Carbon Nanotube Electronics

This book provides readers with a comprehensive toolbox for dispersing single-walled and multiwalled carbon nanotubes in thermoplastic polymer matrices. The book starts with an overview of all known techniques for dispersing CNTs in thermoplastic polymers and then concentrates on one of the most versatile techniques known nowadays: the so-called la

In this book, meshes and networks formed out of multiwalled carbon nanotubes are investigated and analyzed, including their use in niche applications such as electro-optic devices, advanced mechanical, thermal and electrical property enhancement, and gene editing.

Different properties of multi-walled carbon nanotubes, including random network formation, ordering the meshes and networks by mechanical agitation and application of an external field, using crystallization and cross-linking induced phase separation in homopolymers-CNT composites are discussed with theoretical analysis. The book is aimed at researchers and graduate students in Electrical Engineering; Materials Science and Engineering; Chemical Engineering and Nanotechnology, Electronic circuit design, manufacturing, and characterization.

The book describes the state-of-the-art in fundamental, applied and device physics of nanotubes, including fabrication, manipulation and characterization for device applications; optics of nanotubes; transport and electromechanical devices and fundamentals of theory for applications. This information is critical to the field of nanoscience since nanotubes have the potential to become a very significant electronic material for decades to come. The book will benefit all all readers interested in the application of nanotubes, either in their theoretical foundations or in newly developed characterization tools that may enable practical device fabrication.

This book overviews the current status of research and development activities of CNTs in nanodevices, nanomaterials, or nanofabrication. This book presents 15 state-of-the-art review articles that cover CNT synthesis technologies for growing highly orientated CNTs, chirality-pure CNTs and CNTs at a large throughput and low cost, CNT assembly techniques, CNT sorting and separation processes, CNT functionalization engineering for more functionalities, CNT fundamental properties and their practical/potential electrical, electronic, optical, mechanical, chemical and biological applications.

Remarkable progress has been achieved within recent years in developing flexible, wearable, and stretchable (FWS) electronics. These electronics will play an increasingly significant role in the future of electronics and will open new product paradigms that conventional semiconductors are not capable of. This is because flexible electronics will allow us to build flexible circuits and devices on a substrate that can be bent, stretched, or folded without losing functionality. This revolutionary change will impact how we interact with the world around us. Future electronic devices will use flexible electronics as part of ambient intelligence and ubiquitous computing for many different applications such as consumer electronics, medical, healthcare, and security devices. Thus, these devices have the potential to create a huge market all over the world. Flexible, Wearable, and Stretchable Electronics, provide a comprehensive technological review of the state-of-the-art developments in FWS electronics. This book offers the reader a taste of what is possible with FWS electronics and describes how these electronics can provide unique solutions for a wide variety of applications. Furthermore, the book introduces and explains new applications of flexible technology that has opened up the future of FWS electronics.

For more than 50 years, silicon has dominated the electronics industry. However, this growth will come to an end, due to resources limitations. Thus, research developments need to focus to alternative materials, with higher performance and better functionality. Current research achievements have indicated that carbon is one of the promising candidates for its exploitation in the electronics industry. Whereas the physical properties of graphite and diamond have been investigated for many years, the potential for electronic applications of other allotropes of carbon (fullerenes, carbon nanotubes, carbon nanofibres, carbon films, carbon balls and beads, carbon fibers, etc), has only been appreciated relatively recently. Carbon-based materials offer a number of exciting possibilities for new applications of electronic devices, due to their unique thermal and electrical properties. However, the success of carbon-based electronics depends on the rapid progress of the fabrication, doping and manipulation techniques. In this Special Issue, we focus on both insights and advancements in carbon-based electronics. We will also cover various topics ranging from synthesis, functionalisation, and characterisation of carbon-based materials, for their use in electronic devices, including advanced manufacturing techniques, such as 3D printing, ink-jet printing, spray-gun technique, etc.

The book introduces flexible and stretchable wearable electronic systems and covers in detail the technologies and materials required for healthcare and medical applications. A team of excellent authors gives an overview of currently available flexible devices and thoroughly describes their physical mechanisms that enable sensing human conditions. In dedicated chapters, crucial components needed to realize flexible and wearable devices are discussed which include transistors and sensors and deal with memory, data handling and display. Additionally, suitable power sources based on photovoltaics, thermoelectric energy and supercapacitors are reviewed. A special chapter treats implantable flexible sensors for neural recording. The book editor concludes with a perspective on this rapidly developing field which is expected to have a great impact on healthcare in the 21st century.

Carbon-Based Electronics
Techniques and Applications
Graphene, Carbon Nanotubes, and Nanostructures
The Polymer Latex Concept
Carbon Nanotube Electronics
Nano-Physics and Bio-Electronics
Transistors and Interconnects at the Nanoscale
Graphene and Carbon Nanotubes for Advanced Lithium Ion Batteries
Physics of Carbon Nanotube Devices
Properties and Applications

This third volume in the Advanced Nanocarbon Materials series covers the topic of flexible electronics both from a materials and an applications perspective. Comprehensive in its scope, the monograph examines organic, inorganic and composite materials with a section devoted to carbon-based materials with a special focus on the generation and properties of 2D materials. It also presents carbon modifications and derivatives, such as carbon nanotubes, graphene oxide and diamonds. In terms of the topical applications covered these include, but are not limited to, flexible displays, organic electronics, transistors, integrated circuits, semiconductors and solar cells. These offer perspectives for today?s energy and healthcare challenges, such as electrochemical energy storage and wearable devices. Finally, a section on fundamental properties and characterization approaches of flexible electronics rounds off the book. Each contribution points out the importance of the structure-function relationship for the target-oriented fabrication of electronic devices, enabling the design of complex components.

Carbon nanotubes (CNTs) are tubular cylinders of carbon atoms that have extraordinary mechanical, electrical, thermal, optical and chemical properties. CNTs typically have diameters ranging from 1 nanometer (nm) up to 50 nma nanometer is one thousand millionth of a meter. Typical CNT lengths are several micronsseveral thousand nanometers long; by contrast, Nanocomp's produced fibers are measured in millimetersthousands of times longer than all other commercially produced CNTs. They take the form of cylindrical carbon molecules and have novel properties that make them potentially useful in a wide variety of applications in nanotechnology, electronics, optics and other fields of materials science. They exhibit extraordinary strength and unique electrical properties, and are efficient conductors of heat. In the powdery format offered by all CNT producers (but for NTI), applications are limited to the properties possible by this form factore.g. additive active ingredients in semiconductors, liquid crystal displays (LCDs), sensors, and other uses in which these powders add some level of functional performance. Due to its fiber length and its form factors, NTI delivers strength and conductivity unlike any other commercial CNT producer, and so can address a much broader array of applications for which its material rivals copper and aluminum in conductivity, and steel, aluminum, carbon fibers and glass composites where strength and lightweight matter. Carbon nanotubes have been a subject of exhaustive research for a wide range of applications. The purpose of this book entitled Properties of Carbon Nanotubes is to give in-depth understanding of the physics and electronic structure of carbon nanotubes. This book discusses fabrication techniques followed by an analysis on the physical properties of carbon nanotubes, including density of states and electronic structures. Eventually, the book follows a signi fi cant amount of work in the industry applications of carbon nanotubes.

An Alternative to Copper-Based Interconnect Technology With an increase in demand for more circuit components on a single chip, there is a growing need for nanoelectronic devices and their interconnects (a physical connecting medium made of thin metal films between several electrical nodes in a semiconducting chip that transmit signals from one point to another without any distortion). Carbon Nanotube and Graphene Nanoribbon Interconnects explores two new important carbon nanomaterials, carbon nanotube (CNT) and graphene nanoribbon (GNR), and compares them with that of copper-based interconnects. These nanomaterials show almost 1,000 times more current-carrying capacity and significantly higher mean free path than copper. Due to their remarkable properties, CNT and GNR could soon replace traditional copper interconnects. Dedicated to proving their benefits, this book covers the basic theory of CNT and GNR, and provides a comprehensive analysis of the CNT- and GNR-based VLSI interconnects at nanometric dimensions. Explore the Potential Applications of CNT and Graphene for VLSI Circuits The book starts off with a brief introduction of carbon nanomaterials, discusses the latest research, and details the modeling and analysis of CNT and GNR interconnects. It also describes the electrical, thermal, and mechanical properties, and structural behavior of these materials. In addition, it chronicles the progression of these fundamental properties, explores possible engineering applications and growth technologies, and considers applications for CNT and GNR apart from their use in VLSI circuits. Comprising eight chapters this text: Covers the basics of carbon nanotube and graphene nanoribbon Discusses the growth and characterization of carbon nanotube and graphene nanoribbon Presents the modeling of CNT and GNR as future VLSI interconnects Examines the applicability of CNT and GNR in terms of several analysis works Addresses the timing and frequency response of the CNT and GNR interconnects Explores the signal integrity analysis for CNT and GNR interconnects Models and analyzes the applicability of CNT and GNR as power interconnects Considers the future scope of CNT and GNR Beneficial to VLSI designers working in this area, Carbon Nanotube and Graphene Nanoribbon Interconnects provides a complete understanding of carbon-based materials and interconnect technology, and equips the reader with sufficient knowledge about the future scope of research and development for this emerging topic.

Industrial Applications of Carbon Nanotubes covers the current applications of carbon nanotubes in various industry sectors, from the military to visual display products, and energy harvesting and storage. It also assesses the opportunities and challenges for increased commercialization and manufacturing of carbon nanotubes in the years ahead. Real-life case studies illustrate how carbon nanotubes are used in each industry sector covered, providing a valuable resource for scientists and engineers who are involved and/or interested in carbon nanotubes in both academia and industry. The book serves as a comprehensive guide to the varied uses of carbon nanotubes for specialists in many related fields, including chemistry, physics, biology, and textiles. Explains how carbon nanotubes can be used to improve the efficiency and performance of industrial products Includes real-life case studies to illustrate how carbon nanotubes have been successfully employed Explores how carbon nanotubes could be mass-manufactured in the future, and outlines the challenges that need to be overcome

Carbon nanotubes and graphene have been the subject of intense scientific research since their relatively recent discoveries. This book introduces the reader to the science behind these rapidly developing fields, and covers both the fundamentals and latest advances. Uniquely, this book covers the topics in a pedagogical manner suitable for undergraduate students. The book also uses the simple systems of nanotubes and graphene as models to teach concepts such as molecular orbital theory, tight binding theory and the Laue treatment of diffraction. Suitable for undergraduate students with a working knowledge of basic quantum mechanics, and for postgraduate researchers commencing their studies into the field, this book will equip the reader to critically evaluate the physical properties and potential for applications of graphene and carbon nanotubes.

Graphene, Carbon Nanotubes, and Nanostructures: Techniques and Applications offers a comprehensive review of groundbreaking research in nanofabrication technology and explores myriad applications that this technology has enabled. The book examines the historical evolution and emerging trends of nanofabrication and supplies an analytical understanding of some of the most important underlying nanofabrication technologies, with an emphasis on graphene, carbon nanotubes (CNTs), and nanowires. Featuring contributions by experts from academia and industry around the world, this book presents cutting-edge nanofabrication research in a wide range of areas. Topics include: CNT electrodynamics and signal propagation models Electronic structure calculations of a graphene – hexagonal boron nitride interface to aid the understanding of experimental devices based on these heterostructures How a laser field would modify the electronic structure and transport response of graphene, to generate bandgaps The fabrication of transparent CNT electrodes for organic light-emitting diodes Direct graphene growth on dielectric substrates, and potential applications in electronic and spintronic devices CNTs as a promising candidate for next-generation interconnect conductors CMOS – CNT integration approaches, including the promising localized heating CNT synthesis method CNTs in electrochemical and optical biosensors The synthesis of diamondoids by pulsed laser ablation plasmas generated in supercritical fluids, and possible applications The use of DNA nanostructures in lithography CMOS-compatible silicon nanowire biosensors The use of titanium oxide-B nanowires to detect explosive vapors The properties of protective layers on silver nanoparticles for ink-jet printing Nanostructured thin-film production using microreactors A one-stop reference for professionals, researchers, and graduate students working in nanofabrication, this book will also be useful for investors who want an overview of the current nanofabrication landscape.

This book is a collection of some of the invited talks presented at the international meeting held at the Max Planck Institut fuer Physik Komplexer Systeme, Dresden, Germany during August 6-30, 2001, on the rapidly developing field of nanoscale science in science and bio-electronics Semiconductor physics has experienced unprecedented developments over the second half of the twentieth century. The exponential growth in microelectronic processing power and the size of dynamic memorie has been achieved by significant downscaling of the minimum feature size. Smaller feature sizes result in increased functional density, faster speed, and lower costs. In this process one is reaching the limits where quantum effects and fluctuations are beginning to play an important role. This book reflects the achievements of the present times and future directions of research on nanoscopic dimensions.

Synthesis, Structure, Properties, and Applications
Nanocarbon Electronics
Flexible Carbon-based Electronics
Organized Networks of Carbon Nanotubes
Carbon Nanotubes and Graphene
Carbon Nanotube and Graphene Nanoribbon Interconnects
Applied Physics of Carbon Nanotubes
A New Odyssey
An Introduction to Graphene and Carbon Nanotubes
Single-Walled Carbon Nanotubes

Following on from the first AMN volume, this handy reference and textbook examines the topic of nanosystem design in further detail. It explains the physical and chemical basics behind the design and fabrication of nanodevices, covering all important, recent advances in the field, while introducing nanosystems to less experienced readers. The result is an important source for a fast, accurate overview of the state of the art of nanosystem realization, summarizing further important literature.

Carbon nanotubes are exceptionally interesting from a fundamental research point of view. Many concepts of one-dimensional physics have been verified experimentally such as electron and phonon confinement or the one-dimensional singularities in the density of states; other 1D signatures are still under debate, such as Luttinger-liquid behavior. Carbon nanotubes are chemically stable, mechanically very strong, and conduct electricity. For this reason, they open up new perspectives for various applications, such as nano-transistors in circuits, field-emission displays, artificial muscles, or added reinforcements in alloys. This text is an introduction to the physical concepts needed for investigating carbon nanotubes and other one-dimensional solid-state systems. Written for a wide scientific readership, each chapter consists of an instructive approach to the topic and sustainable ideas for solutions. The former is generally comprehensible for physicists and chemists, while the latter enable the reader to work towards the state of the art in that area. The book gives for the first time a combined theoretical and experimental description of topics like luminescence of carbon nanotubes, Raman scattering, or transport measurements. The theoretical concepts discussed range from the tight-binding approximation, which can be followed by pencil and paper, to first-principles simulations. We emphasize a comprehensive theoretical and experimental understanding of carbon nanotubes including - general concepts for one-dimensional systems - an introduction to the symmetry of nanotubes - textbook models of nanotubes as narrow cylinders - a combination of ab-initio calculations and experiments - luminescence excitation spectroscopy linked to Raman spectroscopy - an introduction to the 1D-transport properties of nanotubes - effects of bundling on the electronic and vibrational properties and - resonance Raman scattering in nanotubes.

Carbon nanotubes and graphene are promising and widely explored materials for the development of high performance lithium ion batteries that can operate at a wide range of temperatures. This book deals with carbon nanotube and graphene composite materials for both electrodes and electrolytes in lithium ion battery applications.

Carbon Nanotube Fibres and Yarns for Smart Textiles: Production, Properties and Applications in Smart Textiles explains the relevance of carbon nanotube science and provides new insights on this emerging, high-performance textile material. Particular emphasis is placed on applications in smart textiles and wearable electronics applications, such as flexible sensors, actuators and energy sources. This collection examines the state-of-the-art in carbon nanotube (CNT) research, providing guidance for anyone who is exploring problems where CNTs may provide design solutions. Finally, the book addresses advances in yarn spinning methods, yarn structures and properties. Drawing on his experience in the textile industry, the book's editor presents academic research in a way that is comprehensible and useful to materials scientists and engineers in practice. Explains how carbon nanotube science can meet the challenging requirements of important and emerging smart textiles and wearable electronics applications Reviews and analyzes key developments on CNT yarn spinning methods, yarn structures and properties, and proposed applications Addresses the potential applications of CNT yarns and nanocomposite fibers

This book provides a single-source reference on the use of carbon nanotubes (CNTs) as interconnect material for horizontal, on-chip and 3D interconnects. The authors demonstrate the uses of bundles of CNTs, as innovative conducting material to fabricate interconnect through-silicon vias (TSVs), in order to improve the performance, reliability and integration of 3D integrated circuits (ICs). This book will be first to provide a coherent overview of exploiting carbon nanotubes for 3D interconnects covering aspects from processing, modeling, simulation, characterization and applications. Coverage also includes a thorough presentation of the application of CNTs as horizontal on-chip interconnects which can potentially revolutionize the nanoelectronics industry. This book is a must-read for anyone interested in the state-of-the-art on exploiting carbon nanotubes for interconnects for both 2D and 3D integrated circuits.

Carbon Nanotubes and Graphene is a timely second edition of the original Science and Technology of Carbon Nanotubes. Updated to include expanded coverage of the preparation, purification, structural characterization, and common application areas of single- and multi-walled CNT structures, this work compares, contrasts, and, where appropriate, unitizes CNT to graphene. This much expanded second edition reference supports knowledge discovery, production of impactful carbon research, encourages transition between research fields, and aids the formation of emergent applications. New chapters encompass recent developments in the theoretical treatments of electronic and vibrational structures, and magnetic, optical, and electrical solid-state properties, providing a vital base to research. Current and potential applications of both materials, including the prospect for large-scale synthesis of graphene, biological structures, and flexible electronics, are also critically discussed. Updated discussion of properties, structure, and morphology of biological and flexible electronic applications aids fundamental knowledge discovery Innovative parallel focus on nanotubes and graphene enables you to learn from the successes and failures of, respectively, mature and emergent partner research disciplines High-quality figures and tables on physical and mathematical applications expertly summarize key information – essential if you need quick, critically relevant data

Since their discovery more than a decade ago, carbon nanotubes (CNTs) have held scientists and engineers in captive fascination, seated on the verge of enormous breakthroughs in areas such as medicine, electronics, and materials science, to name but a few. Taking a broad look at CNTs and the tools used to study them, Carbon Nanotubes: Properties and Applications comprises the efforts of leading nanotube researchers led by Michael O'Connell, protégé of the late father of nanotechnology, Richard Smalley. Each chapter is a self-contained treatise on various aspects of CNT synthesis, characterization, modification, and applications. The book opens with a general introduction to the basic characteristics and the history of CNTs, followed by discussions on synthesis methods and the growth of "peapod" structures. Coverage then moves to electronic properties and band structures of single-wall nanotubes (SWNTs), magnetic properties, Raman spectroscopy of electronic and chemical behavior, and electromechanical properties and applications in NEMS (nanoelectromechanical systems). Turning to applications, the final sections of the book explore mechanical properties of SWNTs spun into fibers, sidewall functionalization in composites, and using SWNTs as tips for scanning probe microscopes. Taking a fresh look at this burgeoning field, Carbon Nanotubes: Properties and Applications points the way toward making CNTs commercially viable.

Carbon Nanotube Fibres and Yarns
Polymer Carbon Nanotube Composites
Selective Etching of Metallic Single-walled Carbon Nanotube-high Current All Semiconductor Nanotube Electronics
Carbon Nanotubes and Their Applications
Carbon Nanotube Devices
Carbon Nanotubes for Interconnects
Investigation of Noise and Fluctuations in Carbon Nanotube Electronics
Production, Properties and Applications in Smart Textiles
Industrial Applications of Carbon Nanotubes
Carbon Nanotube Based VLSI Interconnects

After a short introduction and a brief review of the relation between carbon nanotubes, graphite and other forms of carbon, the synthesis techniques and growth mechanisms for carbon nanotubes are described. This is followed by reviews on nanotube electronic structure, electrical, optical, and mechanical properties, nanotube imaging and spectroscopy, and nanotube applications.

Emerging Nanoelectronic Devices focuses on the future direction of semiconductor and emerging nanoscale device technology. As the dimensional scaling of CMOS approaches its limits, alternate information processing devices and microarchitectures are being explored to sustain increasing functionality at decreasing cost into the indefinite future. This is driving new paradigms of 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 world 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.

In recent years, carbon-based electronics have surfaced as potential candidates for substituting silicon-based logic as scaling continues into the new decade and beyond 20nm technology node. In particular, carbon nanotubes (CNTs) and graphene nanoribbons have received significant attention from the academia as well the industry. Ideal electronic and structural properties of these materials make them suitable for electronic applications. In this work we discuss the basics of CNT growth and device fabrication, explore performance and contact resistance for CNT Field Effect Transistors (CNFETs) based on horizontally-aligned grown CNTs. We provide a physics-based compact model for simulation of CNFETs in a) quantum ballistic and b) semiclassical diffusive regimes. Measuring channel carrier density is essential for extracting key device parameters such as mobility while it can also provide a detailed picture of the underlying quantum mechanics. Since CNTs and nanostructures in general are limited by quantum capacitance, will also provide an Integrated Capacitance Bridge (ICB) for wide temperature-range, high resolution measurements of quantum capacitance in nanostructures with an excitation amplitude smaller than kBT/q.

The series Topics in Current Chemistry Collections presents critical reviews from the journal Topics in Current Chemistry organized in topical volumes. The scope of coverage is all areas of chemical science including the interfaces with related disciplines such as biology, medicine and materials science. The goal of each thematic volume is to give the non-specialist reader, whether in academia or industry, a comprehensive insight into an area where new research is emerging which is of interest to a larger scientific audience. Each review within the volume critically surveys one aspect of that topic and places it within the context of the volume as a whole. The most significant developments of the last 5 to 10 years are presented using selected examples to illustrate the principles discussed. The coverage is not intended to be an exhaustive summary of the field or include large quantities of data, but should rather be conceptual, concentrating on the methodological thinking that will allow the non-specialist reader to understand the information presented. Contributions also offer an outlook on potential future developments in the field.

This book provides a complete overview of the field of carbon nanotube electronics. It covers materials and physical properties, synthesis and fabrication processes, devices and circuits, modeling, and finally novel applications of nanotube-based electronics. The book introduces fundamental device physics and circuit concepts of 1-D electronics. At the same time it provides specific examples of the state-of-the-art nanotube devices.

The brief primarily focuses on the performance analysis of CNT based interconnects in current research scenario. Different CNT structures are modeled on the basis of transmission line theory. Performance comparison for different CNT structures illustrates that CNTs are more promising than Cu or other materials used in global VLSI interconnects. The brief is organized into five chapters which mainly discuss: (1) an overview of current research scenario and basics of interconnects; (2) unique crystal structures and the basics of physical properties of CNTs, and the production, purification and applications of CNTs; (3) a brief technical review, the geometry and equivalent RLC parameters for different single and bundled CNT structures; (4) a comparative analysis of crosstalk and delay for different single and bundled CNT structures; and (5) various unique mixed CNT bundle structures and their equivalent electrical models.

This book presents a comprehensive review of research on applications of carbon nanotubes (CNTs) and graphene to electronic devices. As nanocarbons in general, and CNTs and graphene in particular, are becoming increasingly recognized as the most promising materials for future generations of electronic devices, including transistors, sensors, and interconnects, a knowledge gap still exists between the basic science of nanocarbons and their feasibility for cost-effective product manufacturing. The book highlights some of the issues surrounding this missing link by providing a detailed review of the nanostructure and electronic properties, materials, and device fabrication and of the structure–property–application relationships.

Flexible and Stretchable Medical Devices
Carbon Based Electronic Devices
Process, Design and Applications
Physical Properties of Carbon Nanotubes
Preparation, Properties and Applications
Carbon Nanotube-Polymer Composites
Flexible, Wearable, and Stretchable Electronics
Basic Concepts and Physical Properties
Manufacture, Properties, and Applications
Syntheses and Applications of Carbon Nanotubes and Their Composites

The accessible compendium of polymers in carbon nanotubes (CNTs) Carbon nanotubes (CNTs)—extremely thin tubes only a few nanometers in diameter but able to attain lengths thousands of times greater—are prime candidates for use in the development of polymer composite materials. Bringing together thousands of disparate research works, Carbon Nanotube-Polymer Composites: Manufacture, Properties, and Applications covers CNT-polymers from synthesis to potential applications, presenting the basic science and engineering of this dynamic and complex area in an accessible, readable way. Designed to be of use to polymer scientists, engineers, chemists, physicists, and materials scientists, the book covers carbon nanotube fundamentals to help polymer experts understand CNTs, and polymer physics to help those in the CNT field, making it an invaluable resource for anyone working with CNT-polymer composites. Detailed chapters describe the mechanical, rheological, electrical, and thermal properties of carbon nanotube-polymer composites. Including a glossary that defines key terms, Carbon Nanotube-Polymer Composites is essential reading for anyone looking to gain a fundamental understanding of CNTs and polymers, as well as potential and current applications, including electronics (shielding and transparent electrodes), flame retardants, and electromechanics (sensors and actuators), and their challenges.

Carbon nanotubes are rolled up graphene sheets with a quasi-one-dimensional structure of nanometer-scale diameter. In these last twenty years, carbon nanotubes have attracted much attention from physicists, chemists, material scientists, and electronic device engineers, because of their excellent structural, electronic, optical, chemical and mechanical properties. More recently, demand for innovative industrial applications of carbon nanotubes is increasing. This book covers recent research topics regarding syntheses techniques of carbon nanotubes and nanotube-based composites, and their applications. The chapters in this book will be helpful to many students, engineers and researchers working in the field of carbon nanotubes.

Possibly the most impactful material in the nanotechnology arena, carbon nanotubes have spurred a tremendous amount of scientific research and development. Their superior mechanical and chemical robustness makes them easily manipulable and allows for the assembly of various types of devices, including electronic, electromechanical, opto-electronic and sensing devices. In the field of nanotube devices, however, concepts that describe the properties of conventional devices do not apply. Carbon nanotube devices behave much differently from those using traditional materials, and offer entirely new functionality. This book – designed for researchers, engineers and graduate students alike – bridges the experimental and theoretical aspects of carbon nanotube devices. It emphasizes and explains the underlying physics that govern their working principles, including applications in electronics, nanoelectromechanical systems, field emission, optoelectronics and sensing. Other topics include: electrical contacts, p-n junctions, transistors, ballistic transport, field emission, oscillators, rotational actuators, electron-phonon scattering, photoconductivity, and light emission. Many of the aspects discussed here differ significantly from those learned in books or traditional materials, and are essential for the future development of carbon nanotube technology. • Bridges experimental and theoretical aspects of carbon nanotube devices, focusing on the underlying physics that govern their working principles • Explains applications in electronics, nanoelectromechanical systems, field emission, optoelectronics and sensing. • Other topics include: electrical contacts, p-n junctions, transistors, ballistic transport, field emission, oscillators, rotational actuators, electron-phonon scattering, photoconductivity, and light emission. • Covers aspects that significantly differ from those learned in traditional materials, yet are essential for future advancement of carbon nanotube technology. * Bridges experimental and theoretical aspects of carbon nanotube devices, focusing on the underlying physics that govern their working principles * Explains applications in electronics, nanoelectromechanical systems, field emission, optoelectronics and sensing. * Other topics include: electrical contacts, p-n junctions, transistors, ballistic transport, field emission, oscillators, rotational actuators, electron-phonon scattering, photoconductivity, and light emission * Covers aspects that significantly differ from those learned in traditional materials, yet are essential for future advancement of carbon nanotube technology.

In this book, internationally recognized researchers give a state-of-the-art overview of the electronic device architectures required for the nano-CMOS era and beyond. Challenges relevant to the scaling of CMOS nanoelectronics are addressed through different core CMOS and memory device options in the first part of the book. The second part reviews new device concepts for nanoelectronics beyond CMOS. The book covers the fundamental limits of core CMOS, improving scaling by the introduction of new materials or processes, new architectures using SOI, multigates and multichannels, and quantum computing.

This is an introductory textbook for graduate students and researchers from various fields of science who wish to learn about carbon nanotubes. The field is still at an early stage, and progress continues at a rapid rate. This book focuses on the basic principles behind the physical properties and gives the background necessary to understand the recent developments. Some useful computational source codes which generate coordinates for carbon nanotubes are also included in the appendix. Contents:Carbon MaterialsTight Binding Calculation of Molecules and SolidsStructure of a Single-Wall Carbon NanotubeElectronic Structure of Single-Wall NanotubesSynthesis of Carbon NanotubesLandau Energy Bands of Carbon NanotubesConnecting Carbon NanotubesTransport Properties of Carbon NanotubesPhonon Modes of Carbon NanotubesRaman Spectra of Carbon NanotubesElastic Properties of Carbon Nanotubes Readership: Researchers and graduate students in condensed matter and solid state physics. Keywords:Carbon Nanotube;Physics;Graphite;Structure;Electronic Properties;Raman;Phonon;Synthesis;Carbon;ChiralityReviews: "The book is a well organized systematic treatise that should be enjoyed by any researcher in the field as well as by graduate students. Theories and experiments are truly organically linked in the text and this is its unique feature." Fullerene Science & Technology "Those involved in the research of carbon nanotubes will find this book useful for understanding the basic properties of carbon tube materials." IEEE Electrical Insulation Magazine

Carbon nanotubes (CNTs), discovered in 1991, have been a subject of intensive research for a wide range of applications. These one-dimensional (1D) graphene sheets rolled into a tubular form have been the target of many researchers around the world. This book concentrates on the semiconductor physics of carbon nanotubes, it brings unique insight into the phenomena encountered in the electronic structure when operating with carbon nanotubes. This book also presents to reader useful information on the fabrication and applications of these outstanding materials. The main objective of this book is to give in-depth understanding of the physics and electronic structure of carbon nanotubes. Readers of this book should have a strong background on physical electronics and semiconductor device physics. This book first discusses fabrication techniques followed by an analysis on the physical properties of carbon nanotubes, including density of states and electronic structures. Ultimately, the book pursues a significant amount of work in the industry applications of carbon nanotubes.

Discovery of one-dimensional material carbon nanotubes in 1991 by the Japanese physicist Dr. Sumio Iijima has resulted in voluminous research in the field of carbon nanotubes for numerous applications, including possible replacement of silicon used in the fabrication of CMOS chips. One interesting feature of carbon nanotubes is that these can be metallic or semiconducting with a bandgap depending on their diameter. In search of non-classical devices and related technologies, both carbon nanotube-based field-effect transistors and metallic carbon nanotube interconnects are being explored extensively for emerging logic devices and very large-scale integration. Although various models for carbon nanotube-based transistors and interconnects have been proposed in the literature, an integrated approach to make them compatible with the present simulators is yet to be achieved. This book makes an attempt in this direction for the carbon-based electronics through fundamentals of solid-state physics and devices.

Analysis and Design
Advanced Dielectrophoresis for High-performance Single-walled Carbon Nanotube Electronics
Electronic Devices Architectures for the NANO-CMOS Era
Properties, Modeling, Integration and Applications
Carbon Nanotubes
Fundamentals of Theory, Optics and Transport Devices
Electronic Properties of Carbon Nanotubes
Emerging Nanoelectronic Devices