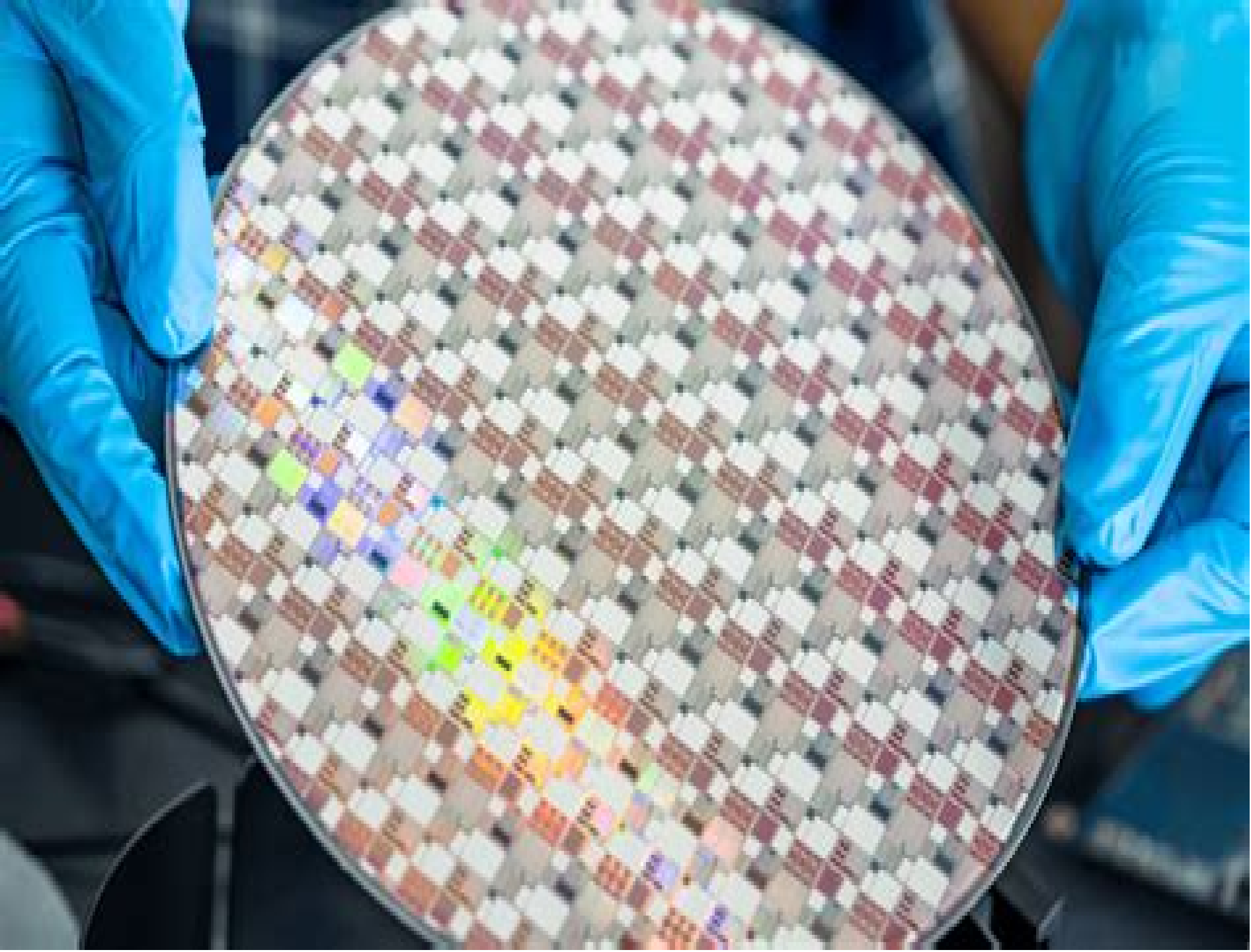




# Semiconductor Optics

**Heinz Kalt, Claus F. Klingshirn**



## Semiconductor Optics:

**Semiconductor Optics** Claus F. Klingshirn, 2012-07-06 The updated and enlarged new edition of this book provides an introduction to and an overview of semiconductor optics from the IR through the visible to the UV It includes coverage of linear and nonlinear optical properties dynamics magneto and electrooptics high excitation effects some applications experimental techniques and group theory The mathematics is kept as elementary as possible The subjects covered extend from physics to materials science and optoelectronics New or updated chapters add coverage of current topics while the chapters on bulk materials have been revised and updated *Semiconductor Optics* Claus F. Klingshirn, 1995-07-21

Semiconductor Optics provides an introduction to and an overview of semiconductor optics from the IR through the visible to the UV including linear and nonlinear optical properties dynamics magneto and electrooptics high excitation effects some applications experimental techniques and group theory Mathematics is kept as elementary as possible enough for an intuitive understanding of the experimental results and techniques treated The subjects covered extend from physics to materials science and optoelectronics **Semiconductor Optics** Claus F. Klingshirn, 2006-01-02 The book on Semiconductor Optics

has been favourably received by the students and the scientific community worldwide After the first edition which appeared in 1995 several reprints became necessary starting from 1997 one of them for the Chinese market They contained only rather limited updates of the material and corrections In the meantime scientific progress brought a lot of new results which necessitate a new seriously revised edition This progress includes bulk semiconductors but especially structures of reduced dimensionality These new trends and results are partly included in existing chapters e.g. for phonons or for time resolved spectroscopy partly new chapters have been introduced like the ones on cavity polaritons and photonic structures We based the description of the optical properties again on the simple and intuitively clear model of the Lorentz oscillators and the concept of polaritons as the quanta of light in matter But since there is presently a trend to describe at least the optical properties of the electronic system of semiconductors by the optical or the semiconductor Bloch equations a chapter has been added on this topic written by Prof. Dr. R. v. Baltz, Karlsruhe to familiarize the reader with this concept too which needs a bit more quantum mechanics compared to the approach used here The chapter on group theory has been revised by Prof. Dr. K. Hummer, Karlsruhe Forchheim, Karlsruhe C. F. Klingshirn September 2004 Preface to the First Edition One of the most prominent senses of many animals and of course of human beings is sight or vision *Semiconductor Optics 1* Heinz Kalt, Claus F.

Klingshirn, 2019-09-20 This revised and updated edition of the well received book by C. Klingshirn provides an introduction to and an overview of all aspects of semiconductor optics from IR to visible and UV It has been split into two volumes and rearranged to offer a clearer structure of the course content Inserts on important experimental techniques as well as sections on topical research have been added to support research oriented teaching and learning Volume 1 provides an introduction to the linear optical properties of semiconductors The mathematical treatment has been kept as elementary as possible to

allow an intuitive approach to the understanding of results of semiconductor spectroscopy Building on the phenomenological model of the Lorentz oscillator the book describes the interaction of light with fundamental optical excitations in semiconductors phonons free carriers excitons It also offers a broad review of seminal research results augmented by concise descriptions of the relevant experimental techniques e g Fourier transform IR spectroscopy ellipsometry modulation spectroscopy and spatially resolved methods to name a few Further it picks up on hot topics in current research like quantum structures mono layer semiconductors or Perovskites The experimental aspects of semiconductor optics are complemented by an in depth discussion of group theory in solid state optics Covering subjects ranging from physics to materials science and optoelectronics this book provides a lively and comprehensive introduction to semiconductor optics With over 120 problems more than 480 figures abstracts to each chapter as well as boxed inserts and a detailed index it is intended for use in graduate courses in physics and neighboring sciences like material science and electrical engineering It is also a valuable reference resource for doctoral and advanced researchers

**Semiconductor Optics and Transport Phenomena** Wilfried Schäfer, Martin Wegener, 2013-06-29 Whenever a physicist visits the physics faculty in Dortmund he/she is bound to hear the success story of the so called integrated course a four semester introduction to physics These lectures are given by two professors simultaneously one experimentalist and one theorist After having asked the common question How many professors have killed each other the visitor usually realizes that this is an excellent way of presenting a coherent introduction to both experimental and theoretical physics We decided to try this concept in an advanced course on semiconductor physics At that point the typical student has already had an introductory course in solid state physics and solid state theory The aim of the lectures was to repeat some of the most important well known classics of semiconductor optics and transport and eventually guide the students to topics of current interest in research When preparing the lectures we did not find a textbook addressing all these aspects experiment and theory in semiconductor optics and transport which made us write this book This book presents the phenomenology and a simple intuitive understanding of many effects and in addition attempts to explain the underlying physics on a consistent theoretical footing Calculations are presented such that a student should be able to follow them with a pencil and a piece of paper

**Semiconductor Optics** Claus F. Klingshirn, 1997-02-03 Semiconductor Optics provides an introduction to and an overview of semiconductor optics from the IR through the visible to the UV including linear and nonlinear optical properties dynamics magneto and electrooptics high excitation effects some applications experimental techniques and group theory Mathematics is kept as elementary as possible enough for an intuitive understanding of the experimental results and techniques treated The subjects covered extend from physics to materials science and optoelectronics

**Optics of Semiconductors and Their Nanostructures** Heinz Kalt, Michael Hetterich, 2013-04-09 In recent years the field of semiconductor optics has been pushed to several extremes The size of semiconductor structures has shrunk to dimensions of a few nanometers the semiconductor light interaction is studied

on timescales as fast as a few femtoseconds and transport properties on a length scale far below the wavelength of light have been revealed. These advances were driven by rapid improvements in both semiconductor and optical technologies and were further facilitated by progress in the theoretical description of optical excitations in semiconductors. This book, written by leading experts in the field, provides an up-to-date introduction to the optics of semiconductors and their nanostructures so as to help the reader understand these exciting new developments. It also discusses recently established applications such as blue light emitters as well as the quest for future applications in areas such as spintronics, quantum information processing, and third-generation solar cells. Coherent Semiconductor Optics Torsten Meier, Peter Thomas, Stephan W.

Koch, 2007-02-13 This book could not have been written without the extensive work of many diploma and Ph.D. students in our Theoretical Semiconductor Physics Group at the Philipps University in Marburg. They have contributed to the fundamental understanding and to many applications in the area of coherent semiconductor optics. The one-dimensional tight-binding model which is exclusively treated in the present book has been the basis of many of their diploma and Ph.D. theses. The reader will find references to their results and also their names as authors of the publications listed in the sections suggested for reading. In particular, the authors wish to thank Irina Kuznetsova who prepared a large number of the figures and recalculated the underlying data on the basis of the equations presented in this book in cases where parameters or presentation had to be changed and/or optimized. Some of the problems in particular those connected to the more introductory chapters were solved by Swantje Horst and Joachim Kalden. They made valuable suggestions for improved formulation of the problems and pointed out a number of hints we should give our readers in order to help them with the solutions. Furthermore, we wish to thank all our numerous collaborators together with whom we have performed research in the area of coherent semiconductor optics in the past and present for many valuable discussions. In particular, without the close cooperation between experiment and theory, this research field would not have advanced to the present level. **Semiconductor Optics**

**2** Heinz Kalt, Claus F. Klingshirn, 2024-03-16 This book provides an introduction to and an overview of the multifaceted area of dynamics and nonlinearities related to optical excitations in semiconductors. It is a revised and significantly extended edition of the well-established book by C. Klingshirn, split into two volumes and restructured to make it more concise. Inserts on important experimental techniques, reference to topical research, and novel materials as well as consideration of photonic applications support research-oriented teaching and learning. This book reviews nonlinear optical properties and many-body phenomena evoked by high densities of quasi-particles in semiconductors. Coherent dynamics and relaxation of optical excitations, carriers, excitons, electron-hole plasmas, etc., as well as condensation phenomena are elucidated in these materials. A broad overview is provided of seminal research results, augmented by detailed descriptions of the relevant experimental techniques, e.g., ultrafast spectroscopy, four-wave mixing, and the Hanbury Brown and Twiss experiment. Offering a comprehensive introduction to hot topics in current research, polariton condensates, valley coherence, and single photons to

name a few it also discusses applications of the described physical concepts in topical areas such as quantum information photonics spintronics and optoelectronics Covering subjects ranging from physics to materials science and optoelectronics the book provides a lively and comprehensive introduction to semiconductor optics beyond the linear regime With many problems chapter introductions schematic depictions of physical phenomena as well as boxed inserts and a detailed index it is suitable for use in graduate courses in physics and neighboring sciences like material science and optical communication It is also a valuable reference resource for doctoral and advanced researchers

**Progress in Optics**, 1993-05-10 A collection of comprehensive reviews in the field of optics The first article presents a review of recent investigations concerning multiphoton ionization of atoms in intense radiation fields and includes discussions on above threshold ionization generation of higher order harmonics of an intense field interacting with a gaseous medium and the role of chaotic dynamics in the interaction of atoms with monochromatic radiation A tutorial section on chaotic behaviour is also included The second article presents a review of modern developments regarding properties of light diffracted by gratings Both a phenomenological treatment and a macroscopic analysis are presented The following article reviews developments relating to optical amplifiers especially those which use semiconductors and optical fibres The article covers the operating principles fabrication and performance characteristics The next article reviews recent research on a promising new class of neural networks the so called adaptive multilayer optical networks Although still in the early states of developments these devices offer the possibility of implementing optical interconnections in three dimensions and they can be functionally equivalent to several thousand chips The fifth article deals with idealized but rather useful models of some atomic systems namely two level and four level atoms The analogy between a quantum two level atom and a classical model consisting of two coupled optical modes is discussed Extension of these considerations to optical band structure and to four level systems is also treated The concluding article deals thoroughly with free electron lasers in a physical way while minimum attention is paid to organic generalities and mathematical rigour

*Optical Properties and Applications of Semiconductors* Inamuddin, Mohd Imran Ahamed, Rajender Boddula, Tariq Altalhi, 2022-07-18 Semiconductors with optical characteristics have found widespread use in evolving semiconductor photovoltaics where optical features are important The industrialization of semiconductors and their allied applications have paved the way for optical measurement techniques to be used in new ways Due to their unique properties semiconductors are key components in the daily employed technologies in healthcare computing communications green energy and a range of other uses This book examines the fundamental optical properties and applications of semiconductors It summarizes the information as well as the optical characteristics and applicability of semiconductors through an in depth review of the literature Accomplished experts in the field share their knowledge and examine new developments

**FEATURES** Comprehensive coverage of all types of optical applications using semiconductors Explores relevant composite materials and devices for each application Addresses the optical properties of crystalline and amorphous

semiconductors Describes new developments in the field and future potential applications Optical Properties and Applications of Semiconductors is a comprehensive reference and an invaluable resource for engineers scientists academics and industry R D teams working in applied physics      Semiconductor Optical Modulators Koichi Wakita,2013-11-27 The introduction of GaAs AlGaAs double heterostructure lasers has opened the door to a new age in the application of compound semiconductor materials to microwave and optical technologies A variety and combination of semiconductor materials have been investigated and applied to present commercial uses with these devices operating at wide frequencies and wavelengths Semiconductor modulators are typical examples of this technical evolutions and hvs been developed for commercial use Although these have a long history to date we are not aware of any book that details this evolution Consequently we have written a book to provide a comprehensive account of semiconductor modulators with emphasis on historical details and experimantal reports The objective is to provide an up to date understanding of semiconductor modulators Particular attention has been paid to multiple quantum well MQW modulators operating at long wavelengths taking into account the low losses and dispersion in silica fibers occuring at around 1.3 and 1.55  $\mu\text{m}$  At the present time MQW structures have been investigated but these have not been sufficiently developed to provide characteristic features which would be instructive enough for readers One problem is the almost daily publication of papers on semiconductor modulators Not only do these papers provide additional data but they often modify the interpretations of particular concepts Almost all chapters refer to the large number of published papers that can be consulted for future study      **Photonics and Fiber Optics** Tarun Kumar Gangopadhyay,Pathik Kumbhakar,Mrinal Kanti Mandal,2019-09-23 The combination of laser and optoelectronics with optical fiber technology can enhance the seamless activities of fiber optic communications and fiber sensor arena This book discusses foundations of laser technology non linear optics laser and fiber optic applications in telecommunication and sensing fields including fundamentals and recent developments in photonics technology Accumulated chapters cover constituent materials techniques of measurement of non linear optical properties of nanomaterials photonic crystals and pertinent applications in medical high voltage engineering and in optical computations and designing logic gates

Understanding Fiber Optics Jeff Hecht,2015-03-31 A tutorial introduction to fiber optics which explains fundamental concepts of fiber optics components and systems with minimal math With more than 100 000 copies in print Understanding Fiber Optics has been widely used in the classroom for self study and in corporate training since the first edition was published in 1987 This is a reprint of the 5th edition originally published by Pearson Education and now available at low cost from Laser Light Press      **Selected Topics on Optical Amplifiers in Present Scenario** Sisir Garai,2012-03-23 With the explosion of information traffic the role of optics becomes very significant to fulfill the demand of super fast computing and data processing and the role of optical amplifier is indispensable in optical communication field This book covers different advance functionalities of optical amplifiers and their emerging applications such as the role of SOA in the next generation of

optical access network high speed switches frequency encoded all optical logic processors optical packet switching architectures microwave photonic system etc Technology of improving the gain and noise figure of EDFA and the study of the variation of material gain of QD structure are also included All the selected topics are very interesting well organized and hope it will be of great value to the postgraduate students academics and anyone seeking to understand the trends of optical amplifiers in present scenario      **Encyclopedic Handbook of Integrated Optics** Kenichi Iga,Yasuo Kokubun,2018-10-03

As optical technologies move closer to the core of modern computer architecture there arise many challenges in building optical capabilities from the network to the motherboard Rapid advances in integrated optics technologies are making this a reality However no comprehensive up to date reference is available to the technologies and principles underlying the field The Encyclopedic Handbook of Integrated Optics fills this void collecting the work of 53 leading experts into a compilation of the most important concepts phenomena technologies and terms covering all related fields This unique book consists of two types of entries the first is a detailed full length description the other a concise overview of the topic Additionally the coverage can be divided into four broad areas A survey of the basics of integrated optics exploring theory practical concerns and the fundamentals behind optical devices Focused discussion on devices and components such as arrayed waveguide grating various types of lasers optical amplifiers and optoelectronic devices In depth examination of subsystems including MEMS optical pickup and planar lightwave circuits Finally systems considerations such as multiplexing demultiplexing 3R circuits transmission and reception Offering a broad and complete treatment of the field the Encyclopedic Handbook of Integrated Optics is the complete guide to the fundamentals principles and applications of integrated optics technology

*Semiconductor Integrated Optics for Switching Light* Charlie Ironside,2017-09-12 This book covers the technology of switching or modulating light in semiconductor optical waveguides Currently a key function for optical communications systems is the conversion of data from an electrical signal to an optical signal for transmission in very low loss optical fibres and the converse process of optical to electrical conversion the O E O data conversion This conversion between electronic and photonic signals imposes an energy consumption overhead on optical communication systems So many research workers have been attracted to ultrafast all optical switching of data in different formats As a way of introduction to all optical switching in semiconductor waveguides the book covers the electro optic effect electroabsorption and electrorefraction effects that can be used in semiconductor optical modulation devices But the book focuses on all optical switching using second and third order optical nonlinearities in AlGaAs optical waveguides It covers a variety of device configurations including integrated nonlinear couplers and Mach Zehnder interferometers Further it provides design software in suit of Mathematica notebooks that can be used to explore the device design      **Fundamentals of Photonics** Bahaa E. A. Saleh,Malvin Carl Teich,2020-03-04 Fundamentals of Photonics A complete thoroughly updated full color third edition Fundamentals of Photonics Third Edition is a self contained and up to date introductory level textbook that thoroughly



surveys this rapidly expanding area of engineering and applied physics. Featuring a blend of theory and applications coverage includes detailed accounts of the primary theories of light including ray optics, wave optics, electromagnetic optics, and photon optics, as well as the interaction of light and matter. Presented at increasing levels of complexity, preliminary sections build toward more advanced topics such as Fourier optics and holography, photonic crystal optics, guided wave and fiber optics, LEDs and lasers, acousto-optic and electro-optic devices, nonlinear optical devices, ultrafast optics, optical interconnects and switches, and optical fiber communications. The third edition features an entirely new chapter on the optics of metals and plasmonic devices. Each chapter contains highlighted equations, exercises, problems, summaries, and selected reading lists. Examples of real systems are included to emphasize the concepts governing applications of current interest. Each of the twenty-four chapters of the second edition has been thoroughly updated.

*All-Optical Signal Processing* Stefan Wabnitz, Benjamin J. Eggleton, 2015-04-11. This book provides a comprehensive review of the state of the art of optical signal processing technologies and devices. It presents breakthrough solutions for enabling a pervasive use of optics in data communication and signal storage applications. It presents optical signal processing as a solution to overcome the capacity crunch in communication networks. The book content ranges from the development of innovative materials and devices such as graphene and slow light structures to the use of nonlinear optics for secure quantum information processing and overcoming the classical Shannon limit on channel capacity and microwave signal processing. Although it holds the promise for a substantial speed improvement, today's communication infrastructure optics remains largely confined to the signal transport layer as it lags behind electronics as far as signal processing is concerned. This situation will change in the near future as the tremendous growth of data traffic requires energy-efficient and fully transparent all-optical networks. The book is written by leaders in the field.

**New Advances in Semiconductors** Alberto Adriano Cavalheiro, 2022-06-15. *New Advances in Semiconductors* brings together contributions from important researchers around the world on semiconductor materials and their applications. It includes seven chapters in two sections: Calculations and Simulations in Semiconductors and Semiconductor Materials. The world will emerge different after the social and economic reorganizations caused by the COVID-19 pandemic and will be even more dependent on semiconductors than ever before. *New Advances in Semiconductors* is a book that brings together the contributions of important researchers around the world and is able to give an idea about the different characteristics of semiconductor materials and their applications. There is a section dedicated to theory, calculations, and logic, and another dedicated to the development and characterization of semiconductor materials of great future interest. I really hope that this book will help to spread knowledge about this research field to other researchers and students working in this area or even to those interested in starting their more advanced studies.

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