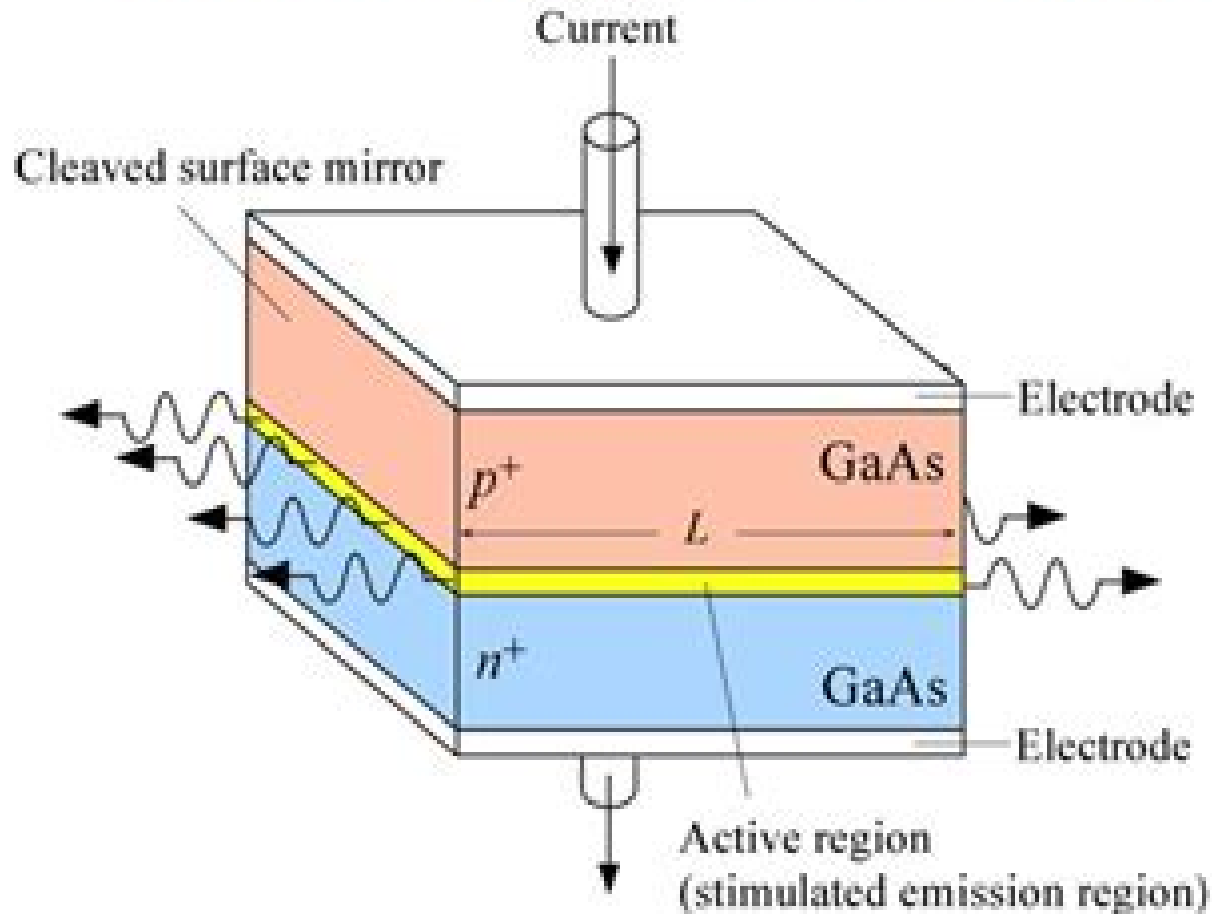


# Semiconductor Laser Diode



A schematic illustration of a GaAs homojunction laser diode. The cleaved surfaces act as reflecting mirrors.

# Semiconductor Laser Physics

**Govind P. Agrawal**



## **Semiconductor Laser Physics:**

**Semiconductor-Laser Fundamentals** Weng W. Chow, Stephan W. Koch, 2013-03-09 Since Fall of 1993 when we completed the manuscript of our book *Semiconductor Laser Physics* W W Chow S W Koch and M Sargent III Springer Berlin Heidelberg 1994 many new and exciting developments have taken place in the world of semiconductor lasers Novel laser and amplifier structures were developed and others for example the VCSEL vertical cavity surface emitting laser and monolithic MOPA master oscillator power amplifier made the transition from research and development to production When investigating some of these systems we discovered instances when device performance and thus design depend critically on details of the gain medium properties e g spectral shape and carrier density dependence of the gain and refractive index New material systems were also introduced with optical emission wave lengths spanning from the mid infrared to the ultraviolet Particularly note worthy are laser and light emitting diodes based on the wide bandgap group III nitride and II VI compounds These devices emit in the visible to ultra violet wavelength range which is important for the wide variety of optoelectronic applications While these novel semiconductor laser materials show many similarities with the more conventional near infrared systems they also possess rather different material parameter combinations These differences appear as band structure modifications and as increased importance of Coulomb effects such that e g excitonic signatures resulting from the attractive electron hole interaction are generally significantly more prominent in the wide bandgap systems

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**Semiconductor-Laser Fundamentals** Weng W. Chow, Stephan W. Koch, 2013-01-08 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

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Nakwaski,1991-01-01 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

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

*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

*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

**Semiconductor Laser Fundamentals** Toshiaki Suhara,2004-03-16 Ranging from fundamental theoretical concepts to advanced device technologies this reference text explores the engineering characteristics and performance of specific semiconductor lasers It defines key principles in electromagnetics optoelectronics and laser implementation for novel applications in optical communications storage processing measurement and sensing This text prepares students for advanced experimental and theoretical research in semiconductor laser technology and provides the only comprehensive systematic and concise description of semiconductor lasers available for an understanding of the physics and parameters of laser operation and function     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     Unlocking Dynamical Diversity Deborah M. Kane,K. Alan Shore,2005-11-01 Applications of semiconductor lasers with optical feedback systems are driving rapid developments in theoretical and experimental research The very broad wavelength gain bandwidth of semiconductor lasers combined with frequency filtered strong optical feedback create the tunable single frequency laser systems utilised in telecommunications environmental sensing measurement and control Those with weak to moderate optical feedback lead to the chaotic semiconductor lasers of private communication This resource illustrates the diversity of dynamic laser states and the technological applications thereof presenting a timely synthesis of current findings and providing the roadmap for exploiting their future potential Provides theory based explanations underpinned by a vast range of experimental studies on optical feedback including conventional phase conjugate and frequency filtered feedback in standard commercial and single stripe semiconductor lasers Includes the classic Lang Kobayashi equation model through to more recent theory with new developments in techniques for solving delay differential equations and bifurcation analysis Explores developments in self mixing interferometry to produce sub nanometre sensitivity in path length measurements Reviews tunable single frequency

semiconductor lasers and systems and their diverse range of applications in sensing and optical communications Emphasises the importance of synchronised chaotic semiconductor lasers using optical feedback and private communications systems Unlocking Dynamical Diversity illustrates all theory using real world examples gleaned from international cutting edge research Such an approach appeals to industry professionals working in semiconductor lasers laser physics and laser applications and is essential reading for researchers and postgraduates in these fields      **Essential Semiconductor Laser**

**Physics** A F J Levi,2018-07-18 The invention of the semiconductor laser along with silica glass fiber has enabled an incredible revolution in global communication infrastructure of direct benefit to all Development of devices and system concepts that exploit the same fundamental light matter interaction continues Researchers and technologists are pursuing a broad range of emerging applications everything from automobile collision avoidance to secure quantum key distribution This book sets out to summarize key aspects of semiconductor laser device physics and principles of laser operation It provides a convenient reference and essential knowledge to be understood before exploring more sophisticated device concepts The contents serve as a foundation for scientists and engineers without the need to invest in specialized detailed study Supplementary material in the form of MATLAB is available for numerically generated figures      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      Quantum Confined Laser Devices Peter Blood,2015-10-23 The semiconductor laser invented over 50 years ago has had an enormous impact on the digital technologies that now dominate so many applications in business commerce and the home The laser is used in all types of optical fibre communication networks that enable the operation of the internet e mail voice and skype transmission Approximately one billion are produced each year for a market valued at around 5 billion Nearly all semiconductor lasers now use extremely thin layers of light emitting materials quantum well lasers Increasingly smaller nanostructures are used in the form of quantum dots The impact of the semiconductor laser is surprising in the light of the complexity of the physical processes that determine the operation of every device This text takes the reader from the fundamental optical gain and carrier recombination processes in quantum wells and quantum dots through descriptions of common device structures to an understanding of their operating characteristics It has a consistent treatment of both quantum dot and quantum well structures taking full account of their dimensionality which provides the reader with a

complete account of contemporary quantum confined laser diodes It includes plenty of illustrations from both model calculations and experimental observations There are numerous exercises many designed to give a feel for values of key parameters and experience obtaining quantitative results from equations Some challenging concepts previously the subject matter of research monographs are treated here at this level for the first time *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

**Basics of Laser Physics** Karl F. Renk,2017-03-30 This textbook provides an introductory presentation of all types of lasers It contains a general description of the laser a theoretical treatment and a characterization of its operation as it deals with gas solid state free electron and semiconductor lasers This expanded and updated second edition of the book presents a description of the dynamics of free electron laser oscillation using a model introduced in the first edition that allows a reader to understand basic properties of a free electron laser and makes the difference to conventional lasers The discussions and the treatment of equations are presented in a way that a reader can immediately follow The book addresses graduate and undergraduate students in science and engineering featuring problems with solutions and over 400 illustrations

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