

Pallab Bhattacharya Semiconductor Optoelectronic Devices Edition 2

The characterization and precisely controlled building of atomic-scale multilayers have been the subject of intensive R&D worldwide. Nanometric structures based on III-V semiconductors have attracted particular attention. Since 1970, around 15,000 papers have been published in all, of which 10,000 have appeared in the last 6 years. The resulting improved materials control is enabling engineers to achieve major improvements in the performance of microelectronic and optoelectronic devices such as QW lasers, tunnelling devices, modulators, switches and photodetectors. In this book, the large volume of research results which have accumulated is evaluated and distilled down to a useful, manageable concentration of up-to-date knowledge for electronic engineers and solid-state physicists. This has been carried out by an invited international team of over 50 specialists under the editorship of Professor Bhattacharya with support from INSPEC, who also compiled the subject index. There are 40 individually-written, self-contained modules ("Datareviews"), each specially commissioned to fit into a pre-determined structure. Subjects reviewed in depth include historical perspective, theory, epitaxial growth and doping,

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structure (e.g. X-ray diffraction), electronic properties, optical properties, modulation doping and devices. Each Datareview comprises tables, text, figures and expert guidance to the literature, as appropriate. Properties of III-V quantum wells and superlattices is intended both as a look-up source of evaluated data and as a finely-structured state-of-the-art review for academic and industrial R&D workers. Textbook presenting the fundamentals of nanoscience and nanotechnology with a view to nanoelectronics. Covers the underlying physics; nanostructures, including nanoobjects; methods for growth, fabrication and characterization of nanomaterials; and nanodevices. Provides a unifying framework for the basic ideas needed to understand the recent developments in the field. Includes numerous illustrations, homework problems and a number of interactive Java applets. For advanced undergraduate and graduate students in electrical and electronic engineering, nanoscience, materials, bioengineering and chemical engineering. Instructor solutions and Java applets available from www.cambridge.org/9780521881722.

III-Nitride semiconductor materials OCo (Al, In, Ga)N OCo are excellent wide band gap semiconductors very suitable for modern electronic and optoelectronic applications. Remarkable breakthroughs have been achieved recently, and current knowledge and data published have to be

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modified and upgraded. This book presents the new developments and achievements in the field. Written by renowned experts, the review chapters in this book cover the most important topics and achievements in recent years, discuss progress made by different groups, and suggest future directions. Each chapter also describes the basis of theory or experiment. The III-Nitride-based industry is building up and new economic developments from these materials are promising. It is expected that III-Nitride-based LEDs may replace traditional light bulbs to realize a revolution in lighting. This book is a valuable source of information for engineers, scientists and students working towards such goals.

Sample Chapter(s). Chapter 1: Hydride Vapor Phase Epitaxy of Group III Nitride Materials (540 KB).
Contents: Hydride Vapor Phase Epitaxy of Group III Nitride Materials (V Dmitriev & A Usikov); Planar MOVPE Technology for Epitaxy of III-Nitride Materials (M Dauelsberg et al.); Close-Coupled Showerhead MOCVD Technology for the Epitaxy of GaN and Related Materials (E J Thrush & A R Boyd); Molecular Beam Epitaxy for III-N Materials (H Tang & J Webb); Growth and Properties of Nonpolar GaN Films and Heterostructures (Y J Sun & O Brandt); Indium-Nitride Growth by High-Pressure CVD: Real-Time and Ex-Situ Characterization (N Dietz); A New Look on InN (L-W Tu et al.); Growth and Optical/Electrical Properties of Al_xGa_{1-x}N

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Alloys in the Full Composition Range (F Yun); Optical Investigation of InGaN/GaN Quantum Well Structures Grown by MOCVD (T Wang); Clustering Nanostructures and Optical Characteristics in InGaN/GaN Quantum-Well Structures with Silicon Doping (Y-C Cheng et al.); III-Nitrides Micro- and Nano-Structures (H M Ng & A Chowdhury); New Developments in Dilute Nitride Semiconductor Research (W Shan et al.). Readership: Scientists; material growers and evaluators; device design, processing engineers; postgraduate and graduate students in electrical & electronic engineering and materials engineering.

This textbook provides a thorough and accessible treatment of semiconductor lasers from a design and engineering perspective. It includes both the physics of devices as well as the engineering, designing and testing of practical lasers. The material is presented clearly with many examples provided. Readers of the book will come to understand the finer aspects of the theory, design, fabrication and test of these devices and have an excellent background for further study of optoelectronics. This book also: Provides a multi-faceted approach to explaining the theories behind semiconductor lasers, utilizing mathematical examples, illustrations and written theoretical presentations Offers a balance of relevant optoelectronic topics, with specific attention given to distributed feedback lasers, growth techniques and

waveguide cavity design Provides a summary of every chapter, worked examples, and problems for readers to solve Incorporates and explains recent breakthroughs in laser design

The book is a history of Molecular Beam Epitaxy (MBE) as applied to the growth of semiconductor thin films (note that it does not cover the subject of metal thin films). It begins by examining the origins of MBE, first of all looking at the nature of molecular beams and considering their application to fundamental physics, to the development of nuclear magnetic resonance and to the invention of the microwave MASER. It shows how molecular beams of silane (SiH_4) were used to study the nucleation of silicon films on a silicon substrate and how such studies were extended to compound semiconductors such as GaAs. From such surface studies in ultra-high vacuum the technique developed into a method of growing high quality single crystal films of a wide range of semiconductors. Comparing this with earlier evaporation methods of deposition and with other epitaxial deposition methods such as liquid phase and vapour phase epitaxy (LPE and VPE). The text describes the development of MBE machines from the early 'home-made' variety to that of commercial equipment and show how MBE was gradually refined to produce high quality films with atomic dimensions. This was much aided by the use of various in-situ surface analysis techniques, such as

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reflection high energy electron diffraction (RHEED) and mass spectrometry, a feature unique to MBE. It looks at various modified versions of the basic MBE process, then proceed to describe their application to the growth of so-called 'low-dimensional structures' (LDS) based on ultra-thin heterostructure films with thickness of order a few molecular monolayers.

Further chapters cover the growth of a wide range of different compounds and describe their application to fundamental physics and to the fabrication of electronic and opto-electronic devices. The authors study the historical development of all these aspects and emphasise both the (often unexpected) manner of their discovery and development and the unique features which MBE brings to the growth of extremely complex structures with monolayer accuracy.

Emphasizes the theory of semiconductor optoelectronic devices, demonstrating comparisons between theoretical and experimental results.

Presents such important topics as semiconductor heterojunctions and band structure calculations near the band edges for bulk and quantum-well semiconductors. Details semiconductor lasers including double-heterostructure, stripe-geometry gain-guided semiconductor, distributed feedback and surface-emitting. Systematically investigates high-speed modulation of semiconductor lasers using linear and nonlinear gains. Features new subjects

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such as the theories on the band structures of strained semiconductors and strained quantum-well lasers. Covers key areas behind the operation of semiconductor lasers, modulators and photodetectors. An Instructor's Manual presenting detailed solutions to all the problems in the book is available from the Wiley editorial department

The first true "introduction" to semiconductor optoelectronic devices, this book provides an accessible, well-organized overview of optoelectric devices that emphasizes basic principles. Coverage begins with an optional review of key concepts— such as properties of compound semiconductor, quantum mechanics, semiconductor statistics, carrier transport properties, optical processes, and junction theory— then progress gradually through more advanced topics. The "Second Edition" has been both updated and expanded to include the recent developments in the field.

This book presents high-quality papers from the 2019 International Conference on Optoelectronics and Measurement (ICOM2019) which was held on November 28–30, 2019, in Hangzhou, China. It focuses on the latest developments in the fields of optics, photonics, optoelectronics, sensors, and related measurement technology. Being closely related to either the key device technology or the important commercial applications, topics of fiber optics, photodetectors, sensors, and measurement

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technology are of particular interest for the readers. The book contains the illustrations of advanced device technologies, measurement principles, as well as scientific and technological conclusions of the great reference value. The readers will gain deep insight into the latest development in the related fields, obtain important technical data and scientific conclusions, and inspire new ideas for their research.

Doping profiles are a key element in the development of modern semiconductor technology. This book is the first to give a comprehensive review of the theory, fabrication, characterization, and device applications of abrupt, shallow, and narrow doping profiles in semiconductors. After an introductory chapter sets out the basic theoretical and experimental concepts involved, the authors discuss the fabrication of abrupt and narrow doping profiles by several different techniques, including epitaxial growth. They then present the techniques for characterizing doping distributions, followed by several chapters on the inherent physical properties of narrow doping profiles. The latter part of the book deals with specific devices. The book will be of great interest to graduate students, researchers, and engineers in the fields of semiconductor physics and microelectronic engineering.

The Committee on Technology Insight-Gauge, Evaluate & Review set up by the NRC at the request

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of the Defense Intelligence Agency, has selected a number of emerging technologies to investigate for their potential threats to and opportunities for national security. This first study focused on emerging applications of nanophotonics, which is about the interaction of matter and light at the scale of the wavelength of the light. Manipulation of matter at that scale allows tailoring the optical properties to permit a wide-range of commercial and defense applications. This book presents a review of the nanoscale phenomena underpinning nanophotonics, an assessment of enabling technologies for developing new applications, an examination of potential military applications, and an assessment of foreign investment capabilities

Semiconductor Optoelectronic Devices

This updated, second edition textbook provides a thorough and accessible treatment of semiconductor lasers from a design and engineering perspective. It includes both the physics of devices as well as the engineering, designing and testing of practical lasers. The material is presented clearly with many examples provided. Readers of the book will come to understand the finer aspects of the theory, design, fabrication and test of these devices and have an excellent background for further study of optoelectronics.

The text is designed for the undergraduate student of Electronics and Communication Engineering as

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the first introduction to Signals, their behaviour and representations, and System responses. The content has been carefully sequenced to help students make a smooth transition to the understanding of Signals by introducing the previously learnt concepts of Laplace and Z Transforms (in mathematics) early in the discussions in this text. With numerous pedagogical features and MATLAB examples, the book will aid the student in understanding the practicality of the subject better.?

This book contains comprehensive reviews of different technologies to harness lattice mismatch in semiconductor heterostructures and their applications in electronic and optoelectronic devices. While the book is a bit focused on metamorphic epitaxial growth, it also includes other methods like compliant substrate, selective area growth, wafer bonding, heterostructure nanowires, and more. Basic knowledge on dislocations in semiconductors and innovative methods to eliminate threading dislocations are provided, and successful device applications are reviewed. It covers a variety of important semiconductor materials like SiGe, III-V including GaN and nano-wires; epitaxial methods like molecular beam epitaxy and metal organic vapor phase epitaxy; and devices like transistors and lasers etc.

Designed for a senior or graduate-level course in optical communications, Principles and Applications

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of Optical Communications offers comprehensive coverage of a variety of light wave technologies not often found in other texts. Taking an applied approach to the subject, this text has utility in a number of different optical communications courses and in advanced signal processing. The coverage and approach reflect Dr. Liu's background in industry. They offer students exposure to the latest technologies and give strong preparation for industry positions in optical communications.

A graduate textbook presenting the underlying physics behind devices that drive today's technologies. The book covers important details of structural properties, bandstructure, transport, optical and magnetic properties of semiconductor structures. Effects of low-dimensional physics and strain - two important driving forces in modern device technology - are also discussed. In addition to conventional semiconductor physics the book discusses self-assembled structures, mesoscopic structures and the developing field of spintronics. The book utilizes carefully chosen solved examples to convey important concepts and has over 250 figures and 200 homework exercises. Real-world applications are highlighted throughout the book, stressing the links between physical principles and actual devices. Electronic and Optoelectronic Properties of Semiconductor Structures provides engineering and physics students and practitioners

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with complete and coherent coverage of key modern semiconductor concepts. A solutions manual and set of viewgraphs for use in lectures are available for instructors, from solutions@cambridge.org.

Developed as an introductory course, this up-to-date text discusses the major building blocks of present-day fiber-optic systems and presents their use in communications and sensing. Starting with easy-to-understand ray propagation in optical fibers, the book progresses towards the more complex topics of wave propagation in planar and cylindrical waveguides. Special emphasis has been given to the treatment of single-mode fibers the backbone of present-day optical communication systems. It also offers a detailed treatment of the theory behind optoelectronic sources (LEDs and injection laser diodes), detectors, modulators, and optical amplifiers. Contemporary in terms of technology, it presents topics such as erbium-doped fiber amplifiers (EDFAs) and wavelength-division multiplexing (WDM) along with dense WDM. Building upon these fundamental principles, the book introduces the reader to system design considerations for analog and digital fiber-optic communications. Emphasis has also been given to fiber-optic sensors and laser-based systems along with their industrial and other applications. This student-friendly text would be very useful to undergraduate students pursuing instrumentation,

electronics, and communication engineering. It would also prove to be a good text for postgraduate students of physics.

Semiconductors are at the heart of modern living. Almost everything we do, be it work, travel, communication, or entertainment, all depend on some feature of semiconductor technology. Comprehensive Semiconductor Science and Technology captures the breadth of this important field, and presents it in a single source to the large audience who study, make, and exploit semiconductors. Previous attempts at this achievement have been abbreviated, and have omitted important topics. Written and Edited by a truly international team of experts, this work delivers an objective yet cohesive global review of the semiconductor world. The work is divided into three sections. The first section is concerned with the fundamental physics of semiconductors, showing how the electronic features and the lattice dynamics change drastically when systems vary from bulk to a low-dimensional structure and further to a nanometer size. Throughout this section there is an emphasis on the full understanding of the underlying physics. The second section deals largely with the transformation of the conceptual framework of solid state physics into devices and systems which require the growth of extremely high purity, nearly defect-free bulk and epitaxial materials. The last section is

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devoted to exploitation of the knowledge described in the previous sections to highlight the spectrum of devices we see all around us. Provides a comprehensive global picture of the semiconductor world Each of the work's three sections presents a complete description of one aspect of the whole Written and Edited by a truly international team of experts

Contributed papers of the workshop held at IIT, Madras, in 2003.

The creation of affordable high speed optical communications using standard semiconductor manufacturing technology is a principal aim of silicon photonics research. This would involve replacing copper connections with optical fibres or waveguides, and electrons with photons. With applications such as telecommunications and information processing, light detection, spectroscopy, holography and robotics, silicon photonics has the potential to revolutionise electronic-only systems. Providing an overview of the physics, technology and device operation of photonic devices using exclusively silicon and related alloys, the book includes: Basic Properties of Silicon Quantum Wells, Wires, Dots and Superlattices Absorption Processes in Semiconductors Light Emitters in Silicon Photodetectors , Photodiodes and Phototransistors Raman Lasers including Raman Scattering Guided Lightwaves Planar Waveguide Devices Fabrication

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Techniques and Material Systems Silicon Photonics: Fundamentals and Devices outlines the basic principles of operation of devices, the structures of the devices, and offers an insight into state-of-the-art and future developments.

The Physics of Stars, Second Edition, is a concise introduction to the properties of stellar interiors and consequently the structure and evolution of stars. Strongly emphasising the basic physics, simple and uncomplicated theoretical models are used to illustrate clearly the connections between fundamental physics and stellar properties. This text does not intend to be encyclopaedic, rather it tends to focus on the most interesting and important aspects of stellar structure, evolution and nucleosynthesis. In the Second Edition, a new chapter on Helioseismology has been added, along with a list of physical constants and extra student problems. There is also new material on the Hertzsprung-Russell diagram, as well as a general updating of the entire text. It includes numerous problems at the end of each chapter aimed at both testing and extending student's knowledge.

Optoelectronic devices impact many areas of society, from simple household appliances and multimedia systems to communications, computing, spatial scanning, optical monitoring, 3D measurements and medical instruments. This is the most complete book about optoelectromechanic

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systems and semiconductor optoelectronic devices; it provides an accessible, well-organized overview of optoelectronic devices and properties that emphasizes basic principles.

Groundbreaking book that combines information on power electronics and optoelectronic applications of nitride semiconductors With contributions from a panel of international experts, Nitride Semiconductor Technology: Power Electronics and Optoelectronic Devices offers a state-of-the-art review of GaN-based technologies that covers the fields of both power electronics and optoelectronic devices. The authors present detailed explanations of the physical properties of materials and their growth methods. They also include information on GaN-based technology applications in high electron mobility transistors, vertical power devices, LEDs, laser diodes, and vertical-cavity surface-emitting lasers. Nitride Semiconductor Technology contains an in-depth examination of reliability issues with the materials and offers advice on integrating them with 2D materials for novel high-frequency and high-power devices. The book also contains a review of the most recent advances in the field. This important book: Presents an in-depth overview of properties, growth techniques, and applicability of nitride semiconductors Offers a one-stop resource that covers nitride semiconductor technology from materials to devices Reviews a widerange of nitride

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semiconductor applications in high-power and high-frequency devices. Written for materials scientists, semiconductor physicists, semiconductor industry professionals, electrical engineers, and electrotechnical industry professionals, *Nitride Semiconductor Technology: Power Electronics and Optoelectronic Devices* combines the most recent information on power electronics and optoelectronic applications of nitride semiconductors.

This book focuses on the theory of phonon interactions in nanoscale structures with particular emphasis on modern electronic and optoelectronic devices. The continuing progress in the fabrication of semiconductor nanostructures with lower dimensional features has led to devices with enhanced functionality and even novel devices with new operating principles. The critical role of phonon effects in such semiconductor devices is well known. There is therefore a great need for a greater awareness and understanding of confined phonon effects. A key goal of this book is to describe tractable models of confined phonons and how these are applied to calculations of basic properties and phenomena of semiconductor heterostructures. The level of presentation is appropriate for undergraduate and graduate students in physics and engineering with some background in quantum mechanics and solid state physics or devices. A basic understanding of electromagnetism and

classical acoustics is assumed.

This textbook, now in the second edition, offers a completely up-to-date and in-depth introduction to the principles and applications of optoelectronic devices and systems. The text gives a detailed description of optical fibre waveguides, optical fibre cables and their characteristics, manufacturing process and drawing of optical fibres. In addition, it deals with photon sources, photon detectors, fibre optics as a medium and LAN and WAN systems, short and long haul optical fibre communication systems, electro-optic modulators and their characteristics. The second edition possesses a new section on Optical Fibre Based Broadband High Speed Network in Chapter 8, thus highlighting an updated version. Apart from this, a new chapter on Intensity Dependent Refractive Index Effect has been introduced into the text that discusses the effect of focusing on spatial and temperature profiles in a non-linear crystal medium. This chapter further explains the various physical phenomena like the creation of sharp opaque filaments, irradiation induced damaging of the crystal, oscillatory waveguide propagation, saturation effects and other properties in detail. Primarily intended for the undergraduate students of electronics and communication engineering, the book should also prove extremely useful for the postgraduate students of physics. Key features • Provides comprehensive

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explanation of optical fibre communication with illustrations. • Gives extensive theory and experimental and holographic applications. • Discusses the applications of lasers in industry, military and medical as well as fibre optics applications. • Describes optical computing, optical gates and their applications with illustrations. • Includes solved numericals at the end of book for better understanding of topics.

Essential for anyone interested in a career in renewable energy, **ELECTRICAL THEORY FOR RENEWABLE ENERGY** presents a solid foundation of electrical theory and applications for both photovoltaic (PV) power and wind power in one engaging book. Designed to apply to electricians as well as individuals specializing in PV and wind turbines, each chapter provides a common technical language and knowledge base for all renewable energy practitioners so that all members of the team (i.e., practitioners, designers, installers and engineers) are able to work together effectively in the field. With multiple examples and opportunities for practice, this book covers the basic electrical theory that is required for you to understand any renewable energy source that generates electricity. Important Notice: Media content referenced within the product description or the product text may not be available in the ebook version.

This book addresses material growth, device

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fabrication, device application, and commercialization of energy-efficient white light-emitting diodes (LEDs), laser diodes, and power electronics devices. It begins with an overview on basics of semiconductor materials, physics, growth and characterization techniques, followed by detailed discussion of advantages, drawbacks, design issues, processing, applications, and key challenges for state of the art GaN-based devices. It includes state of the art material synthesis techniques with an overview on growth technologies for emerging bulk or free standing GaN and AlN substrates and their applications in electronics, detection, sensing, optoelectronics and photonics. Wengang (Wayne) Bi is Distinguished Chair Professor and Associate Dean in the College of Information and Electrical Engineering at Hebei University of Technology in Tianjin, China. Hao-chung (Henry) Kuo is Distinguished Professor and Associate Director of the Photonics Center at National Chiao-Tung University, Hsin-Tsu, Taiwan, China. Pei-Cheng Ku is an associate professor in the Department of Electrical Engineering & Computer Science at the University of Michigan, Ann Arbor, USA. Bo Shen is the Cheung Kong Professor at Peking University in China.

The first true introduction to semiconductor optoelectronic devices, this book provides an accessible, well-organized overview of optoelectronic

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devices that emphasizes basic principles. Coverage begins with an optional review of key concepts—such as properties of compound semiconductor, quantum mechanics, semiconductor statistics, carrier transport properties, optical processes, and junction theory—then progress gradually through more advanced topics. The Second Edition has been both updated and expanded to include the recent developments in the field.

Covers both the fundamentals and the state-of-the-art technology used for MBE Written by expert researchers working on the frontlines of the field, this book covers fundamentals of Molecular Beam Epitaxy (MBE) technology and science, as well as state-of-the-art MBE technology for electronic and optoelectronic device applications. MBE applications to magnetic semiconductor materials are also included for future magnetic and spintronic device applications. Molecular Beam Epitaxy: Materials and Applications for Electronics and Optoelectronics is presented in five parts: Fundamentals of MBE; MBE technology for electronic devices application; MBE for optoelectronic devices; Magnetic semiconductors and spintronics devices; and Challenge of MBE to new materials and new researches. The book offers chapters covering the history of MBE; principles of MBE and fundamental mechanism of MBE growth; migration enhanced epitaxy and its application; quantum dot formation and selective area growth by

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MBE; MBE of III-nitride semiconductors for electronic devices; MBE for Tunnel-FETs; applications of III-V semiconductor quantum dots in optoelectronic devices; MBE of III-V and III-nitride heterostructures for optoelectronic devices with emission wavelengths from THz to ultraviolet; MBE of III-V semiconductors for mid-infrared photodetectors and solar cells; dilute magnetic semiconductor materials and ferromagnet/semiconductor heterostructures and their application to spintronic devices; applications of bismuth-containing III–V semiconductors in devices; MBE growth and device applications of Ga₂O₃; Heterovalent semiconductor structures and their device applications; and more. Includes chapters on the fundamentals of MBE Covers new challenging researches in MBE and new technologies Edited by two pioneers in the field of MBE with contributions from well-known MBE authors including three AI Cho MBE Award winners Part of the Materials for Electronic and Optoelectronic Applications series Molecular Beam Epitaxy: Materials and Applications for Electronics and Optoelectronics will appeal to graduate students, researchers in academia and industry, and others interested in the area of epitaxial growth.

SiGe HBTs is a hot topic within the microelectronics community because of its applications potential within integrated circuits operating at radio frequencies. Applications range from high speed

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optical networking to wireless communication devices. The addition of germanium to silicon technologies to form silicon germanium (SiGe) devices has created a revolution in the semiconductor industry. These transistors form the enabling devices in a wide range of products for wireless and wired communications. This book features: SiGe products include chip sets for wireless cellular handsets as well as WLAN and high-speed wired network applications Describes the physics and technology of SiGe HBTs, with coverage of Si and Ge bipolar transistors Written with the practising engineer in mind, this book explains the operating principles and applications of bipolar transistor technology. Essential reading for practising microelectronics engineers and researchers. Also, optical communications engineers and communication technology engineers. An ideal reference tool for masters level students in microelectronics and electronics engineering.

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