevant quantum and solid-state physics and nanoelectronic device principles. Written in lucid language with accessible mathematical treatment. Includes extensive end-of-chapter exercises and many insightful diagrams.

**Nanoelectronic Circuit Design**

This book provides readers with the knowledge in fundamentals of nanoelectronic devices. The authors build the principles of nanoelectronic devices based on those of microelectronic devices wherever possible and introduce the inherently nanoelectronic principles gradually. They briefly review quantum mechanics and solid-state physics and nanoelectronic device principles. Written in lucid language with accessible mathematical treatment. Includes extensive end-of-chapter exercises and many insightful diagrams.

**Nanoelectronics**

This book explores emerging topics in atomic- and nano-scale electronics after the era of Moore’s Law, covering both the physical principles behind, and technological implementations for many devices that are now expected to become key elements of the future of nanoelectronics beyond traditional complementary metal-oxide-semiconductor (CMOS). Moore’s law is not a physical law itself, but rather a visionary prediction that has worked well for more than 50 years but is rapidly coming to its end as the gate length of CMOS transistors approaches the length scale of only a few atoms. Thus, the key question here is “What is the future for nanoelectronics beyond CMOS?” The possible answers are found in this book. Introducing novel quantum devices such as atomic-scale electronic devices, ballistic devices, memristors, superconducting devices, this book also presents the reader with the physical principles underlying new ways of computing as well as their practical implementation. Topics such as quantum computing, neuromorphic computing are highlighted here as some of the most promising candidates for ushering in a new era of atomic-scale electronics beyond CMOS.

**Low-Dimensional Functional Materials**

This book provides readers with the knowledge in fundamentals of nanoelectronic devices. The authors build the principles of nanoelectronic devices based on those of microelectronic devices wherever possible and introduce the inherently nanoelectronic principles gradually. They briefly review quantum mechanics and solid-state physics that can form the basis of semiconductor device physics. The book also covers the basics of electron transport and p–n junctions, develops the fundamental physics in these semiconductor physics and NDR in CNT FETs. Discusses spin-controlled devices and their applications, multi-material devices, and gates in addition to phase-change devices.

**MOSFETs, Carbon Nanotube FETs, High-Electron-Mobility Transistors, Single-Electron Transistors, and Heterostructure Optoelectronic Devices**

The tremendous impact of electronic devices on our lives is the result of continuous improvements of the billions of nanoelectronic components inside integrated circuits (ICs). However, ultra-scaled semiconductor devices require nanometer control of the many parameters essential for their fabrication. Through the years, this created a strong alliance between microscopy techniques and IC manufacturing. This book reviews the latest progress in IC devices, with emphasis on the impact of electrical atomic force microscopy (AFM) techniques on their development. The operation principles of many techniques are introduced, and the associated metrology challenges described. Blending the expertise of industrial specialists and academic researchers, the chapters are dedicated to various AFM methods and their impact on the development of emerging nanoelectronic devices. The goal is to introduce the major electrical AFM methods, following the journey that has seen our lives changed by the advent of ubiquitous nanoelectronic devices, and has extended our capability to sense matter on a scale previously inaccessible.

**Nanotechnology: Concepts, Methodologies, Tools, and Applications**

This book presents the achievements in bionanoelectronics in a coherent manner. It deals with nanodevices applied to biostructures, molecular motors, molecular pumps, molecular nanoelectromotors and electronic biodiodes, including nanodevices for sensing and imaging biomolecules. The book describes bionanoelectronics, detection of biomolecules and targets various biological applications such as detection and sequencing of DNA and early detection of various diseases and nanomedicine. Further important topics of the book are biomimetics and bioinspired electronics. The book also deals with biomolecules as building blocks of nanodevices for nanoelectronics or future computing architecture. The application of scanning probe techniques to biological samples is described.

**Atomic-Scale Electronics Beyond CMOS**

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**Bionanoelectronics**

It is becoming increasingly clear that the two-dimensional layout of devices on computer chips hinders the development of high-performance computer systems. Three-dimensional structures will be needed to provide the performance required to implement computationally intensive tasks. 3-D Nanoelectronic Computer Architecture and Implementation reviews the state of the art in nanoelectronic device design and fabrication and discusses the architectural aspects of 3-D designs, including the possible use of molecular wiring and carbon nanotube interconnections. This is a valuable reference for those involved in the design and development of nanoelectronic devices and technology.

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**Nanoelectronic Circuit Design**

This book provides readers with the knowledge in fundamentals of nanoelectronic devices. The authors build the principles of nanoelectronic devices based on those of microelectronic devices wherever possible and introduce the inherently nanoelectronic principles gradually. They briefly review quantum mechanics and solid-state physics that can form the basis of semiconductor device physics. The book also covers the basics of electron transport and p–n junctions, develops the operations of MOS capacitors and MOSFETs, and introduces some basic CMOS circuits. The last chapter is devoted to the nano-biotechnology application of field-effect transistors.
This book is about large-scale electronic circuits design driven by nanotechnology, where nanotechnology is broadly defined as building circuits using nanoscale atoms. It covers and connects a wide spectrum of topics related to semiconductor device physics, design of circuits and systems, bridging the existing gap between nanodevice research and nanosystem design. The book extends from basic research in physics, chemistry, and biology, including computational work and simulations, through to the development of new devices and technologies for applications in a wide range of industrial sectors (including information technology, medicine, manufacturing, high-performance materials, and also those of nanobiotechnology, pharmaceuticals, food packaging, biosensors, and electronic devices). The book will be an exhilarating read for advanced undergraduate- and graduate-level students, general readers interested in nanotechnology, and researchers in chemistry, biology, and engineering. The scope of the book includes nanotechnology in different areas of research. It discusses the role of nanotechnology in different areas, such as healthcare, especially in target-specific drug therapy for managing a number of medical disorders; agriculture, for developing smart field systems; and food industry, for improving and stabilizing the quality, healthiness, and shelf life of food. Being multidisciplinary, this book brings together the principles, theory, practices, and applications of not only nanotechnology but also those of nanobiotechnology, pharmaceuticals, food packaging, bioreactors, and electronic devices. The book will be an exhilarating read for advanced undergraduate- and graduate-level students, general readers interested in nanotechnology, and researchers in chemistry, biology, and engineering. The scope of the book extends from basic research in physics, chemistry, and biology, including computational work and simulations, through to the development of new devices and technologies for applications in a wide range of industrial sectors (including information technology, medicine, manufacturing, high-performance materials, and energy and environmental technologies). It covers organic, inorganic, and hybrid materials and is an interdisciplinary book.

Field Effect Transistors, A Comprehensive Overview

This book discusses modern-day Metal Oxide Semiconductor Field Effect Transistors (MOSFETs) and future trends of transistor devices. This book provides an overview of Field Effect Transistors (FETs) by discussing the basic principles of FETs and exploring the latest technological developments in the field. It covers and connects a wide spectrum of topics related to semiconductor device physics, design of circuits and systems, bridging the existing gap between nanodevice research and nanosystem design. The book contains six chapters. Chapter 1 discusses electronic materials and charge. Chapter 2 examines junctions, discusses contacts under thermal-equilibrium, metal-semiconductor contacts, and metal-insulator-semiconductor systems. Chapter 3 covers traditional planar Metal Oxide Semiconductor Field Effect Transistors (MOSFETs). Chapter 4 describes self-driving technologies and device dimensions of MOSFETs. Chapter 5 analyzes Heterojunction Field Effect Transistors (FETs) and also discusses the challenges and rewards of heterotaxy. Finally, Chapter 6 examines FETs at molecular scales. Links the discussion of contemporary transistor device design to physical processes. Material has been class-tested in undergraduate and graduate courses on the design of integrated circuit components taught by the author. Contains a list of examples and end-of-chapter problems. Field Effect Transistors, A Comprehensive Overview: From Basic Concepts to Novel Technologies is a reference for senior undergraduate/graduate students and professional engineers needing insight into physics of operation of modern FETs. Pouya Valizadeh is Associate Professor in the Department of Electrical and Computer Engineering at Concordia University in Quebec, Canada. He received B.S. and M.S. degrees with honors from the University of Tehran and Ph.D. degree from The University of Michigan (Ann Arbor) in Electrical Engineering in 1997, 1999, and 2003, respectively. Over the past decade, Dr. Valizadeh has taught numerous sections of five different courses covering topics such as semiconductor process technology, semiconductor materials and their properties, advanced solid state devices, transistor design for modern CMOS technology, and high speed transistors.

Quantum Nanoelectronics

Given the rapid advances in the field, this book offers an up-to-date introduction to nanomaterials and nanotechnology. Though condensed into a relatively small volume, it spans the whole range of multidisciplinary topics related to nanotechnology. Starting with the basic concepts of quantum mechanics and solid state physics, it presents both physical and chemical synthetic methods, as well as analytical techniques for studying nanostructures. This size specific properties of nanomaterials, such as their thermal, mechanical, optical and magnetic characteristics, are discussed in detail. The book goes on to illustrate the various applications of nanomaterials in electronics, optoelectronics, cosmetics, energy, textiles and the medical field and discusses the environmental impact of these technologies. Many new areas, materials and effects are then introduced, including spintronics, soft lithography, metamaterials, the lotus effect, the Gecko effect and graphene. The book also explains the fundamental principles of essential techniques, such as scanning tunneling microscopy (STM), atomic force microscopy (AFM), scanning near field optical microscopy (SNOM), Raman spectroscopy and photoelectron microscopy. In closing, Chapter 34, “Practicals”, provides a helpful guide to setting up and conducting inexpensive nanotechnology experiments in teaching laboratories.

Nanoelectronic Devices

Computational nanoelectronics is an emerging multi-disciplinary field covering condensed matter physics, applied mathematics, computer science, and electronic engineering. In recent decades, a few state-of-the-art software packages have been developed to carry out first-principles atomistic simulations. Nevertheless, those packages are either black boxes (commercial codes) or accessible only to very limited users (private research codes). The purpose of this book is to open one of the commercial black boxes, and to demonstrate the complete procedure from theoretical derivation, to numerical implementation, all the way to device simulation. Meanwhile the affiliated source code constitutes an open platform for new researchers. This is the first book of its kind. We hope the book will make a modest contribution to the field of computational nanoelectronics. Contents: Introduction, The NECPA Theory, The NECPA-LMTO Method, NanodSim: The Package Design, NanoSim: Bulk Systems, NanoSim: Two-Probe Systems, and Optimization, and Parallelization, A Kaleidoscope of the Physics in Disordered Systems. Appendix: Readership: Postgraduate students or professional researchers who are interested in computational physics, device physics, quantum transport, disorder systems, and overlap of the above.

Nanoelectronic Devices

This book gives a summary of the rapidly growing field of nanotechnology and includes materials and technologies that help in developing particles of various sizes, which can be utilized in different areas of research. It discusses the role of nanotechnology in different aspects, such as healthcare, especially in target-specific drug therapy for managing a number of medical disorders; agriculture, for developing smart field systems; and food industry, for improving and stabilizing the quality, healthiness, and shelf life of food. Being multidisciplinary, this book brings together the principles, theory, practices, and applications of not only nanotechnology but also those of nanobiotechnology, pharmaceuticals, food packaging, bioreactors, and electronic devices. The book will be an exhilarating read for advanced undergraduate- and graduate-level students, general readers interested in nanotechnology, and researchers in chemistry, biology, and engineering. The scope of the book extends from basic research in physics, chemistry, and biology, including computational work and simulations, through to the development of new devices and technologies for applications in a wide range of industrial sectors (including information technology, medicine, manufacturing, high-performance materials, and energy and environmental technologies). It covers organic, inorganic, and hybrid materials and is an interdisciplinary book.

Atomic Simulation of Quantum Transport in Nanoelectronic Devices

This book is about large-scale electronic circuits design driven by nanotechnology, where nanotechnology is broadly defined as building circuits using nanoscale devices that are either implemented with nanomaterials (e.g., nanotubes or nanowires) or following an unconventional method (e.g., FinFET or III/V compound-based devices). These nanoscale devices have significant potential to revolutionize the fabrication and integration of electronic systems and scale beyond the perceived scaling limitations of traditional CMOS. While innovations in nanotechnology originate at the individual device level, realizing the maximum impact of electronic systems demands that these device-level capabilities be translated into system-level benefits. This is the first book to focus on nanoscale circuits and their design issues, bridging the existing gap between nanodevice research and nanosystem design.

Nanoelectronics and Photonics

This book gives a summary of the rapidly growing field of nanotechnology and includes materials and technologies that help in developing particles of various sizes, active in different areas of research. It discusses the role of nanotechnology in different areas, such as healthcare, especially in target-specific drug therapy for managing a number of medical disorders; agriculture, for developing smart field systems; and food industry, for improving and stabilizing the quality, healthiness, and shelf life of food. Being multidisciplinary, this book brings together the principles, theory, practices, and applications of not only nanotechnology but also those of nanobiotechnology, pharmaceuticals, food packaging, bioreactors, and electronic devices. The book will be an exhilarating read for advanced undergraduate- and graduate-level students, general readers interested in nanotechnology, and researchers in chemistry, biology, and engineering. The scope of the book extends from basic research in physics, chemistry, and biology, including computational work and simulations, through to the development of new devices and technologies for applications in a wide range of industrial sectors (including information technology, medicine, manufacturing, high-performance materials, and energy and environmental technologies). It covers organic, inorganic, and hybrid materials and is an interdisciplinary book.
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Basic Principles of Nanotechnology

A tutorial coverage of electronic technology, starting from the basics of condensed matter and quantum physics. Experienced author Ed Wolf presents established and novel devices like Field Effect and Single Electron Transistors, and leads the reader up to applications in data storage, quantum computing, and energy harvesting. Intended to be self-contained for students with two years of calculus-based college physics, with corresponding fundamental knowledge in mathematics, computing, and chemistry.

Introduction to Nanoelectronic Single-Electron Circuit Design

Over the past few decades, devices and technologies have been significantly miniaturized from one generation to the next, providing far more potential in a much smaller package. The smallest of these recently developed tools are minuscule enough to be visible to the naked eye. Nanotechnology: Concepts, Methodologies, Tools, and Applications describes some of the latest advances in microscopic technologies in fields as diverse as biochemistry, materials science, medicine, and electronics. Through its investigation of theories, applications, and new developments in nanotechnology field, this impressive reference source will serve as a valuable tool for researchers, engineers, academics, and students alike.

Nanotechnology for Energy Sustainability, 3 Volume Set

Academic Paper from the year 2018 in the subject Physics– Nuclear Physics, Molecular Physics, Solid State Physics, Language: English, Abstract: This book can be useful for an academic course on nanoscience and nanotechnology. This book is very useful for the beginner in nanotechnology and nanoelectronics. The book is divided into seven chapters: The first chapter contains the introduction of nanodevices, definition and classification of nanomaterials and nanodevices. The second chapter contains the detailed summary of the semiconductors and various semiconductor nanodevices. This will be helpful to study the changes occur at the nanoscale in bulk materials or bulk devices when they approach the nanoscale. The third chapter contains the introduction, principles, and applications of various quantum confined structures and devices. The fourth chapter gives the idea about the molecular junction, single molecular devices, and their applications in other devices as an incorporated structures or hybrid applications. It contains the overview of natural and artificial nanodevices. It has given the knowledge of molecular nanoelectronics. The fifth chapter contains the overview and advanced knowledge of natural and artificial nanosensors. It explains the various nanosensors and their applications.

Fundamentals of Nanoelectronics

This introductory text develops the reader’s fundamental understanding of core principles and experimental aspects underlying the operation of nanoelectronic devices. The author makes a thorough and systematic presentation of electronic transport in quantum-confined systems such as quantum dots, quantum wires, and quantum wells together with Landauer-Büttiker formalism and non-equilibrium Green’s function approach. The coverage encompasses nanofabrication techniques and characterization tools followed by a comprehensive exposition of nanoelectronic devices including resonant tunneling diodes, quantum well MOSFETs, carbon nanotube FETs, high-electron-mobility transistors, single-electron transistors, and heterostructure optoelectronic devices. The writing throughout is simple and straightforward, with clearly drawn illustrations and extensive self-study exercises for each chapter. Introduces the basic concepts underlying the operation of nanoelectronic devices. Offers a broad overview of the field, including state-of-the-art developments. Covers the relevant quantum and solid-state physics and nanoelectronic device principles. Written in lucid language with accessible mathematical treatment. Includes extensive end-of-chapter exercises and many insightful diagrams.

Nanostructures and Thin Films for Multifunctional Applications

For undergraduate courses in nanoelectronics. This is the first actual nanoelectronics textbook for undergraduate engineering and applied sciences students. It provides an introduction to nanoelectronics, as well as a self-contained overview of the necessary physical concepts — taking a fairly gentle but serious approach to a field that will be extremely important in the near future.

Nanotechnology

Today, the concepts of single-electron tunneling (SET) are used to understand and model single-atom and single-molecule nanoelectronics. The characteristics of nanoelectronic devices, especially SET transistors, can be understood on the basis of the physics of nanoelectronic devices and circuit models. A circuit theory approach is necessary for considering possible integration with current microelectronic circuitry. To explain the properties and possibilities of SET devices, this book follows an approach to modeling these devices using electronic circuit theory. All models and equivalent circuits are derived from the first principles of circuit theory. Based on energy conservation, the circuit model of SET is an impulsive current source, and modeling distinguishes between bounded and unbounded currents. The Coulomb blockade is explained as a property of a single junction. In addition, this edition differs from the previous one by elaborating on the section on spicel simulations and providing a spice simulation on the SET electron box circuit, including the spice netlist. Also, a complete, new proof of the two-capacitor problem in circuit theory is presented; the importance of this proof in understanding energy conservation in SET circuits cannot be underestimated. This book will be very useful for advanced undergraduate- and graduate-level students of electrical engineering and nanoelectronics and researchers in nanoelectronics, nanoelectronic devices, and computer science. Only book modeling both single-electron tunneling and many-electron tunneling from the points of view of electronics starting from experiments, via a physics description, working towards a circuit description, and based on energy conservation, in electrical circuits, developing the impulse circuit model for single-electron tunneling.

Communication Shock

Textbook presenting the fundamentals of nanoscience and nanotechnology with a view to nanoelectronics. Covers the underlying physics, nanomaterials, including nanoobjects; methods for growth, fabrication and characterization of nanomaterials; and nanodevices. Provides a unifying framework for the basic ideas
Electronic Conduction

In the spirit of Alvin Toffler’s acclaimed works peering into the future of the technological society, Communication Shock is a concise history of communication technologies and an exploration of the possible social and human impacts of nanotechnology on the ecology of human communication. As we become increasingly more networked with communication technologies, we must come to understand and confront the social impact of these changes. More importantly, we must wisely choose in embracing or rejecting these technologies and exploring how we might do both by striking an appropriate balance. Grounded in communication theory and praxis, Communication Shock brings some objectivity to the discussion of technology, maps its development, and encourages a rational conversation about its potential problems and promises. It challenges readers to reach their own conclusions—about the future, imagined and unimaginable, about the fundamental values in conflict, and how one might choose to embrace or contest them to maintain individual autonomy in the face of increasingly ubiquitous marketing and technological change. Present and emerging communication technologies hold the promise for a bold new future, but they also have inherent risks and drawbacks. Communication shock is the human response, conscious or unconscious, wherein the individual chooses to resist the growing pervasiveness of technology in his or her life by seeking ways to reduce or redirect new technologies or to reject the addition of such technologies altogether. Here is a framework for understanding the potential of the evolving technologies, determining which are essential and which are distractions from the life that one believes to be meaningful, and making informed choices for the life one wishes to live.

Nanoscale Electronic Devices and Their Applications

Nanotechnology has the potential to revolutionize the agricultural and food industry with new tools for the molecular treatment of diseases, rapid disease detection, enhancing the ability of plants to absorb nutrients, etc. Nanotechnology combines solid state physics, chemistry, electrical engineering, chemical engineering, biochemistry, and biophysics, and materials science. It is a highly interdisciplinary area meaning that it involves ideas integrated from many traditional disciplines. Nanotechnology (NT) is the production and use of materials with purposely engineered features close to the atomic or molecular scale. NT deals with putting things together atom by atom and with structures so small they are invisible to the naked eye. It provides the ability to create materials, devices, and systems with fundamentally new functions and properties. The promise of NT is enormous. It has implications for almost every type of manufacturing process and product. Nanomaterials have extremely small size which having at least one dimension 100 nm or less. Nanomaterials can be nanoscale in one dimension (e.g. surface films), two dimensions (e.g. strands or fibres), or three dimensions (e.g. particles). They can exist in single, fused, aggregated or agglomerated forms with spherical, tubular, and irregular shapes. Common types of nanomaterials include nanotubes, dendrimers, quantum dots and fullerenes. Nanoparticle research is currently an area of intense scientific research, due to a wide variety of potential applications in biomedical, optical, and electronic fields. Nanoparticles are of great scientific interest, as they are effectively bridges between bulk materials and atomic or molecular structures. A bulk material should have constant physical properties regardless of its size, but at the nano-scale this is often not the case. This book introduces the reader to the world of nanotechnology by giving them in-depth details of different aspects of the field.

Vacuum Nanoelectronic Devices

The subject of this thesis is the study of hybrid nanoelectronic components involving superconductors or excitonic systems. The behavior of such electronic devices is relevant both for the miniaturization of electronics as well as for possible future on-chip quantum computation. In order to characterize them, the cumulant generating function of charge transfer is calculated. First, quantum point contacts between (conventional and unconventional) superconductors, ferromagnets or Majorana fermions are investigated. The focus of interest are transport processes involving non-trivial correlated electronic states such as Cooper pairs, excitons or Majorana fermions. In the second part quantum impurities are included and the effects of onsite Coulomb and electron-phonon interaction are discussed. Using these results the possibility to witness entanglement in superconducting beamsplitters is demonstrated. The results are compared both to different theoretical approaches and experimental data.

Introduction to Nanoelectronics

Electronic Conduction: Classical and Quantum Theory to Nanoelectronic Devices provides a concise, complete introduction to the fundamental principles of electronic conduction in microelectronic and nanoelectronic devices, with an emphasis on integrating the quantum aspects of conduction. The chapter coverage begins by presenting the classical theory of conduction, including introductory chapters on quantum mechanics and the solid state, then moving to a complete presentation of essential theory for understanding modern electronic devices. The author’s unique approach is applicable to microscale and nanoscale device simulation, which is particularly timely given the explosion in the nanoelectronics field. Features: Self-contained and self-sufficient. Gives a complete account of classical and quantum aspects of conduction in nanometer scale devices. Emphasizes core principles, the book can be useful to electrical engineers and material scientists, and no prior course in semiconductors is necessary. Highlights the bridge to modern electronics, first presenting the physics, and then the engineering complications related to quantum behaviour. Includes many clear, illustrative diagrams and chapter problem sets. Gives an account of post-Silicon devices such as the GaAs MOSFET, the CNT-FET and the vacuum transistor. Discusses why quantum mechanics is necessary with modern devices due to their size and corresponding electron transport properties. Discusses all the issues that will enable readers to conduct their own research.

Introduction to Nanoelectronics

Nanoelectronics and Photonics provides a fundamental description of the core elements and problems of advanced and future information technology. The authoritative book collects a series of tutorial chapters from leaders in the field covering fundamental topics from materials to devices and system architecture, and bridges the fundamental laws of physics and chemistry of materials at the atomic scale with device and circuit design and performance requirements.