

Semiconductor Lasers Stability Instability And Chaos

[#semiconductor lasers](#) [#laser stability](#) [#laser instability](#) [#nonlinear laser dynamics](#) [#laser chaos](#)

Explore the complex operational behaviors of semiconductor lasers, covering their intrinsic stability, the onset of instability, and the fascinating emergence of chaotic dynamics. This analysis delves into critical factors influencing laser performance and reliability in various applications.

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Semiconductor Lasers

This book describes the fascinating recent advances made concerning the chaos, stability and instability of semiconductor lasers, and discusses their applications and future prospects in detail. It emphasizes the dynamics in semiconductor lasers by optical and electronic feedback, optical injection, and injection current modulation. Applications of semiconductor laser chaos, control and noise, and semiconductor lasers are also demonstrated. Semiconductor lasers with new structures, such as vertical-cavity surface-emitting lasers and broad-area semiconductor lasers, are intriguing and promising devices. Current topics include fast physical number generation using chaotic semiconductor lasers for secure communication, development of chaos, quantum-dot semiconductor lasers and quantum-cascade semiconductor lasers, and vertical-cavity surface-emitting lasers. This fourth edition has been significantly expanded to reflect the latest developments. The fundamental theory of laser chaos and the chaotic dynamics in semiconductor lasers are discussed, but also for example the method of self-mixing interferometry in quantum-cascade lasers, which is indispensable in practical applications. Further, this edition covers chaos synchronization between two lasers and the application to secure optical communications. Another new topic is the consistency and synchronization property of many coupled semiconductor lasers in connection with the analogy of the dynamics between synaptic neurons and chaotic semiconductor lasers, which are compatible nonlinear dynamic elements. In particular, zero-lag synchronization between distant neurons plays a crucial role for information processing in the brain. Lastly, the book presents an application of the consistency and synchronization property in chaotic semiconductor lasers, namely a type of neuro-inspired information processing referred to as reservoir computing.

Quantum Dot Lasers on Silicon

This book provides guidelines and design rules for developing high-performance, low-cost, and energy-efficient quantum-dot (QD) lasers for silicon photonic integrated circuits (PIC), optical frequency comb generation, and quantum information systems. To this end, the nonlinear properties and dynamics of QD lasers on silicon are investigated in depth by both theoretical analysis and experiment. This book aims at addressing four issues encountered in developing silicon PIC: 1) The instability of laser emission caused by the chip-scale back-reflection. During photonic integration, the chip-scale

back-reflection is usually responsible for the generation of severe instability (i.e., coherence collapse) from the on-chip source. As a consequence, the transmission performance of the chip could be largely degraded. To overcome this issue, we investigate the nonlinear properties and dynamics of QD laser on Si in this book to understand how can it be applied to isolator-free photonic integration in which the expensive optical isolator can be avoided. Results show that the QD laser exhibits a high degree of tolerance for chip-scale back-reflections in absence of any instability, which is a promising solution for isolator-free applications. 2) The degradation of laser performance at a high operating temperature. In this era of Internet-of-Thing (IoT), about 40% of energy is consumed for cooling in the data center. In this context, it is important to develop a high-temperature continuous-wave (CW) emitted laser source. In this book, we introduce a single-mode distributed feedback (DFB) QD laser with a design of optical wavelength detuning (OWD). By taking advantage of the OWD technique and the high-performance QD with high thermal stability, all the static and dynamical performances of the QD device are improved when the operating temperature is high. This study paves the way for developing uncooled and isolator-free PIC. 3) The limited phase noise level and optical bandwidth of the laser are the bottlenecks for further increasing the transmission capacity. To improve the transmission capacity and meet the requirement of the next generation of high-speed optical communication, we introduce the QD-based optical frequency comb (OFC) laser in this book. Benefiting from the gain broadening effect and the low-noise properties of QD, the OFC laser is realized with high optical bandwidth and low phase noise. We also provide approaches to further improve the laser performance, including the external optical feedback and the optical injection. 4) Platform with rich optical nonlinearities is highly desired by future integrated quantum technologies. In this book, we investigate the nonlinear properties and four-wave mixing (FWM) of QD laser on Si. This study reveals that the FWM efficiency of QD laser is more than ten times higher than that of quantum-well laser, which gives insight into developing a QD-based silicon platform for quantum states of light generation. Based on the results in this book, scientists, researchers, and engineers can come up with an informed judgment in utilizing the QD laser for applications ranging from classical silicon PIC to integrated quantum technologies.

Handbook of Chaos Control

This long-awaited revised second edition of the standard reference on the subject has been considerably expanded to include such recent developments as novel control schemes, control of chaotic space-time patterns, control of noisy nonlinear systems, and communication with chaos, as well as promising new directions in research. The contributions from leading international scientists active in the field provide a comprehensive overview of our current level of knowledge on chaos control and its applications in physics, chemistry, biology, medicine, and engineering. In addition, they show the overlap with the traditional field of control theory in the engineering community. An interdisciplinary approach of interest to scientists and engineers working in a number of areas.

Handbook of Information and Communication Security

At its core, information security deals with the secure and accurate transfer of information. While information security has long been important, it was, perhaps, brought more clearly into mainstream focus with the so-called "Y2K" issue. The Y2K scare was the fear that computer networks and the systems that are controlled or operated by software would fail with the turn of the millennium, since their clocks could lose synchronization by not recognizing a number (instruction) with three zeros. A positive outcome of this scare was the creation of several Computer Emergency Response Teams (CERTs) around the world that now work - operatively to exchange expertise and information, and to coordinate in case major problems should arise in the modern IT environment. The terrorist attacks of 11 September 2001 raised security concerns to a new level. The international community responded on at least two fronts; one front being the transfer of reliable information via secure networks and the other being the collection of information about potential terrorists. As a sign of this new emphasis on security, since 2001, all major academic publishers have started technical journals focused on security, and every major communications conference (for example, Globecom and ICC) has organized workshops and sessions on security issues. In addition, the IEEE has created a technical committee on Communication and Information Security. The first editor was intimately involved with security for the Athens Olympic Games of 2004.

Mid-infrared Quantum Cascade Lasers for Chaos Secure Communications

The mid-infrared domain is a promising optical domain because it holds two transparency atmospheric windows, as well as the fingerprint of many chemical compounds. Quantum cascade lasers (QCLs) are one of the available sources in this domain and have already been proven useful for spectroscopic applications and free-space communications. This thesis demonstrates how to implement a private free-space communication relying on mid-infrared optical chaos and this requires an accurate cartography of non-linear phenomena in quantum cascade lasers. This private transmission is made possible by the chaos synchronization of two twin QCLs. Chaos in QCLs can be generated under optical injection or external optical feedback. Depending on the parameters of the optical feedback, QCLs can exhibit several non-linear phenomena in addition to chaos. Similarities exist between QCLs and laser diodes when the chaotic dropouts are synchronized with an external modulation, and this effect is known as the entrainment phenomenon. With a cross-polarization reinjection technique, QCLs can generate all-optical square-waves. Eventually, it is possible to trigger optical extreme events in QCLs with tilted optical feedback. All these experimental results allow a better understanding of the non-linear dynamics of QCLs and will extend the potential applications of this kind of semiconductor lasers.

Microcavity Semiconductor Lasers

Microcavity Semiconductor Lasers Explore this thorough overview of integrable microcavity semiconductor lasers and their applications from two leading voices in the field Attracting a great deal of attention over the last decades for their promising applications in photonic integration and optical interconnects, microcavity semiconductor lasers continue to develop via advances in fundamental physics, theoretical analysis, and numerical simulations. In a new work that will be of interest to researchers and practitioners alike, *Microcavity Semiconductor Lasers: Principles, Design, and Applications* delivers an application-oriented and highly relevant exploration of the theory, fabrication, and applications of these practical devices. The book focuses on unidirectional emission microcavity lasers for photonic integrated circuits, including polygonal microresonators, microdisk, and microring lasers. After an introductory overview of optical microcavities for microlasers and detailed information of the lasers themselves, including mode structure control and characteristics, and lasing properties, the distinguished authors discuss fabrication and applications of different microcavity lasers. Prospects for future research and potential new applications round out the book. Readers will also benefit from the inclusion of: A thorough introduction to multilayer optical waveguides, the FDTD Method, and Padé Approximation, and deformed, chaos, and unidirectional emission microdisk lasers An exploration of mode analysis for triangle and square microresonators similar as FP Cavity Practical discussions of mode analysis and control for deformed square microlasers An examination of hexagonal microcavity lasers and polygonal microcavities, along with vertical radiation loss for 3D microcavities Perfect for laser specialists, semiconductor physicists, and solid-state physicists, *Microcavity Semiconductor Lasers: Principles, Design, and Applications* will also earn a place in the libraries of materials scientists and professionals working in the semiconductor and optical industries seeking a one-stop reference for integrable microcavity semiconductor lasers.

Oscillations, Waves and Interactions

Diode Lasers and Photonic Integrated Circuits, Second Edition provides a comprehensive treatment of optical communication technology, its principles and theory, treating students as well as experienced engineers to an in-depth exploration of this field. Diode lasers are still of significant importance in the areas of optical communication, storage, and sensing. Using the the same well received theoretical foundations of the first edition, the Second Edition now introduces timely updates in the technology and in focus of the book. After 15 years of development in the field, this book will offer brand new and updated material on GaN-based and quantum-dot lasers, photonic IC technology, detectors, modulators and SOAs, DVDs and storage, eye diagrams and BER concepts, and DFB lasers. Appendices will also be expanded to include quantum-dot issues and more on the relation between spontaneous emission and gain.

Diode Lasers and Photonic Integrated Circuits

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.

Single Frequency Semiconductor Lasers

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.

Theory of Semiconductor Lasers

Chaos is a deterministic random phenomenon. Many signal processes (e.g., radar and sonar) have a random appearance, and chaos provides an alternative approach to processing these signals. This book presents up-to-date research results on chaotic signal processing, including the application of nonlinear dynamics to radar target recognition, an exactly solvable chaos approach for communications, a chaotic approach for reconfigurable computing, system identification using chaos, design of a high resolution LADAR system based on chaos, and the use of chaos in compressive sensing.

Chaotic Signal Processing

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.

Unlocking Dynamical Diversity

This thesis investigates passively mode-locked semiconductor lasers by numerical methods. The understanding and optimization of such devices is crucial to the advancement of technologies such as optical data communication and dual comb spectroscopy. The focus of the thesis is therefore on the development of efficient numerical models, which are able both to perform larger parameter studies and to provide quantitative predictions. Along with that, visualization and evaluation techniques for the rich spatio-temporal laser dynamics are developed; these facilitate the physical interpretation of the observed features. The investigations in this thesis revolve around two specific semiconductor devices,

namely a monolithically integrated three-section tapered quantum-dot laser and a V-shaped external cavity laser. In both cases, the simulations closely tie in with experimental results, which have been obtained in collaboration with the TU Darmstadt and the ETH Zurich. Based on the successful numerical reproduction of the experimental findings, the emission dynamics of both lasers can be understood in terms of the cavity geometry and the active medium dynamics. The latter, in particular, highlights the value of the developed simulation tools, since the fast charge-carrier dynamics are generally not experimentally accessible during mode-locking operation. Lastly, the numerical models are used to perform laser design explorations and thus to derive recommendations for further optimizations.

Spatio-Temporal Modeling and Device Optimization of Passively Mode-Locked Semiconductor Lasers

This book represents a unique collection of the latest developments in the rapidly developing world of semiconductor laser diode technology and applications. An international group of distinguished contributors have covered particular aspects and the book includes optimization of semiconductor laser diode parameters for fascinating applications. This collection of chapters will be of considerable interest to engineers, scientists, technologists and physicists working in research and development in the field of semiconductor laser diode, as well as to young researchers who are at the beginning of their career.

Semiconductor Laser Diode

Presenting a blend of applied and fundamental research in highly interdisciplinary subjects of rapidly developing areas, this book contains contributions on the frontiers and hot topics of laser physics, laser technology and laser engineering, and covers a wide range of laser topics, from all-optical signal processing and chaotic optical communication to production of superwicking surfaces, correction of extremely high-power beams, and generation of ultrabroadband spectra. It presents both review-type contributions and well researched and documented case studies, and is intended for graduate students, young scientist, and emeritus scientist working/studying in laser physics, optoelectronics, optics, photonics, and adjacent areas. The book contains both experimental and theoretical studies, as well as combinations of these two, which is known to be a most useful and interesting form of reporting scientific results, allowing students to really learn from each contribution. The book contains over 130 illustrations.

Advanced Lasers

This work addresses time-delay in complex nonlinear systems and, in particular, its applications in complex networks; its role in control theory and nonlinear optics are also investigated. Delays arise naturally in networks of coupled systems due to finite signal propagation speeds and are thus a key issue in many areas of physics, biology, medicine, and technology. Synchronization phenomena in these networks play an important role, e.g., in the context of learning, cognitive and pathological states in the brain, for secure communication with chaotic lasers or for gene regulation. The thesis includes both novel results on the control of complex dynamics by time-delayed feedback and fundamental new insights into the interplay of delay and synchronization. One of the most interesting results here is a solution to the problem of complete synchronization in general networks with large coupling delay, i.e., large distances between the nodes, by giving a universal classification of networks that has a wide range of interdisciplinary applications.

Delay-Coupled Complex Systems

Starting with an introduction to the fundamental physics in chaotic instabilities in laser systems, this comprehensive and unified reference goes on to present the techniques and technology of synchronization of chaos in coupled lasers, as well as the many applications to lasers and optics, communications, security and information technology. Throughout, it presents the current state of knowledge, including encoding/decoding techniques, performance of chaotic communication systems, random number generation, and novel communication technologies.

Optical Communication with Chaotic Lasers

Volume 54 of the Advances in Atomic, Molecular, and Optical Physics Series contains ten contributions, covering a diversity of subject areas in atomic, molecular and optical physics. The article by Regal and Jin reviews the properties of a Fermi degenerate gas of cold potassium atoms in the crossover regime between the Bose-Einstein condensation of molecules and the condensation of fermionic

atom pairs. The transition between the two regions can be probed by varying an external magnetic field. Sherson, Julsgaard and Polzik explore the manner in which light and atoms can be entangled, with applications to quantum information processing and communication. They report on the result of recent experiments involving the entanglement of distant objects and quantum memory of light. Recent developments in cold Rydberg atom physics are reviewed in the article by Choi, Kaufmann, Cubel-Liebisch, Reinhard, and Raithel. Fascinating experiments are described in which cold, highly excited atoms ("Rydberg atoms) and cold plasmas are generated. Evidence for a collective excitation of Rydberg matter is also presented. Griffiin and Pindzola offer an account of non-perturbative quantal methods for electron-atom scattering processes. Included in the discussion are the R-matrix with pseudo-states method and the time-dependent close-coupling method. An extensive review of the R-matrix theory of atomic, molecular, and optical processes is given by Burke, Noble, and Burke. They present a systematic development of the R-matrix method and its applications to various processes such as electron-atom scattering, atomic photoionization, electron-molecule scattering, positron-atom scattering, and atomic/molecular multiphoton processes. Electron impact excitation of rare-gas atoms from both their ground and metastable states is discussed in the article by Boffard, Jung, Anderson, and Lin. Excitation cross sections measured by the optical method are reviewed with emphasis on the physical interpretation in terms of electronic structure of the target atoms. Ozier and Moazzen-Ahmadi explore internal rotation of symmetric top molecules. Developments of new experimental methods based on high-resolution torsional, vibrational, and molecular beam spectroscopy allow accurate determination of internal barriers for these symmetric molecules. The subject of attosecond and angstrom science is reviewed by Niikura and Corkum. The underlying physical mechanisms allowing one to generate attosecond radiation pulses are described and the technology needed for the preparation of such pulses is discussed. LeGouët, Bretenaker, and Lorgère describe how rare earth ions embedded in crystals can be used for processing optically carried broadband radio-frequency signals. Methods for reaching tens of gigahertz instantaneous bandwidth with submegahertz resolution using such devices are analyzed in detail and demonstrated experimentally. Finally, in the article by Illing, Gauthier, and Roy, it is shown that small perturbations applied to optical systems can be used to suppress or control optical chaos, spatio-temporal dynamics, and patterns. Applications of these techniques to communications, laser stabilization, and improving the sensitivity of low-light optical switches are explored. International experts Comprehensive articles New developments

Advances in Atomic, Molecular, and Optical Physics

This book contains a collection of recent advanced contributions in the field of nonlinear dynamics and synchronization, including selected applications in the area of theoretical electrical engineering. The present book is divided into twenty-one chapters grouped in five parts. The first part focuses on theoretical issues related to chaos and synchronization and their potential applications in mechanics, transportation, communication and security. The second part handles dynamic systems modelling and simulation with special applications to real physical systems and phenomena. The third part discusses some fundamentals of electromagnetics (EM) and addresses the modelling and simulation in some real physical electromagnetic scenarios. The fourth part mainly addresses stability concerns. Finally, the last part assembles some sample applications in the area of optimization, data mining, pattern recognition and image processing.

Selected Topics in Nonlinear Dynamics and Theoretical Electrical Engineering

With a good background in nonlinear dynamics, chaos theory, and applications, the author of this leading book gives a systematic treatment of the basic principle of nonlinear dynamics in different fields. The contributions from leading international scientists active in the field provide a comprehensive overview of our current level of background on chaos theory and applications in different sciences. In addition, they show overlap with the traditional field of control theory in scientific community.

Chaos Theory

Photonic Instrumentation: Sensing and Measuring with Lasers is designed as a source for university-level courses covering the essentials of laser-based instrumentation, and as a useful reference for working engineers. Photonic instruments have very desirable features like non-contact operation and unparalleled sensitivity. They have quickly become a big industrial success, passing unaffected through the bubble years and, not any less important, well-established methods in measurement science. This book offers coverage of the most proven instruments, with a balanced treatment of the optical and

electronic aspects involved. It also attempts to present the basic principles, develop the guidelines of design and evaluate the ultimate limits of performances set by noise. The instruments surveyed include: alignment instruments, such as wire diameter and particle size analyzers, telemeters, laser interferometers and self-mixing interferometers, and speckle pattern instruments, laser doppler velocimeters, gyroscopes, optical fiber sensors and quantum sensing. A few appendices offer convenient reference material for key principles on lasers, optical interferometers, propagation, scattering and diffraction.

Photonic Instrumentation

An in-depth exploration of the dynamics of lasers and other relevant optical systems for graduate students and researchers.

Nonlinear Optical Systems

Basics of Laser Physics provides an introductory presentation of the field 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 and, furthermore, with a few laser related topics. The different subjects are connected to each other by the central principle of the laser, namely, that it is a self-oscillating system. Special emphasis is put on a uniform treatment of gas and solid-state lasers, on the one hand, and semiconductor lasers, on the other hand. The discussions and the treatment of equations are presented in a way that a reader can immediately follow. The book addresses undergraduate and graduate students of science and engineering. Not only should it enable instructors to prepare their lectures, but it can be helpful to students for preparing for an examination.

Basics of Laser Physics

In the thirty-seven years that have gone by since the first volume of Progress in Optics was published, optics has become one of the most dynamic fields of science. At the time of inception of this series, the first lasers were only just becoming operational, holography was in its infancy, subjects such as fiber optics, integrated optics and optoelectronics did not exist and quantum optics was the domain of only a few physicists. The term photonics had not yet been coined. Today these fields are flourishing and have become areas of specialisation for many science and engineering students and numerous research workers and engineers throughout the world. Some of the advances in these fields have been recognized by awarding Nobel prizes to seven physicists in the last twenty years. The volumes in this series which have appeared up to now contain nearly 190 review articles by distinguished research workers, which have become permanent records for many important developments. They have helped optical scientists and optical engineers to stay abreast of their fields. There is no sign that developments in optics are slowing down or becoming less interesting. We confidently expect that, just like their predecessors, future volumes of Progress in Optics will faithfully record the most important advances that are being made in optics and related fields.

Progress in Optics

The book summarizes the state-of-the-art of research on control of self-organizing nonlinear systems with contributions from leading international experts in the field. The first focus concerns recent methodological developments including control of networks and of noisy and time-delayed systems. As a second focus, the book features emerging concepts of application including control of quantum systems, soft condensed matter, and biological systems. Special topics reflecting the active research in the field are the analysis and control of chimera states in classical networks and in quantum systems, the mathematical treatment of multiscale systems, the control of colloidal and quantum transport, the control of epidemics and of neural network dynamics.

Control of Self-Organizing Nonlinear Systems

This book summarizes a five year research project, as well as subsequent results regarding high power diode laser systems and their application in materials processing. The text explores the entire chain of technology, from the semiconductor technology, through cooling mounting and assembly, beam shaping and system technology, to applications in the processing of such materials as metals and polymers. Includes theoretical models, a range of important parameters and practical tips.

High Power Diode Lasers

This book is a self-contained collection of scholarly papers targeting an audience of practicing researchers, academics, PhD students, and other scientists. This book describes the rapidly developing field of fiber laser technology filling the very important role of providing students, researchers, and technology managers with valuable, timely, and unbiased information on the subject. The objective of this book is to highlight recent progress and trends in fiber laser technology covering a wide range of topics, such as self-pulsing phenomena in high-power continuous wave (CW) Yb-doped fiber lasers, Q-switched fiber laser, mode-locked fiber laser using carbon nanotubes (CNT), properties of double-scale pulses in mode-locked fiber laser, Brillouin fiber laser, dual-wave length fiber laser (DWFL) for microwave (MHz) and terahertz (THz) radiation generation, tunable fiber laser based on twin core optical fiber, reflective semiconductor optical amplifier (RSOA)-based fiber laser, dissipative soliton phenomena in fiber lasers, noiselike pulses (NLPs) in Yb-doped fiber laser, ultra fast fiber laser, numerical simulation in Q-switched and mode-locked fiber laser, gain saturation in optical fiber laser amplifiers, heat generation and removal in fiber lasers, and different fiber laser based technologies for material processing. We hope that this book will be useful for students, researchers, and professionals, who work with fiber lasers. This book will also serve as an interesting and valuable reference that will impact, stimulate, and promote further advances in the area of fiber lasers

Fiber Laser

Laser ablation describes the interaction of intense optical fields with matter, in which atoms are selectively driven off by thermal or nonthermal mechanisms. This is the first book that combines the most recent results in this rapidly advancing field with authoritative treatment of laser ablation and its applications, including the physics of high-power laser-matter interaction.

Laser Ablation and its Applications

This book is based on the results of our interest in the field of ultrashort laser pulses interaction with matter. The aim of our monograph was to build the balanced description of the thermal transport phenomena generated by laser pulses shorter than the characteristic relaxation time. In the book we explore the matter on the quark, nuclear as well atomic scales. Also on the cosmic scale (Planck Era) the thermal disturbance shorter than the Planck time creates the new picture of the Universe. The mathematics, especially PDE, are the main tool in the description of the ultrashort thermal phenomena. Two types of the PDE: parabolic and hyperbolic partial differential equations are of special interest in the study of the thermal processes. We assume a moderate knowledge of basic Fourier and d'Alembert equations. The scope of the book is deliberately limited to the background of the quantum mechanics equations: Schrödinger and Klein-Gordon. In this book the attosecond laser pulses are the main source of the disturbance of the thermal state of the matter. Recently, the attosecond laser pulses constitute a novel tool for probing processes taking place on the time scale of electron motion inside atoms. The research presented in this book appears to provide the basic tools and concepts for attosecond thermal dynamics. Nevertheless much research is still needed to make this emerging field routinely applicable for a broad range of processes on atomic and subatomic scales.

Thermal Processes Using Attosecond Laser Pulses

In the thirty-seven years that have gone by since the first volume of Progress in Optics was published, optics has become one of the most dynamic fields of science. At the time of inception of this series, the first lasers were only just becoming operational, holography was in its infancy, subjects such as fiber optics, integrated optics and optoelectronics did not exist and quantum optics was the domain of only a few physicists. The term photonics had not yet been coined. Today these fields are flourishing and have become areas of specialisation for many science and engineering students and numerous research workers and engineers throughout the world. Some of the advances in these fields have been recognized by awarding Nobel prizes to seven physicists in the last twenty years. The volumes in this series which have appeared up to now contain nearly 190 review articles by distinguished research workers, which have become permanent records for many important developments. They have helped optical scientists and optical engineers to stay abreast of their fields. There is no sign that developments in optics are slowing down or becoming less interesting. We confidently expect that, just like their predecessors, future volumes of Progress in Optics will faithfully record the most important advances that are being made in optics and related fields.

Progress in Optics

This book is the first comprehensive volume on nonlinear dynamics and chaos in optical systems. A few books have been published recently, but they summarize applied mathematical methodologies toward understanding of nonlinear dynamics in laser systems with small degrees of freedom focusing on linearized perturbation and bifurcation analyses. In contrast to these publications, this book summarizes nonlinear dynamic problems in optical complex systems possessing large degrees of freedom, systematically featuring our original experimental results and their theoretical treatments. The new concepts introduced in this book will have a wide appeal to audiences involved in a rapidly-growing field of nonlinear dynamics. This book focuses on nonlinear dynamics and cooperative functions in realistic optical complex systems, such as multimode lasers, laser array, coupled nonlinear-element systems, and their applications to optical processing. This book is prepared for graduate students majoring in optical and laser physics, but the generic nature of complex systems described in this book may stimulate researchers in the field of nonlinear dynamics covering different academic areas including applied mathematics, hydrodynamics, celestial mechanics, chemistry, biology, and economics.

Nonlinear Dynamics in Optical Complex Systems

This is the first book dedicated to wavelength filters for fibre optics. It provides a comprehensive account of the principles and applications of such filters, including their technological realizations. It explains the relevant performance parameters, the particular advantages and shortcomings of the various concepts and components, and the preferred applications. There is also in-depth information on the characteristics of commercially available devices.

Wavelength Filters in Fibre Optics

26thth International Conference on Plastic Optical Fibres, POF 2017 September 13 to 15, 2017 Aveiro, Portugal

26th International Conference on Plastic Optical Fibres

Engineering Optics is a book for students who want to apply their knowledge of optics to engineering problems, as well as for engineering students who want to acquire the basic principles of optics. It covers such important topics as optical signal processing, holography, tomography, holographic radars, fiber optical communication, electro- and acousto-optic devices, and integrated optics (including optical bistability). Practical examples, such as the video disk, the Fresnel zone plate, and many more, appear throughout the text, together with numerous solved exercises. There is an entirely new section in this updated edition on 3-D imaging.

Engineering Optics

This book develops the theory of the null-field method (also called T-matrix method), covering almost all aspects and current applications. This book also incorporates FORTRAN programs and simulation results. Worked examples of the application of the FORTRAN programs show readers how to adapt or modify the programs for their specific application.

Light Scattering by Systems of Particles

This book, written from an industrial vantage point, describes the characteristics, design, and operation of solid-state lasers. As the title implies, the emphasis is placed on the technical aspects of these systems rather than on theoretical concepts. Lengthy mathematical derivations have been avoided because the theory is not treated as an end in itself, but rather serves to explain the experimental results observed in the laboratory. However, there is sufficient theoretical background provided in each chapter to make the book self-contained. Solid-State Laser Engineering is mainly intended for the practicing scientist or engineer who is interested in the design or use of solid-state lasers. The response from readers has shown that the comprehensive treatment of the subject makes the work useful also to students of laser physics who want to supplement their theoretical knowledge with the engineering aspects of lasers. Although not written in the form of a college text, the book might be used in an advanced college course on laser technology. After a historical overview, the book starts with a review of the basic concepts of laser physics (Chap. 1). Analytical expressions of the threshold condition, gain, and output of laser oscillators are derived in Chap. 3. An oscillator followed by one or more amplifiers is a common architecture in pulsed solid-state laser systems to boost output energy. Energy storage and gain of amplifiers is discussed in Chap. 4. Four chapters deal with the basic subsystems of solid-state

lasers. These are the active medium, the optical resonator, the pumping system, and the thermal management. Properties of solid-state laser hosts and active ions are reviewed in Chap. 2.

Solid-State Laser Engineering

Optical Micro-Resonators are an exciting new field of research that has gained prominence in the past few years due to the emergence of new fabrication technologies. This book is the first detailed text on the theory, fabrication, and applications of optical micro-resonators, and will be found useful by both graduate students and researchers in the field.

Optical Microresonators

Focusing on nanophotonics, which has been proposed by M. Ohtsu in 1993, this volume begins with theories for operation principles of characteristic nanophotonic devices and continues with novel optical near field phenomena for fabricating nanophotonic devices. Further topics include: unique properties of optical near fields and their applications to operating nanophotonic devices; and nanophotonic information and communications systems that can overcome the integration-density limit with ultra-low-power operation as well as unique functionalities. Taken as a whole, this overview will be a valuable resource for engineers and scientists working in the field of nano-electro-optics.

Progress in Nano-Electro-Optics V

A bird's-eye view of the developmental trends and problems of recent photovoltaics is presented. The worldwide effort to develop high-efficiency low-cost PV modules, making use of most efficient solar cells and clever low-cost solar concentrators is described.

High-Efficient Low-Cost Photovoltaics

This book deals with influencing the properties of solids by light-driven electron transport. The theoretical basis of these effects, light-driven ordering and self-organisation, as well as optical motors are presented. With light as a tool, new ways to produce materials are opened.

Light-Driven Alignment