



**Laser Diode Bar**

# Diode Laser Arrays

**SHAWE-SHIUAN WANG**



## Diode Laser Arrays:

Monolithic Diode-Laser Arrays Nils W. Carlson, 2012-12-06 Over the last two decades the search for a compact high power semiconductor source has produced many designs and concepts for monolithic diode laser arrays and optical amplifiers. However, only a few design approaches have emerged with the potential for producing high power high brightness monolithic sources. Although semiconductor diode lasers are the most compact, highest gain and most efficient laser sources, challenges remain in developing structures that will produce high quality diffraction limited output beams. This book presents and analyzes the results of work performed over the last twenty years in the development of high brightness diode laser arrays.

**Diode Laser Arrays** Dan Botez, Don R. Scifres, 1994 This book provides a thorough overview of the principles and uses of semiconductor diode laser arrays.

**Non-parallel Etched Facet Diode Laser Arrays** Daniel Alphonse Francis, 1997

2.3 Micron High Power Continuous Wave Diode Laser Arrays, 2004 Report developed under STTR contract for topic AFO3TO25 2.3 Micron High Power Continuous Wave Diode Laser Arrays This final technical report describes progress made to demonstrate the technical feasibility of high power GaSb based semiconductor laser arrays. These arrays have many potential applications including infrared countermeasures, IRCM pumping of solid state lasers, low probability of intercept communication links and trace gas analysis. Civilian applications exist in the fields of medical diagnostics and dermatological treatments. The research involved the fabrication and complete characterization of single emitter GaSb based devices. Successful results with the single emitter devices led to the demonstration for the first time of a one dimensional 2.3 micron laser array. The array produced 10 watts in continuous wave operation, 18.5W in long pulse operation and over 20W in short pulse operation, short pulse power limited by current source.

High-Power Diode Laser Arrays for Large Scientific Lasers and Inertial Fusion, 2014

**Performance Improvements in Diode Laser Arrays**, 1994

*Surface Emitting Semiconductor Lasers and Arrays* Gary A. Evans, J. M. Hammer, 1993 Reviews all the basic types of surface emitting semiconductor lasers including vertical cavity etched mirror integrated beam deflectors and grating out coupled devices. The book also addresses such topics as edge emitting arrays, thermal management and coherence.

**Tailoring the Emission of Stripe-array Diode Lasers with External Cavities to Enable Nonlinear Frequency Conversion** Andreas Jechow, 2009 A huge number of applications require coherent radiation in the visible spectral range. Since diode lasers are very compact and efficient light sources, there exists a great interest to cover these applications with diode laser emission. Despite modern band gap engineering, not all wavelengths can be accessed with diode laser radiation. Especially in the visible spectral range between 480 nm and 630 nm, no emission from diode lasers is available yet. Nonlinear frequency conversion of near infrared radiation is a common way to generate coherent emission in the visible spectral range. However, radiation with extraordinary spatial, temporal and spectral quality is required to pump frequency conversion. Broad area BA diode lasers are reliable high power light sources in the near infrared spectral range. They belong to the most efficient coherent light sources with electro

optical efficiencies of more than 70% Standard BA lasers are not suitable as pump lasers for frequency conversion because of their poor beam quality and spectral properties For this purpose tapered lasers and diode lasers with Bragg gratings are utilized However these new diode laser structures demand for additional manufacturing and assembling steps that makes their processing challenging and expensive An alternative to BA diode lasers is the stripe array architecture The emitting area of a stripe array diode laser is comparable to a BA device and the manufacturing of these arrays requires only one additional process step Such a stripe array consists of several narrow striped emitters realized with close proximity Due to the overlap of the fields of neighboring emitters or the presence of leaky waves a strong coupling between the emitters exists As a consequence the emission of such an array is characterized by a so called supermode However for the free running stripe array mode competition between several supermodes occurs because of the lack of wavelength stabilization This leads to power fluctuations spectral instabilities and poor beam quality Thus it was necessary to study the emission properties of those stripe arrays to find new concepts to realize an external synchronization of the emitters The aim was to achieve stable longitudinal and transversal single mode operation with high output powers giving a brightness sufficient for efficient nonlinear frequency conversion For this purpose a comprehensive analysis of the stripe array devices was done here The physical effects that are the origin of the emission characteristics were investigated theoretically and experimentally In this context numerical models could be verified and extended A good agreement between simulation and experiment was observed One way to stabilize a specific supermode of an array is to operate it in an external cavity Based on mathematical simulations and experimental work it was possible to design novel external cavities to select a specific supermode and stabilize all emitters of the array at the same wavelength This resulted in stable emission with 1 W output power a narrow bandwidth in the range of 2 MHz and a very good beam quality with M

**Applications of Microlens-conditioned Laser Diode Arrays**, 1995 The ability to condition the radiance of laser diodes using shaped fiber cylindrical microlens technology has dramatically increased the number of applications that can be practically engaged by diode laser arrays Lawrence Livermore National Laboratory LLNL has actively pursued optical efficiency and engineering improvements in this technology in an effort to supply large radiance conditioned laser diode array sources for its own internal programs This effort has centered on the development of a modular integrated laser diode packaging technology with the goal of enabling the simple and flexible construction of high average power high density two dimensional arrays with integrated cylindrical microlenses Within LLNL the principal applications of microlens conditioned laser diode arrays are as high intensity pump sources for diode pumped solid state lasers DPSSLs A simple end pumping architecture has been developed and demonstrated that allows the radiation from microlens conditioned two dimensional diode array apertures to be efficiently delivered to the end of rod lasers To date pump powers as high as 2.5 kW have been delivered to 3 mm diameter laser rods Such high power levels are critical for pumping solid state lasers in which the terminal laser level is a Stark level lying in the

ground state manifold Previously such systems have often required operation of the solid state gain medium at low temperature to freeze out the terminal laser Stark level population The authors recently developed high intensity pump sources overcome this difficulty by effectively pumping to much higher inversion levels allowing efficient operation at or near room temperature Because the end pumping technology is scalable in absolute power the number of rare earth ions and transitions that can be effectively accessed for use in practical DPSSL systems has grown tremendously

**Single-element Optical Injection Locking of Diode-laser Arrays**, 1986 By optically injecting a single end element of a semiconductor laser array both the spatial and spectral emission characteristics of the entire laser array is controlled With the output of the array locked the farfield emission angle of the array is continuously scanned over several degrees by varying the injection frequency

*Studies of Phase-locked Semiconductor Laser Arrays* Yihjye Twu, 1985

**Beam Multiplexing of Diode Laser Arrays\*Project Supported by the National Science Foundation of China (No. 61275145).**, 2015

**Diode-Pumped Micro-Laser Arrays** R. Waarts, SPECTRA DIODE LABS INC SAN JOSE CA., 1994 In this work SDL investigated the operation of 2 D high power micro laser arrays based on novel monolithic surface emitting laser diode arrays coupled to Yb YAG and Er YSGG micro laser crystals The experimental demonstrations include 1 200 mW q cw single Yb YAG microlaser 2 930 mW cw linear 12 element Er YSGG micro laser 3 130 Watt q cw 2 D surface emitting laser diode array at 970 nm and 4 600 mW q cw from an 18 element 3 D Er YSGG microlaser array The experiments performed at SDL under this contract demonstrate the suitability of monolithic 2 D laser diode arrays for pumping solids state lasers In addition the experiments show the flexibility of the micro laser concept Using different pump wavelengths in combination with different micro lasers a wide output wavelength range from 1 micron to 3 micron is demonstrated Finally the micro laser array is shown to be scalable by exploiting one and two dimensional laser diode pump arrays

*Quantum-Well Laser Array Packaging* Jens W. Tømm, Juan Jiménez, 2006-12-01 Publisher's Note Products purchased from Third Party sellers are not guaranteed by the publisher for quality authenticity or access to any online entitlements included with the product The very latest nanoscale packaging techniques needed to keep quantum well lasers functioning In this book the authors address the nanoscale packaging issue by providing you with state of the art screening and packaging techniques not found in any other resource

*Feasibility of High-Power Diode Laser Array Surrogate to Support Development of Predictive Laser Lethality Model*, 2011 Predictive modeling and simulation of high power laser target interactions is sufficiently undeveloped that full scale field testing is required to assess lethality of military directed energy DE systems The cost and complexity of such testing programs severely limit the ability to vary and optimize parameters of the interaction Thus development of advanced simulation tools validated by experiments under well controlled and diagnosed laboratory conditions that are able to provide detailed physics insight into the laser target interaction and reduce requirements for full scale testing will accelerate development of DE weapon systems The ultimate goal is a comprehensive end to end simulation capability from targeting and

firing the laser system through laser target interaction and dispersal of target debris a Stockpile Science like capability for DE weapon systems To support development of advanced modeling and simulation tools requires laboratory experiments to generate laser target interaction data Until now to make relevant measurements required construction and operation of very high power and complex lasers which are themselves costly and often unique devices operating in dedicated facilities that don't permit experiments on targets containing energetic materials High power diode laser arrays pioneered by LLNL provide a way to circumvent this limitation as such arrays capable of delivering irradiances characteristic of De weapon requires are self contained compact light weight and thus easily transportable to facilities such as the High Explosives Applications Facility HEAF at Lawrence Livermore National Laboratory LLNL where testing with energetic materials can be performed The purpose of this study was to establish the feasibility of using such arrays to support future development of advanced laser lethality and vulnerability simulation codes through providing data for materials characterization and laser material interaction models and to validate the accuracy of code predictions This project was a Feasibility Study under the LLNL Laboratory Directed Research and Development LDRD Program Study of Phase Locked Diode Laser Array and DFB/DBR Surface Emitting Laser Diode Wei Hsin,1990 **DYNAMICS OF SEMICONDUCTOR LASER ARRAYS (WAVE PROPAGATION, INTEGRATED OPTICS).** SHAWE-SHIUAN WANG,1991 agree the stability conditions *Diode-Laser Phase Conjugation 03-FS-030 Final Report* ,2005 Arrays of lasers are often considered when a need exists to increase laser optical output power for a variety of purposes Similarly individual semiconductor laser diodes generating 0.01 to 10 W each are commonly placed in arrays in order to increase total optical power onto targeted objects Examples of such usage are diode laser pump arrays for solid slab heat capacity lasers laser arrays for heat treating materials and arrays for efficient solid state laser systems The commercial and defense communities also use such arrays for many applications from laser range finders laser designators to laser machining systems etc However the arraying process does not automatically increase focusable light on target i.e intensity steradian For those applications requiring the highest focusability it is necessary that the collective output beam from arrays of individual lasers be phase coherent Under this condition the individual laser element optical outputs are fused together into a larger area phase coherent i.e all wavefronts are in step high power combined beam The process of joining multiple laser beams together to produce a single coherent wave is in general very difficult and seldom accomplished Thus joining together many hundreds to thousands of beams from individual laser diodes in large arrays is still an unsolved problem There are 2 major reasons for this Firstly the phase of each output laser beam i.e the wave fronts from each laser diode often fluctuates within nanosecond time periods making a control loop with sufficient bandwidth difficult to build In fact phase fluctuations related to laser linewidth limit the size of an extended system of arrayed diodes because of speed of light restrictions on information flow Secondly the output power per prior laser diode has been low 1W so that the size expense and complexity of control systems for correcting a multitude of output phases of the

individual diode lasers in a large array become prohibitive Recently we have been considering ways to use new diode geometries and 4 wave mixing phase conjugation technologies to enable large arrays of semiconductor lasers to be phased together to produce large output power laser systems with good beam quality If the ideas hold up arrays of 100 to 1 million laser elements might produce 100 W to 1 Megawatt laser beams Such systems can have many defense and commercial applications

**SEMICONDUCTOR LASER ARRAYS.** Lothar Wandering, Kenneth L. Kohn, John F Armata (Jr), ARMY ELECTRONICS COMMAND FORT MONMOUTH NJ., 1968 Semiconductor laser arrays are shown to offer a means for increasing the optical power available by use of injection lasers This report discusses various methods of fabricating parallel laser array structures which are electrically in parallel and their characteristics Arrays have been tested in pulse operation at 77K for their optical power output threshold current spectral distribution linewidth efficiency and possible interference in the optical output of the laser array The optical power output of array structures is aside from inevitable heat losses the sum of the outputs of the individual diodes The spectral wavelength was 8404Å and the linewidth for a double array was 8Å at the half power point Interference patterns were obtained and no mutual interference between the individual diodes was observed Photoresist technology is shown to offer an excellent and uncomplicated means of developing large arrays with very good control on the geometry Author

**Near-diffraction-limited High-power Pulsed and CW Antiguided Semiconductor Laser Arrays** Haiquan Yang, 1999

## Whispering the Techniques of Language: An Emotional Quest through **Diode Laser Arrays**

In a digitally-driven world where screens reign supreme and instant transmission drowns out the subtleties of language, the profound strategies and psychological subtleties concealed within words usually move unheard. However, located within the pages of **Diode Laser Arrays** a captivating fictional value pulsating with organic thoughts, lies an exceptional journey waiting to be undertaken. Published by a talented wordsmith, that wonderful opus encourages viewers on an introspective trip, softly unraveling the veiled truths and profound impact resonating within the fabric of every word. Within the psychological depths of this poignant review, we can embark upon a sincere exploration of the book's primary themes, dissect their charming writing model, and yield to the strong resonance it evokes deep within the recesses of readers' hearts.

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