



# Semiconductor Lasers I

**David J. Klotzkin**



## **Semiconductor Lasers I:**

Semiconductor Lasers I Eli Kapon, 1999-01-12 This book covers the device physics of semiconductor lasers in five chapters written by recognized experts in this field The volume begins by introducing the basic mechanisms of optical gain in semiconductors and the role of quantum confinement in modern quantum well diode lasers Subsequent chapters treat the effects of built in strain one of the important recent advances in the technology of these lasers and the physical mechanisms underlying the dynamics and high speed modulation of these devices The book concludes with chapters addressing the control of photon states in squeezed light and microcavity structures and electron states in low dimensional quantum wire and quantum dot lasers The book offers useful information for both readers unfamiliar with semiconductor lasers through the introductory parts of each chapter as well as a state of the art discussion of some of the most advanced semiconductor laser structures intended for readers engaged in research in this field This book may also serve as an introduction for the companion volume *Semiconductor Lasers II Materials and Structures* which presents further details on the different material systems and laser structures used for achieving specific diode laser performance features Introduces the reader to the basics of semiconductor lasers Covers the fundamentals of lasing in semiconductors including quantum confined and microcavity structures Beneficial to readers interested in the more general aspects of semiconductor physics and optoelectronic devices such as quantum confined heterostructures and integrated optics Each chapter contains a thorough introduction to the topic geared toward the non expert followed by an in depth discussion of current technology and future trends Useful for professionals engaged in research and development Contains numerous schematic and data containing illustrations

**Fundamentals of Semiconductor Lasers** Takahiro Numai, 2006-05-10 *Fundamentals of Semiconductor Lasers* explains the physics and fundamental characteristics of semiconductor lasers with regard to systems applications The detailed and comprehensive presentation is unique in that it encourages the reader to consider different semiconductor lasers from different angles Emphasis is placed on recognizing common concepts such operating principles and structure and solving problems based on individual situations The treatment is enhanced by an historical account of advances in semiconductor lasers over the years discussing both those ideas that have persisted over the years and those that have faded out The first four chapters cover the basics of semiconductors including band structures optical transitions optical waveguides and optical resonators The remaining chapters discuss operating principles and basic characteristics of semiconductor lasers and advanced topics including dynamic single mode lasers quantum well lasers and control of spontaneous emission The reader need only be familiar with undergraduate level electromagnetism and quantum mechanics After reading this book the student will be able to think critically about semiconductor lasers and be able to read and understand journal papers in the field This book will be essential to any advanced undergraduate or graduate student of semiconductor lasers and any professional physicist or engineer looking for a good overview of the subject      *Semiconductor Lasers* Govind P.

Agrawal, Niloy K. Dutta, 2013-11-27 Since its invention in 1962 the semiconductor laser has come a long way. Advances in material purity and epitaxial growth techniques have led to a variety of semiconductor lasers covering a wide wavelength range of 0.3–100  $\mu\text{m}$ . The development during the 1970s of GaAs semiconductor lasers emitting in the near infrared region of 0.8–0.9  $\mu\text{m}$  resulted in their use for the first generation of optical fiber communication systems. However, to take advantage of low losses in silica fibers occurring around 1.3 and 1.55  $\mu\text{m}$ , the emphasis soon shifted toward long wavelength semiconductor lasers. The material system of choice in this wavelength range has been the quaternary alloy InGaAsP. During the last five years or so the intense development effort devoted to InGaAsP lasers has resulted in a technology mature enough that lightwave transmission systems using InGaAsP lasers are currently being deployed throughout the world. This book is intended to provide a comprehensive account of long wavelength semiconductor lasers. Particular attention is paid to InGaAsP lasers although we also consider semiconductor lasers operating at longer wavelengths. The objective is to provide an up to date understanding of semiconductor lasers while incorporating recent research results that are not yet available in the book form. Although InGaAsP lasers are often used as an example the basic concepts discussed in this text apply to all semiconductor lasers irrespective of their wavelengths.

**Semiconductor Lasers** Junji Ohtsubo, 2006 This monograph describes fascinating recent progress in the field of chaos stability and instability of semiconductor lasers. Applications and future prospects are discussed in detail. The book emphasizes the various dynamics induced in semiconductor lasers by optical and electronic feedback, optical injection and injection current modulation. Recent results of both theoretical and experimental investigations are presented. Demonstrating applications of semiconductor laser chaos control and noise. Semiconductor Lasers describes suppression and chaotic secure communications. For those who are interested in optics but not familiar with nonlinear systems a brief introduction to chaos analysis is presented.

**Physics of Semiconductor Lasers** B. Mroziwicz, M. Bugajski, W. Nakwaski, 2017-01-31 Written for readers who have some background in solid state physics but do not necessarily possess any knowledge of semiconductor lasers this book provides a comprehensive and concise account of fundamental semiconductor laser physics, technology and properties. The principles of operation of these lasers are therefore discussed in detail with the interrelations between their design and optical, electrical and thermal properties. The relative merits of a large number of laser structures and their parameters are described to acquaint the reader with the various aspects of the semiconductor lasers and the trends in their development.

Introduction to Semiconductor Lasers for Optical Communications David J. Klotzkin, 2020-01-07 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.

Single

Frequency Semiconductor Lasers Jens Buus,1991 This tutorial text describes the properties of advanced semiconductor lasers in detail Although the text gives a detailed theoretical account a number of practical examples and experimental results are described as well The material presented is at an advanced level and is of particular interest to scientists and engineers with a basic familiarity with semiconductor lasers who would like a description of the properties of single frequency semiconductor lasers and of the possibilities offered by these devices *Semiconductor Lasers II* Eli Kapon,1999-01-14 Judging from the impact it has on our everyday lives the semiconductor laser has emerged as perhaps the most important laser device currently in use This volume presents information on recent advances in materials and structures *Semiconductor-Laser Fundamentals* Weng W. Chow,Stephan W. Koch,1999-07-21 This in depth title discusses the underlying physics and operational principles of semiconductor lasers It analyzes the optical and electronic properties of the semiconductor medium in detail including quantum confinement and gain engineering effects The text also includes recent developments in blue emitting semiconductor lasers **Advances in Semiconductor Lasers** James J Coleman,A. Catrina Bryce,Chennupati Jagadish,2012-05-02 Since its inception in 1966 the series of numbered volumes known as Semiconductors and Semimetals has distinguished itself through the careful selection of well known authors editors and contributors The Willardson and Beer Series as it is widely known has succeeded in publishing numerous landmark volumes and chapters Not only did many of these volumes make an impact at the time of their publication but they continue to be well cited years after their original release Recently Professor Eicke R Weber of the University of California at Berkeley joined as a co editor of the series *Long-Wavelength Semiconductor Lasers* Govind Agrawal,Niloy K. Dutta,1986-12-31 Since its invention in 1962 the semiconductor laser has come a long way Advances in material purity and epitaxial growth techniques have led to a variety of semiconductor lasers covering a wide wavelength range of 0.3-100  $\mu\text{m}$  The development during the 1970s of GaAs semiconductor lasers emitting in the near infrared region of 0.8-0.9  $\mu\text{m}$  resulted in their use for the first generation of optical fiber communication systems However to take advantage of low losses in silica fibers occurring around 1.3 and 1.55  $\mu\text{m}$  the emphasis soon shifted toward long wavelength semiconductor lasers The material system of choice in this wavelength range has been the quaternary alloy InGaAsP During the last five years or so the intense development effort devoted to InGaAsP lasers has resulted in a technology mature enough that lightwave transmission systems using InGaAsP lasers are currently being deployed throughout the world This book is intended to provide a comprehensive account of long wave length semiconductor lasers Particular attention is paid to InGaAsP lasers although we also consider semiconductor lasers operating at longer wave lengths The objective is to provide an up to date understanding of semicon ductor lasers while incorporating recent research results that are not yet available in the book form Although InGaAsP lasers are often used as an example the basic concepts discussed in this text apply to all semiconductor lasers irrespective of their wavelengths **Single Frequency Semiconductor Lasers** Zujie Fang,Haiwen Cai,Gaoting Chen,Ronghui Qu,2017-07-29

This book systematically introduces the single frequency semiconductor laser which is widely used in many vital advanced technologies such as the laser cooling of atoms and atomic clock high precision measurements and spectroscopy coherent optical communications and advanced optical sensors It presents both the fundamentals and characteristics of semiconductor lasers including basic F P structure and monolithic integrated structures interprets laser noises and their measurements and explains mechanisms and technologies relating to the main aspects of single frequency lasers including external cavity lasers frequency stabilization technologies frequency sweeping optical phase locked loops and so on It paints a clear physical picture of related technologies and reviews new developments in the field as well It will be a useful reference to graduate students researchers and engineers in the field

**Process Technology for Semiconductor Lasers** Kenichi Iga, Susumu Kinoshita, 2013-03-07 Process Technology for Semiconductor Lasers describes the design principles of semiconductor lasers mainly from the fabrication point of view A review is given of the history of semiconductor laser development and applications and of the materials used in lasing at short to long wavelengths The basic design principles for semiconductor laser devices and the epitaxy for laser production are discussed An entire chapter is devoted to the technology of liquid phase epitaxy and another one to vapor phase and beam epitaxies The characterizations of laser materials and the fabrication and characteristics of semiconductor lasers are treated Mode control techniques are presented and surface emitting lasers are introduced in the final chapter

Advances In Semiconductor Lasers And Applications To Optoelectronics (Ijhses Vol. 9 No. 4) Mitra Dutta, Michael A Strosio, 2000-06-21 Foreword by Charles H Townes This volume includes highlights of the theories underlying the essential phenomena occurring in novel semiconductor lasers as well as the principles of operation of selected heterostructure lasers To understand scattering processes in heterostructure lasers and related optoelectronic devices it is essential to consider the role of dimensional confinement of charge carriers as well as acoustical and optical phonons in quantum structures Indeed it is important to consider the confinement of both phonons and carriers in the design and modeling of novel semiconductor lasers such as the tunnel injection laser quantum well intersubband lasers and quantum dot lasers The full exploitation of dimensional confinement leads to the exciting new capability of scattering time engineering in novel semiconductor lasers As a result of continuing advances in techniques for growing quantum heterostructures recent developments are likely to be followed in coming years by many more advances in semiconductor lasers and optoelectronics As our understanding of these devices and the ability to fabricate them grow so does our need for more sophisticated theories and simulation methods bridging the gap between quantum and classical transport

Semiconductor Lasers Alexei Baranov, Eric Tournié, 2013-04-23 Semiconductor lasers have important applications in numerous fields including engineering biology chemistry and medicine They form the backbone of the optical telecommunications infrastructure supporting the internet and are used in information storage devices bar code scanners laser printers and many other everyday products Semiconductor lasers Fundamentals and applications is a comprehensive review of this vital technology Part one introduces

the fundamentals of semiconductor lasers beginning with key principles before going on to discuss photonic crystal lasers high power semiconductor lasers and laser beams and the use of semiconductor lasers in ultrafast pulse generation Part two then reviews applications of visible and near infrared emitting lasers Nonpolar and semipolar GaN based lasers advanced self assembled InAs quantum dot lasers and vertical cavity surface emitting lasers are all considered in addition to semiconductor disk and hybrid silicon lasers Finally applications of mid and far infrared emitting lasers are the focus of part three Topics covered include GaSb based type I quantum well diode lasers interband cascade and terahertz quantum cascade lasers whispering gallery mode lasers and tunable mid infrared laser absorption spectroscopy With its distinguished editors and international team of expert contributors Semiconductor lasers is a valuable guide for all those involved in the design operation and application of these important lasers including laser and telecommunications engineers scientists working in biology and chemistry medical practitioners and academics working in this field Provides a comprehensive review of semiconductor lasers and their applications in engineering biology chemistry and medicine Discusses photonic crystal lasers high power semiconductor lasers and laser beams and the use of semiconductor lasers in ultrafast pulse generation Reviews applications of visible and near infrared emitting lasers and mid and far infrared emitting lasers

*Semiconductor Laser Theory* Prasanta Kumar Basu, Bratati Mukhopadhyay, Rikmantra Basu, 2015-06-17 Developed from the authors classroom tested material Semiconductor Laser Theory takes a semiclassical approach to teaching the principles structure and applications of semiconductor lasers Designed for graduate students in physics electrical engineering and materials science the text covers many recent developments including diode lasers

**Theory of Semiconductor Lasers** Minoru Yamada, 2014-04-10 This book provides a unified and complete theory for semiconductor lasers covering topics ranging from the principles of classical and quantum mechanics to highly advanced levels for readers who need to analyze the complicated operating characteristics generated in the real application of semiconductor lasers The author conducts a theoretical analysis especially on the instabilities involved in the operation of semiconductor lasers A density matrix into the theory for semiconductor lasers is introduced and the formulation of an improved rate equation to help understand the mode competition phenomena which cause the optical external feedback noise is thoroughly described from the basic quantum mechanics The derivation of the improved rate equation will allow readers to extend the analysis for the different types of semiconductor materials and laser structures they deal with This book is intended not only for students and academic researchers but also for engineers who develop lasers for the market as the advanced topics covered are dedicated to real problems in implementing semiconductor lasers for practical use

**Semiconductor Lasers: Basic Physics, Technology, and Design** Heinrich Rieck, 1970

Laser Diode Microsystems Hans Zappe, 2013-03-14 Laser Diode Microsystems provides the reader with the basic knowledge and understanding required for using semiconductor laser diodes in optical microsystems and micro optical electromechanic systems This tutorial addresses the fundamentals of semiconductor laser

operation and design coupled with an overview of the types of laser diodes suitable for use in Microsystems along with their distinguishing characteristics Emphasis is placed on laser diode characterization and measurement as well as the assembly techniques and optical accessories required for incorporation of semiconductor lasers into complex microsystems Equipped with typical results and calculation examples this hand on text helps readers to develop a feel for how to choose a laser diode characterize it and incorporate it into a microsystem

Semiconductor Disk Lasers Oleg G. Okhotnikov, 2010-03-30 This timely publication presents a review of the most recent developments in the field of Semiconductor Disk Lasers Covering a wide range of key topics such as operating principles thermal management nonlinear frequency conversion semiconductor materials short pulse generation electrical pumping and laser applications the book provides readers with a comprehensive account of the fundamentals and latest advances in this rich and diverse field In so doing it brings together contributions from world experts at major collaborative research centers in Europe and the USA Each chapter includes a tutorial style introduction to the selected topic suitable for postgraduate students and scientists with a basic background in optics making it of interest to a wide range of scientists researchers engineers and physicists working and interested in this rapidly developing field It will also serve as additional reading for students in the field



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## **Table of Contents Semiconductor Lasers I**

1. Understanding the eBook Semiconductor Lasers I
  - The Rise of Digital Reading Semiconductor Lasers I
  - Advantages of eBooks Over Traditional Books
2. Identifying Semiconductor Lasers I
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Semiconductor Lasers I
  - User-Friendly Interface
4. Exploring eBook Recommendations from Semiconductor Lasers I
  - Personalized Recommendations
  - Semiconductor Lasers I User Reviews and Ratings
  - Semiconductor Lasers I and Bestseller Lists
5. Accessing Semiconductor Lasers I Free and Paid eBooks
  - Semiconductor Lasers I Public Domain eBooks
  - Semiconductor Lasers I eBook Subscription Services
  - Semiconductor Lasers I Budget-Friendly Options
6. Navigating Semiconductor Lasers I eBook Formats

- ePub, PDF, MOBI, and More
- Semiconductor Lasers I Compatibility with Devices
- Semiconductor Lasers I Enhanced eBook Features
- 7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Semiconductor Lasers I
  - Highlighting and Note-Taking Semiconductor Lasers I
  - Interactive Elements Semiconductor Lasers I
- 8. Staying Engaged with Semiconductor Lasers I
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Semiconductor Lasers I
- 9. Balancing eBooks and Physical Books Semiconductor Lasers I
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Semiconductor Lasers I
- 10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
- 11. Cultivating a Reading Routine Semiconductor Lasers I
  - Setting Reading Goals Semiconductor Lasers I
  - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Semiconductor Lasers I
  - Fact-Checking eBook Content of Semiconductor Lasers I
  - Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
  - Utilizing eBooks for Skill Development
  - Exploring Educational eBooks
- 14. Embracing eBook Trends
  - Integration of Multimedia Elements
  - Interactive and Gamified eBooks

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