



Distributed Feedback Semiconductor Lasers Operating In

Shun Lien Chuang



Distributed Feedback Semiconductor Lasers Operating In:

Distributed Feedback Semiconductor Lasers John E. Carroll, James Whiteaway, Dick Plumb, 1998 Concentrating on presenting a thorough analysis of DFB lasers from a level suitable for research students this book emphasises and gives extensive coverage of computer aided modeling techniques

Distributed Feedback Laser Diodes Dr. H. Ghafouri-Shiraz, B. S. K. Lo, 1996-08-06 Distributed Feedback Laser Diodes Principles and Physical Modelling H Ghafouri Shiraz B S K Lo University of Birmingham UK Advances in optical fibre based communications systems have played a crucial role in the development of the information highway By offering a single mode oscillation and narrow spectral output distributed feedback DFB semiconductor laser diodes offer an excellent optical light source for fibre based communication systems This comprehensive text focuses on the basic working principles of DFB laser diodes and details the development of a new technique for enhanced system performance Considers the optical waveguiding characteristics and properties of semiconductor materials and the physics of DFB semiconductor lasers Presents a powerful modelling technique based on the transfer matrix method which can be used to improve the design of laser diodes optical filters and amplifiers Examines the effect of the various corrugation shapes on the coupling coefficients and lasing characteristics of DFB laser diodes Technical advice to improve immunity against the spatial hole burning effect Extensive referencing throughout and a comprehensive glossary of symbols and abbreviations Distributed Feedback Laser Diodes is an indispensable text for senior students of electrical and electronic engineering and physics and will consolidate their knowledge in this rapidly growing field As a technical guide for the structural design of DFB laser diodes it will serve as an invaluable reference for researchers in optoelectronics and semiconductor and device physics

Distributed Feedback Laser Diodes and Optical Tunable Filters Dr. H. Ghafouri-Shiraz, 2004-02-06 Advances in optical fibre based communications systems have played a crucial role in the development of the information highway By offering a single mode oscillation and narrow spectral output distributed feedback DFB semiconductor laser diodes offer excellent optical light sources as well as optical filters for fibre based communications and dense wavelength division multiplexing DWDM systems This comprehensive text focuses on the basic working principles of DFB laser diodes and optical filters and details the development of a new technique for enhanced system performance Considers the optical waveguiding characteristics and properties of semiconductor materials and the physics of DFB semiconductor lasers Presents a powerful modelling technique based on the transfer matrix method which can be used to improve the design of laser diodes optical fibres and amplifiers Examines the effect of the various corrugation shapes on the coupling coefficients and lasing characteristics of DFB laser diodes Technical advice to improve immunity against the spatial hole burning effect Extensive referencing throughout and a comprehensive glossary of symbols and abbreviations Suitable for both introductory and advanced levels This is an indispensable textbook for undergraduate and postgraduate students of electrical and electronic engineering and physics as it consolidates their knowledge in this rapidly

growing field As a technical guide for the structural design of DFB laser diodes and optical filters the book will serve as an invaluable reference for researchers in opto electronics and semi conductor device physics *Progress in Optics*,1988-05-01 **Laser Diode Modulation and Noise** Klaus Petermann,2012-12-06 Laser diodes represent a key element in the emerging field of opto electronics which includes for example optical communication optical sensors or optical disc systems For all these applications information is either transmitted stored or read out The performance of these systems depends to a great deal on the performance of the laser diode with regard to its modulation and noise characteristics Since the modulation and noise characteristics of laser diodes are of vital importance for optoelectronic systems the need for a book arises that concentrates on this subject This book thus closes the gap between books on the device physics of semiconductor lasers and books on system design Complementary to the specific topics concerning modulation and noise the first part of this book reviews the basic laser characteristics so that even a reader without detailed knowledge of laser diodes may follow the text In order to understand the book the reader should have a basic knowledge of electronics semiconductor physics and optical communications The work is primarily written for the engineer or scientist working in the field of optoelectronics however since the book is self contained and since it contains a lot of numerical examples it may serve as a textbook for graduate students In the field of laser diode modulation and noise a vast amount has been published during recent years Even though the book contains more than 600 references only a small part of the existing literature is included **Handbook of Distributed Feedback Laser Diodes, Second Edition** Geert Morthier,Patrick Vankwikelberge,2013-09-01 Since the first edition of this book was published in 1997 the photonics landscape has evolved considerably and so has the role of distributed feedback DFB laser diodes Although tunable laser diodes continue to be introduced in advanced optical communication systems DFB laser diodes are still widely applied in many deployed systems This also includes wavelength tunable DFB laser diodes and DFB laser diode arrays usually integrated with intensity or phase modulators and semiconductor optical amplifiers This valuable resource gives professionals a comprehensive description of the different effects that determine the behavior of a DFB laser diode Special attention is given to two new chapters on wavelength tunable DFB laser diodes and bistable and unstable DFB laser diodes Among many other updates throughout the reference semi conductor and electromagnetic professionals are also provided two new appendices This book fully covers the underlying theory commercial applications necessary design criteria and future direction of this technology Nuclear Science Abstracts ,1976 Handbook of Laser Technology and Applications Chunlei Guo,2021-06-24 This comprehensive handbook gives a fully updated guide to lasers and laser systems including the complete range of their technical applications The first volume outlines the fundamental components of lasers their properties and working principles The second volume gives exhaustive coverage of all major categories of lasers from solid state and semiconductor diode to fiber waveguide gas chemical and dye lasers The third volume covers modern applications

in engineering and technology including all new and updated case studies spanning telecommunications and data storage to medicine optical measurement defense and security nanomaterials processing and characterization

Dynamics of Distributed Feedback Lasers and Semiconductor Laser Arrays Yuan-Hwang Liao, 1997 *Low threshold organic thin-film laser devices* Christian Karnutsch, 2007-07-25

In this work low threshold organic semiconductor lasers emitting throughout the entire visible wavelength range are presented Organic semiconductor lasers OSLs are a fascinating class of laser devices that have a huge potential for sensing and display applications Their ease of fabrication and tuneability across the full visible wavelength range are only a few of their advantageous properties which fueled intense research towards organic laser devices For future electrically pumped organic lasers as well as for compact laser diode pumped devices reduction of the organic laser threshold is of crucial importance since low optically pumped thresholds translate into lower current densities required for injection lasing With blue emitting one dimensional first and second order distributed feedback DFB lasers based on the copolymer BN PFO laser operation in a wavelength range from 438 to 459 nm was realized For an optimized second order laser we obtained a very low threshold energy of 280 pJ pulse which could be further reduced to 160 pJ pulse by employing first order feedback These very low threshold values render BN PFO a very promising material for future organic semiconductor laser diodes Furthermore we have investigated DFB lasers based on a mixed order resonator concept and the polyfluorene derivative F8DP We showed that this improved resonator concept is a very promising design which combines the advantages of first and second order DFB resonators By varying the grating parameters organic solid state lasers with customized properties can be fabricated Optimizing the polymer film parameters led to a very low laser threshold of 45 pJ pulse 36 nJ cm² which is among the lowest values ever reported for organic semiconductor lasers These DFB lasers have been optically pumped by frequency tripled Nd YVO₄ lasers or complex optical parametric oscillator OPO systems resulting in versatile but expensive and bulky laser sources For many applications e g for laser based analytical techniques and sensors much more compact and inexpensive all solid state laser sources are desirable Whilst an organic injection laser doesn't exist it might prove useful for numerous applications to adopt an indirect electrical pumping scheme using efficient and compact electrically driven light sources to pump an OSL optically The recent evolution of blue violet emitting inorganic In GaN laser diodes renders them attractive as such a pump source During the course of this work a very compact all solid state laser system using a low cost pulsed In GaN laser diode has been realized Laser emission spanning the complete visible wavelength range was achieved by employing a variety of organic materials and resonator geometries As a future asset these hybrid organic inorganic lasers could be made mechanically tuneable by either using a wedge shaped organic thin film or by spatially varying the lattice period Both concepts alter the emission wavelength when the organic laser is moved mechanically in front of the focussed pump laser diode These hybrid laser systems could provide the basis for innovative portable analysis systems e g for medical point of care sensor systems An even lower cost pumping scheme based

on LEDs could lead to extremely low cost and versatile laser sources emitting throughout the entire visible wavelength range. But the ultimate goal remains the realization of an electrically pumped organic laser diode. In the course of this thesis a self-consistent numerical simulation tool was employed to carry out comprehensive investigations of the influence of various parameters on the laser threshold in electrically pumped multilayer OSLs. It could be shown that the threshold current densities necessary for lasing in an organic laser diode structure will be of the order of 500–1000 A cm². The main reasons for these high threshold values are waveguide losses, excited state absorptions, bimolecular annihilation processes. In order to reduce the waveguide losses, two concepts have been discussed: either using thin active layers in combination with low-loss transparent conductive oxide (TCO) electrode materials or using thick doped multilayer devices with metal electrodes. The threshold current density is also negatively influenced by polaron and excited state absorption. The dimensionless quantity has been introduced to quantify the effect of polaron and excited state absorption in the device. It saturates at increasing current densities, implying that polaron and triplet-triplet absorption might prevent electrically pumped devices from lasing for all current densities depending on the respective absorption cross sections. It was shown that this does not strongly depend on the device geometry. For the studied devices, an increased charge carrier mobility in the transport layers does not reduce polaron absorption significantly, but if the mobilities in the emission layer and in the transport layers could be increased simultaneously, the effect of polaron absorption would be reduced. We also investigated the influence of bimolecular annihilation processes on the threshold current density using numerical simulations. For a set of typical annihilation and material parameters, the threshold current density was calculated to be 560 A cm². It was found to depend critically on the emission layer thickness. Singlet polaron and singlet-triplet annihilations were identified as the dominating quenching processes for the investigated parameter range. According to the presented numerical simulations, organic laser diodes will require very high current densities; hence, the current durability of organic materials will be an important issue. Dielectric discharges and thermal breakdown were identified as the major causes for catastrophic device failure under high excitation conditions. Thus, thermal management was identified as a key element to improve device stability. To reduce the thermal load of the devices, high thermal conductivity substrates or pulsed operation can be employed. We were able to demonstrate that organic materials can indeed sustain the required current densities. In high current excitation experiments, more than 550 A cm² could be passed through a thick photocrosslinked hole transport layer in pulsed mode. This very encouraging and significant result shows that photocrosslinked all-polymer devices might be the proper choice to realize an organic injection laser. Apart from the concepts elucidated above, further approaches to an organic injection laser exist. Recently, ambipolar light-emitting organic field-effect transistor (OFET) geometries were discussed in the context of OSLs. But to date, the achieved current densities are typically about one order of magnitude too low. Another promising novel approach is to induce capacitively coupled lasing action in OSLs. An organic active material is sandwiched between two dielectric-clad electrodes.

and excited via an AC voltage This is advantageous as it avoids the optical losses associated with injecting electrodes close to the active layer This concept will be evaluated in the near future in our group at the LTI

Ultrafast All-Optical Signal Processing Devices Dr. Hiroshi Ishikawa, 2008-09-15 Semiconductor based Ultra Fast All Optical Signal Processing Devices a key technology for the next generation of ultrahigh bandwidth optical communication systems The introduction of ultra fast communication systems based on all optical signal processing is considered to be one of the most promising ways to handle the rapidly increasing global communication traffic Such systems will enable real time super high definition moving pictures such as high reality TV conference remote diagnosis and surgery cinema entertainment and many other applications with small power consumption The key issue to realize such systems is to develop ultra fast optical devices such as light sources all optical gates and wavelength converters Ultra Fast All Optical Signal Processing Devices discusses the state of the art development of semiconductor based ultrafast all optical devices and their various signal processing applications for bit rates 100Gb/s to 1Tb/s Ultra Fast All Optical Signal Processing Devices Provides a thorough and in depth treatment of the most recent achievements in ultrafast all optical devices Discusses future networks with applications such as HD TV and super high definition moving screens as a motivating background for devices research Covers mode locked semiconductor lasers electro absorption modulator based 160Gb/s signal sources SOA based symmetric Mach Zehnder type all optical gates intersubband transition gate device and more Explains the technical issues behind turning the ultra fast optical devices into practical working tools Examples of above 160Gb/s transmission experiments Discusses future prospects of the ultra fast signal processing devices This invaluable reference will provide device researchers and engineers in industry researchers at universities including graduate students and post doctoral researchers and professors and research institutes with a thorough understanding of ultrahigh bandwidth optical communication systems Device and communication market watchers will also find this book useful

Physics of Photonic Devices Shun Lien Chuang, 2012-11-07 The most up to date book available on the physics of photonic devices This new edition of Physics of Photonic Devices incorporates significant advancements in the field of photonics that have occurred since publication of the first edition Physics of Optoelectronic Devices New topics covered include a brief history of the invention of semiconductor lasers the Lorentz dipole method and metal plasmas matrix optics surface plasma waveguides optical ring resonators integrated electroabsorption modulator lasers and solar cells It also introduces exciting new fields of research such as surface plasmonics and micro ring resonators the theory of optical gain and absorption in quantum dots and quantum wires and their applications in semiconductor lasers and novel microcavity and photonic crystal lasers quantum cascade lasers and GaN blue green lasers within the context of advanced semiconductor lasers Physics of Photonic Devices Second Edition presents novel information that is not yet available in book form elsewhere Many problem sets have been updated the answers to which are available in an all new Solutions Manual for instructors Comprehensive timely and practical Physics of Photonic Devices is an invaluable textbook

for advanced undergraduate and graduate courses in photonics and an indispensable tool for researchers working in this rapidly growing field

Energy Research Abstracts, 1979

Theorie und Simulation des Doppelstreifen-Lasers Miguel Ángel Palacios Lázaro, 2011-01-13

In der heutigen Welt ist der Informationsaustausch einer der stärksten Motoren der Wirtschaft und der Entwicklung der Gesellschaft. Dementsprechend spielt die Kommunikationstechnik eine immer wichtigere und bedeutendere Rolle im Bereich der Forschung der Technik und der Ausbildung. Neue Systeme werden entwickelt, die existierenden verbessert und ihre Datenübertragungsgeschwindigkeit überschreitet weitere Grenzen. Diese Prozesse sind die Antwort auf den wachsenden Bedarf an technischen Lösungen, die das Wachstum der oben genannten wirtschaftlichen und technologischen Welt unterstützen. Unter diesen Lösungen sind optische Übertragungssysteme diejenigen, die höchsten Geschwindigkeiten zur Datenübertragung ermöglichen. Auf sehr langen Strecken können optische Fasern analoge sowie digitale Information übertragen. Der Einsatz von optischen Verstärkern EDFA hat den Umfang dieses Informationsaustausches auf bisher unbekannte Größen gebracht. Als Quelle dieser Systeme werden Laserdioden verwendet, die mit den unterschiedlichsten Technologien entworfen und aufgebaut werden können. Diese Dioden Fabry-Pérot und DFB Laserdiode Heteroübergang Heteroübergang und Quantenbrunnenlaserdiode werden meist mit modulierten Strömen angeregt, sodass die Information im Basisband übertragen wird. Der Einsatz dieser Quellen zur Erzeugung von Mikrowellen- und Millimeterwellenoszillationen ist jedoch ein weniger bekanntes Anwendungsgebiet. Doppelstreifen-Laser sind Halbleiterstrukturen, in denen nicht nur eine aktive Schicht, sondern zwei parallele aktive Streifen vergraben sind. Die Existenz dieser zwei aktiven Bereiche ermöglicht das Entstehen einer Schwingung des vom Halbleiter abgestrahlten Lichts. Dieses Licht kann unter bestimmten Bedingungen moduliert oder als Mikrowellen- bzw. Millimeterwellenoszillator benutzt werden. Diese Arbeit befasst sich mit dieser Art von Strukturen. Die Einleitung der Arbeit stellt die Prinzipien der Erzeugung kohärenten Lichts vor sowie die meist verbreiteten Arten von Laserdioden. Darauf folgend werden die theoretischen Grundlagen der Arbeit präsentiert. Das Ziel unserer Forschung ist die Entwicklung einer Modellierung, die zum theoretischen Begreifen des Doppelstreifen-Lasers beiträgt. Dieses Verständnis soll zur Optimierung dieser Struktur führen. Die Erzeugung einer rauscharmen Oszillation im Bereich von Gigahertz ist der endgültige Zweck der Optimierung. Diese Arbeit geht von der Anwendung eines Wanderwellenmodells aus. Herkömmliche Modellierungen wurden jedoch auf die Simulation von gewöhnlichen Lasern mit einem einzigen aktiven Streifen angewendet. Auf der Theorie dieser Modelle basierend wurde ein Wanderwellenmodell für Doppelstreifen-Laser entwickelt. Das Entstehen von zwei gleichzeitig existierenden lateralen Moden als symmetrische bzw. antisymmetrische Mode bezeichnet die leicht unterschiedlichen Brechungsindizes aufweisen, ermöglicht die Erzeugung der angestrebten Oszillation. Unseren Überlegungen zufolge sind zwei nachrichtentechnische Anwendungen dieses Phänomens von Bedeutung. Ein Laser kann nur im Basisband moduliert werden. Wird eine vom Bauteil abhängende Frequenz erreicht, fällt die Leistung des Lichts stark ab. Die Bandbreite der modulierenden Signale kann aus diesem Grund

nur einige Gigahertz betragen Die Erzeugung einer Oszillation im Bereich von Gigahertz ermöglicht jedoch die Modulation des Lasers um diese Schwingung was eine zusätzliche Bandbreite zur Signalübertragung bietet wie diese Arbeit bewiesen hat Eine besonders wichtige Anwendung eines Doppelstreifen Lasers kann durch die Optimierung der erzeugten Oszillation erreicht werden Dies führt zu einer rauscharmen Schwingung die eine sehr niedrige Linienbreite aufweist Solche Oszillationen können als Mikro und Millimeterwellenquellen zum Einsatz kommen die über lange Strecken mittels Glasfaser übertragen und verteilt werden was aus nachrichtentechnischer Sicht sehr attraktiv ist Solche engen Linienbreiten können bisher nur mittels komplizierter Systeme z.B. über optische Injektion erreicht werden Die vorliegende Arbeit hat gezeigt dass die dem Doppelstreifen Laser inhärente optische Kopplung eine technisch machbare Reduktion der Linienbreite ermöglicht Die Erweiterung des Wanderwellenmodells und die theoretische Erklärung der zweiten der oben genannten Anwendungen bilden die wichtigsten Ergebnisse der vorliegenden Arbeit die zu einer zukünftigen praktischen Entwicklung solcher Quellen als Grundlage dienen könnten

Nonlinear Fiber Optics Govind P. Agrawal, 2013 Machine generated contents note ch 1 Introduction 1 1 Historical Perspective 1 2 Fiber Characteristics 1 2 1 Material and Fabrication 1 2 2 Fiber Losses 1 2 3 Chromatic Dispersion 1 2 4 Polarization Mode Dispersion 1 3 Fiber Nonlinearities 1 3 1 Nonlinear Refraction 1 3 2 Stimulated Inelastic Scattering 1 3 3 Importance of Nonlinear Effects 1 4 Overview Problems References ch 2 Pulse Propagation in Fibers 2 1 Maxwell's Equations 2 2 Fiber Modes 2 2 1 Eigenvalue Equation 2 2 2 Single Mode Condition 2 2 3 Characteristics of the Fundamental Mode 2 3 Pulse Propagation Equation 2 3 1 Nonlinear Pulse Propagation 2 3 2 Higher Order Nonlinear Effects 2 3 3 Raman Response Function and its Impact 2 3 4 Extension to Multimode Fibers 2 4 Numerical Methods 2 4 1 Split Step Fourier Method 2 4 2 Finite Difference Methods Problems References ch 3 Group Velocity DispersionNote continued 3 1 Different Propagation

Analysis and mitigation of the factors limiting the efficiency of high power distributed feedback diode lasers Christoph Matthias Schultz, 2013-10-08 High power high efficiency wavelength stabilized broad area BA diode lasers are promising devices for industrial applications They can be used for example for pumping narrow absorption bands in gain media of solid state and fiber lasers as well as for power scaling by means of dense spectral beam combining This thesis focuses on the analysis and mitigation of the factors limiting the efficiency of high power distributed feedback DFB diode lasers In particular it will be shown how a power conversion efficiency in the 60 % range can be achieved from 10 W class 100 μ m stripe DFB BA lasers values close to those of state of the art Fabry P rot FP BA lasers For the first time world wide newly developed DFB BA lasers achieve 12 W continuous mode optical output power with 62 % peak power conversion efficiency and 58 % at 10 W respectively Wavelength stabilization is demonstrated from threshold to 15 A with a spectral width below 0.8 nm containing 95 % of the emitted power The factors limiting the efficiency of DFB BA lasers compared to state of the art 10 W class FP BA lasers have been identified and as a result largely eliminated

Handbook of Laser Technology and Applications Colin Webb, Julian D.C. Jones, 2020-09-29 The

invention of the laser was one of the towering achievements of the twentieth century At the opening of the twenty first century we are witnessing the burgeoning of the myriad technical innovations to which that invention has led The Handbook of Laser Technology and Applications is a practical and long lasting reference source for scientists and engineers who work with lasers The Handbook provides a comprehensive guide to the current status of lasers and laser systems it is accessible to science or engineering graduates needing no more than standard undergraduate knowledge of optics Whilst being a self contained reference work the Handbook provides extensive references to contemporary work and is a basis for studying the professional journal literature on the subject It covers applications through detailed case studies and is therefore well suited to readers who wish to use it to solve specific problems of their own The first of the three volumes comprises an introduction to the basic scientific principles of lasers laser beams and non linear optics The second volume describes the mechanisms and operating characteristics of specific types of laser including crystalline solid state lasers semiconductor diode lasers fibre lasers gas lasers chemical lasers dye lasers and many others as well as detailing the optical and electronic components which tailor the laser s performance and beam delivery systems The third volume is devoted to case studies of applications in a wide range of subjects including materials processing optical measurement techniques medicine telecommunications data storage spectroscopy earth sciences and astronomy and plasma fusion research This vast compendium of knowledge on laser science and technology is the work of over 130 international experts many of whom are recognised as the world leaders in their respective fields Whether the reader is engaged in the science technology industrial or medical applications of lasers or is researching the subject as a manager or investor in technical enterprises they cannot fail to be informed and enlightened by the wide range of information the Handbook supplies

Handbook of Laser Technology and Applications (Three-Volume Set) Colin Webb, Julian D. C. Jones, 2003-12-01

The invention of the laser was one of the towering achievements of the twentieth century At the opening of the twenty first century we are witnessing the burgeoning of the myriad technical innovations to which that invention has led The Handbook of Laser Technology and Applications is a practical and long lasting reference source for scientists a *Current Research And Development In Optical Fiber Communications In China* Qiming Wang, 1997-01-03 In the last decade China has experienced one of the fastest economic growth in the world Leading this enormous growth is the development of telecommunications that has a growth rate far exceeding that of its GNP With such fast growth China will have the largest telecommunication network with 420 million lines by 2010 The backbone of the national telecom network in China is primarily optical fiber cables today This book contains a selection of reports reviewing the progress of the research and development in optoelectronics and optical fiber communications in China The first four papers focus on the current development in optical fiber communications with particular interest in studies of soliton transmission and optical WDM transmission experiments The next four papers describe the research results on quantum well lasers bi stable lasers electro absorption modulators and SEED and photonic integrated devices Fiber ring lasers using EDFA

and the ASE noise in the PIN receiver due to EDFA are discussed in the next two papers respectively The last two papers describe the research activities and results of the development of the GaAs ICs for high speed lightwave systems and their characterization using optical sampling techniques The contents included in this book may be regarded as the epitome of the current status of research in this field in mainland China

Comprehensive Semiconductor Science and Technology

,2011-01-28 Semiconductors are at the heart of modern living Almost everything we do be it work travel communication or entertainment all depend on some feature of semiconductor technology Comprehensive Semiconductor Science and Technology Six Volume Set captures the breadth of this important field and presents it in a single source to the large audience who study make and exploit semiconductors Previous attempts at this achievement have been abbreviated and have omitted important topics Written and Edited by a truly international team of experts this work delivers an objective yet cohesive global review of the semiconductor world The work is divided into three sections The first section is concerned with the fundamental physics of semiconductors showing how the electronic features and the lattice dynamics change drastically when systems vary from bulk to a low dimensional structure and further to a nanometer size Throughout this section there is an emphasis on the full understanding of the underlying physics The second section deals largely with the transformation of the conceptual framework of solid state physics into devices and systems which require the growth of extremely high purity nearly defect free bulk and epitaxial materials The last section is devoted to exploitation of the knowledge described in the previous sections to highlight the spectrum of devices we see all around us Provides a comprehensive global picture of the semiconductor world Each of the work s three sections presents a complete description of one aspect of the whole Written and Edited by a truly international team of experts

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