2024 ASIAN VCSEL DAY

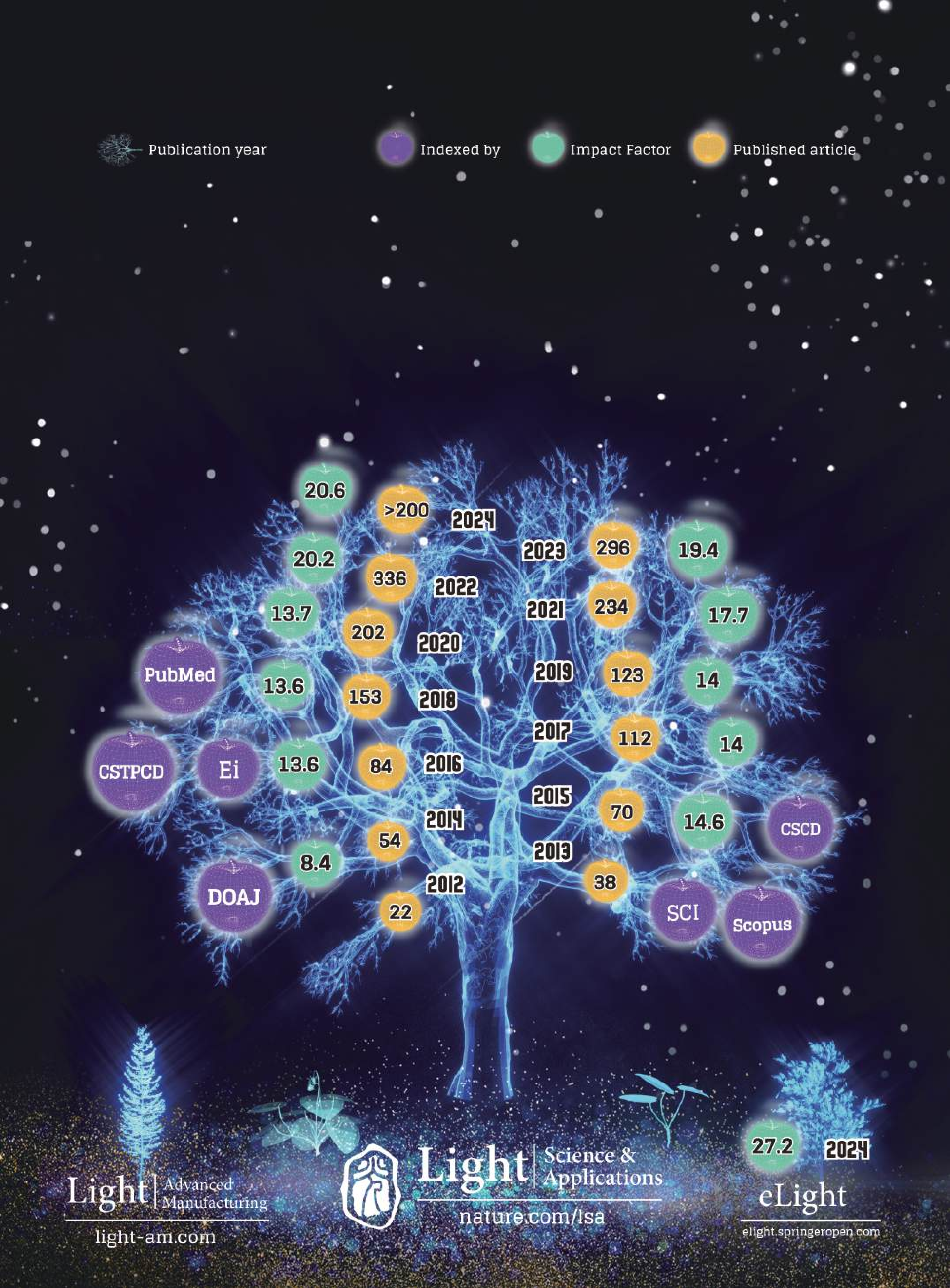
• 13-15th October
Changchun · China

Host

Changchun Institute of Optics, Fine Mechanics and Physics (CIOMP), CAS

Organizers

Bimberg Chinese-German Center for Green Photonics of Chinese Academy of Sciences at CIOMP
Tokyo Institute of Technology
Light Publishing Group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BIMBERG CHINESE–GERMAN CENTER FOR GREEN PHOTONICS

of Chinese Academy of Sciences CAS at CIOMP

Changchun Institute of Optics, Fine Mechanics and Physics, Chinese Academy of Sciences

Introduction

The “Bimberg Chinese-German Center of Green Photonics” was established in April, 2018 by COIMP and Professor Dieter Bimberg, who is an academician of the German Academy of Sciences, the US National Academy of Engineering, the Russian and EU Academies of Sciences, and the US National Academy of Inventors.

The research and development will be conducted autonomously, in cooperation with other national and international research institutions and in cooperation with industry.

The research directions of the Bimberg Center will focus on quantum devices including

- long-wavelength quantum dot HIBBEE laser technology for next-generation LIDAR,
- mode-locked quantum dot lasers for future Terabit/sec metropolitan area networks (MAN),
- high bit rate and energy efficient vertical cavity surface emitting lasers for optical computer interconnects,
- including in each case module development and based on own developments of quantum materials

“Quantum technologies will enable more energy efficient photonic systems for a sustainable society”

In line with the rapid development of the center, we plan to recruit now top talents, researchers and Ph. D. students from China and abroad.

New positions:

Job description and previous experience

a.Heads departments on the associate professor level.

Previous experience in photonic device modeling and/or epitaxial growth and/or nanostructure characterization and/or photonic device processing and/or ultrahigh speed/bit rate measurement techniques and/or high power semiconductor laser measurement techniques, cw and pulsed, are prerequisite. Leadership experience, good ommunicator.

b.Postdoctoral scientist with project

and/or technical area responsibility and background as in a., except leadership experience.

c.Ph. D. students preferably with a Master thesis in one of the subjects mentioned in

a.and the motivation to dive rapidly into a new multidisciplinary field comprising in parts device design, nanomaterial science, process development, and device test.

Prof. Dr. Dr. h.c. mult. Dieter BIMBERG

received the Ph.D. degree from Goethe University, Frankfurt, Germany. He held a

Principal Scientist position at the Max Planck-Institute for Solid State Research, Grenoble, France. After serving as a Professor of Electrical Engineering, Technical University of Aachen, Germany, he assumed the Chair of Applied Physics at Technical University of Berlin. He is the Founding Director of its Center of Nanophotonics . He held guest professorships at the Technion in Haifa, University of California at Santa Barbara, CA, USA, and at Hewlett-Packard in Palo Alto, CA. He was Distinguished Adjunct Professor at KAU, Jeddah from 2012-18 and Einstein Professor at the Chinese Academy of Sciences in 2017/8. Since 2018 he is the Director of the "Bimberg Chinese-G erman Center for Green Photonics" of the CAS at C IOMP, Changchun. He is a Member of the Russian Academy of Sciences and the German Academy of Sciences Leopoldina, a Foreign Member of the National Academy of Engineering o f USA, a Fellow of the US National Instituteof Inventors. The American Physical Society and IEEE elected him as fellow/life fellow, Chinese Optical Society elected Prof. Bimberg as a Foreign Fellow, respectively. Numerous international awards like the UNESCO award, medal for Nanosc ience and –technology, Russian State Prize for Science and Tech nology, IEEE Jun-ichi Nishizaw a Medal , OSA N. Holonyak jr. Award, DPG Stern-Ge rlach Medal, JSAP Microoptics Award. He ha s authored more tha n 1500 papers, 61 pat ents , six books .The number of times his research works have been cited exceeds5900 and his Hirsch factor is 109.

Contact information:

Please send your resume to the following

E-mail box:
Contact person: Wei An
Email address: ciompjob@163.com
Telephone: +86-431-86176928
Fax: +86-431-85682987

Address: No.3888 Dong Nanhu Road, Changchun, Jilin, China,

Postcode: 130033

And in parallel to:

bimberg@physik.tu-berlin.de;
bimberg@ciomp.ac.cn;

BIMBERG CHINESE-GERMAN CENTER FOR GREEN PHOTONICS
77 Ying Kou Road,
Changchun 130033, PR China

www.bimberg-green-photonics.org

General Information

Introduction

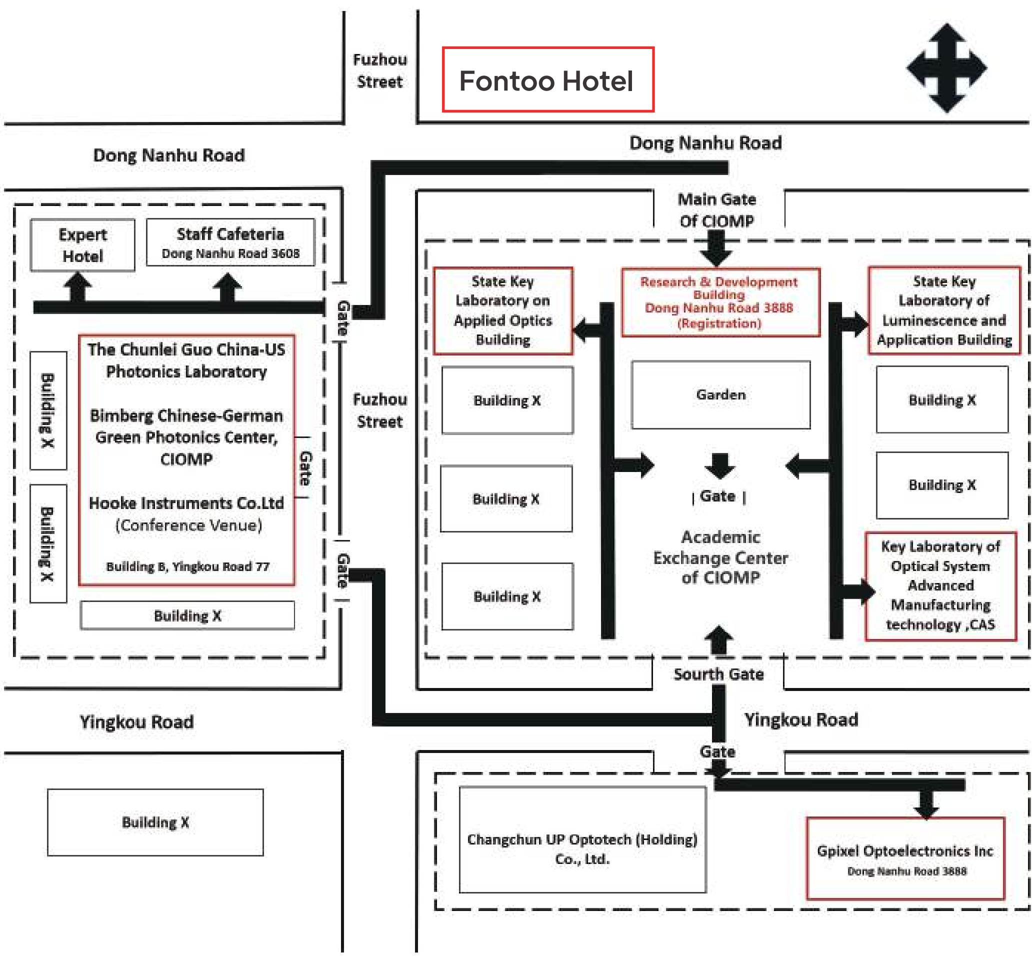
Surface emitting lasers (VCSELs) have emerged as decisive devices for a multitude of high-volume systems.
The European VCSEL community meets in a quite informal frame since about 15 years at always changing places to present their latest results and exchange ideas how to meet future challenges.

The Second Asian VCSEL Day is the premier event dedicated to Vertical-Cavity Surface-Emitting Lasers (VCSELs). Building on the success of the inaugural 2023 event, this conference will gather leading scientists, engineers, and industry experts from Asai and two guest speakers form Germany and Russia to share their latest research, innovations, and applications in the field of VCSEL technology.

The 2nd AVD is scheduled to take place on October 13th and 15th 2024, which is organized by "Bimberg Chinese-German Center for Green Photonics" of Chinese Academy of sciences at CIOMP in Changchun, Tokyo Institute of Technology and Light Publishing Group.

Venue & Date

Date: October 13th-15th 2024
Conference Venue: East Hall at Research & Development Building,CIOMP, Changchun, China
Address: 3888 Dong Nanhu Road, Changchun 130033, China



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General Programs

Sunday, October 13th, Fontoo Hotel **Registration, Lobby, 10:00-17:00** **Welcome reception, Banquet Hall at Fontoo Hotel, 19:00**	
Monday, October 14th **East Hall at Research & Development Building, CIOMP**	
Opening Ceremony **Chair: Cunzhu Tong**	
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11:50-12:20	***Dr. Dawei Ge*** Department of Fundamental Network Technology, China Mobile Research Institute Title: Perspective on Future VCSEL Transmission over Anti-resonant Hollow-core Fiber

12:20-12:50	***Prof. Sicong Tian*** CIOMP, CAS Title: Energy-Efficient High-Speed Vertical-Cavity Surface-Emitting Lasers for Data Communication
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14:30-15:00	***Dr. Jiaxing Wang*** Berxel Photonics Co., Ltd. Title: High speed HCG VCSELs
15:00-15:30	***Dr. Ryan Rao*** Vertilite Co., Ltd. Title: Progress of High-speed Datacom VCSELs and High-power LiDAR VCSELs at Vertilite
15:30-16:00	***Coffee break***
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16:30-17:00	***Dr. Pan Cao*** Advanced Opto-Electronics Laboratory HiSilicon Huawei Title: High Speed VCSEL Application for AI Optical Interconnects
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Abstracts

VCSEL Review 2
Principle, Device Physics, and Merits for Applications

Kenichi Iga
Honorary Professor/ Retired President
Institute of Science Tokyo *)
c/o FIRST Lab, 4259 Nagatsuta, Midoriku, Yokohama, Japan
(lasingcontrabass40@vcsel.org)
*) The New Name of Tokyo Institute of Technology after merging with Tokyo Medical and Dental University

Abstract
In this review talk, we will trace the development of the vertical-cavity surface-emitting laser (VCSEs) from its conception by the author in 1977 to their significant role in today's social life. We will begin with explaining the basic concept of the VCSEL, followed by a discussion on its principle. We learn principal device physics, including resonant cavities, active regions, highly reflective distributed Bragg reflectors (DBRs) and high-contrast grating (HCG) reflectors, threshold conditions, power output, direct modulation, noise, and arrays. From a device perspective, we will explore the technologies of current and optical confinement. We will then introduce the advantages and characteristics of VCSELs for various applications. Finally, we will highlight the key features of these applications and how their underlying principles are utilized in communication and sensing technologies. If time permits, we will also discuss on micro-cavities and photon behavior connecting to quantum technology.

Kenichi Iga received his Bachelor of Engineering (B.E.) degree in 1963, his Master of Engineering (M.E.) degree in 1965, and his Doctor of Engineering (Dr. Eng.) degree in 1968, all from the Tokyo Institute of Technology. He joined the P&I (Presently FIRST) Laboratory at the Tokyo Institute of Technology in 1968, became an Associate Professor in 1973, and was promoted to Professor in 1984. After a distinguished career, he retired in March 2001 and was honored with the title of Professor Emeritus. Dr. Iga served as Executive Director of the Japan Society for the Promotion of Science (JSPS) from April 2001 to September 2007. He then served as President of the Tokyo Institute of Technology from October 2007 until September 2012. Additionally, he spent time at Bell Laboratories as a Visiting Technical Staff Member from 1979 to 1980.
Professor Iga is renowned for his pioneering research on vertical-cavity surface-emitting lasers (VCSELs) and microoptics. His contributions to the field have been recognized with numerous prestigious awards, including the Ichimura Award in 1990, the IEEE/LEOS William Streifer Award in 1992, the IEEE/OSA John Tyndall Award in 1998, and the IEEE Daniel E. Noble Award in 2003. He received the Medal with Purple Ribbon in 2001, the Rank Prize in 2002, the Fujiwara Award in 2003, the C&C Prize in 2007, and the NHK Broadcast Cultural Award in 2009. In 2013, he was awarded the Franklin Medal with the Bower Award and Prize in Science. He also received the Order of the Sacred Treasure, Gold and Silver Star in 2018, the IEEE Edison Medal in 2021, and was honored as a Person of Cultural Merits by the Japanese Government in 2022. Most recently, in 2024, he received the Frederic Ives Medal /Jarus Quinn Prize from OPTICA.

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[1] K. Iga: Lab Note, March 22 (1977) See [5]
[2] K. Iga et al: Appl. Phys. Soc., No. 27p-C-1. (1978)
[3] H. Soda et al: Jpn. J. Appl. Phys., 18, p. 2329 (1979)
[4] K. Iga, F. Koyama, and S Konosita: IEEE J. Quant Electron., QE24, p.1845- (1988)
[5] K. Iga: Proc. SPIE 1126302 (2 March 2020); doi: 10.1117/12.2554953.
Books
[1] Kenichi Iga: "The VCSE Odyssey", SPIE Press (2020).
[2] Babu Dayal Padullaparthi, Jim Taum, and Kenichi Iga: “VCSEL Industry: communication and Sensing”, IEEE Press/Wiley (2022)

Volume VCSEL Production Epi by MOCVD

Ping Gong
Wafer China Co., Ltd. Xian,China
Ping.gong@waferchina.com

Abstract

Over last a couple of years VCSEL demanding is fast increasing. Lidar market in automotive and robotics has been ramping up to a volume business. It is getting clearer that VCSEL is becoming the dominating technology due to its cost advantage and power density improvement by using multi junctions. The new AI wave is pushing data transit speed up quickly. Data center is demanding higher speed of VCSELs 50G/100G/200G.

VCSEL application in consumer market is also increasing such as 3D sensing, industrial and medical use.

This talk will show some statistic data of volume VCSEL epi wafers, from wavelength to surface morphology. A stable and cost effective VCSEL Epi volume production capability is needed for the fast increasing VCSEL market.

Short Bio

Ping Gong founded WaferChina in November 2017. Prior to embarking on this venture, he worked for AkzoNobel for more than 12 years, initially as Marketing Director for the Asia Pacific region, and since 2012 as the Global Technical Development Director. Between 1998 and 2005 Gong held the role of Senior MOCVD Growth Engineer and then Product Manager at IQE, Cardiff. During his time at IQE, he was responsible for the production of epi-wafers for various lasers, including several types of VCSEL. He holds a PhD in Optoelectronic Materials from The Chinese Academy of Sciences.

High-speed VCSEL photonics and their CPO/LPO transceiver applications

Prof. Fumio Koyama
Institute of Science Tokyo (formerly Tokyo Institute of Technology), Japan
Email: koyama@pi.titech.ac.jp

Abstract

The 47 years' research and developments opened up a new world of VCSELphotonics, including, sensors, optical interconnects in datacenter networks,LiDAR and high power sources. High speed VCSELs have been intensively developed for rapid growths in network traffics, which has been accelerated by AI clusters in datacenters. A VCSEL is a key component in AI datacenter and supercomputer networks because of its fascinating properties, which provides high-speed operations, low power consumption, small footprint, wafer-scale testing, low-cost packaging, ease of fabrication into arrays. Co-packaged optics (CPO) and Linear-drive Pluggable Optics (LPO) has been attracting much attention in datacenter and edge computing networks, so that power consumption could be saved. In particular, VCSELs give us high-speed and low-power consumption, which will meet requirements in CPO and LPO solutions. In this talk, our recent activity on high-speed transverse-coupled-cavity VCSEL array is presented for 200Gbps/lane or beyond. A single-mode 1060nm metal-aperture VCSELs array has been developed, which offers high-speed and high-density I/O platform. By further increase in the modulation speed of VCSEL, we expect a possibility of ultrahigh capacity Tera-bps CPO and LPO.

Short Bio

Fumio Koyama received the Ph.D. degree from Tokyo Institute of Technology in 1985. He is a specially appointed professor/professor emeritus of Institute of Science Tokyo (formerly Tokyo Institute of Technology). His research interest includes VCSEL photonics, photonic integrated devices, optical sensing. He received various awards, including IEE Electronics Letters Premium in 1985 and in 1988, Prize for Science and Technology from the MEXT in 2007, IEEE/LEOS William Streifer Scientific Achievement Award in 2008, Izuo Hayashi Award in 2012, Okawa Prize in 2018, OSA Nick Holonyak Jr. Award in 2019, Hirose Prize in 2024, IEEE Nick Holonyak, Jr. Medal for Semiconductor Optoelectronic Technologies in 2024. He is Fellow of IEEE, Optica, IEICE and the Japan Society of Applied Physics.

High-Performance of Multi-junction Vertical Cavity Surface Emitting Lasers

Jun Wang, Yao Xiao, Heng Liu, Pei Miao,Yuanbing Gao and Xingdong Lu
Suzhou Everbright Photonics Co. Ltd, Suzhou, P.R.China
Sichuan University, Chengdu, P.R. China
Email: mike.wang@everbrightphotonics.com

Abstract

Compared to conventional single junction Vertical Cavity Surface Emitting Laser (VCSEL), multi-junction ones have the characteristics of high slope efficiency, which can further break the upper limit of power density, as well as electrical to optical power conversion efficiency. In this report, we will cover the most recent progress on both multi-mode and single-mode multi-junction VCSELs.
Multi-mode VCSEL have been widely used for Lidar, 3D sensing, as well as well materials processing. We will report most recent record high (about 80%) efficiency and high temperature performance of multi-mode VCSEL. Polarization improvement and lifetime test will also be mentioned.
Single-mode VCSELs are crucial in the realm of green photonics for high-speed optical communication. This study combines theoretical modeling with experiments for 940 nm VCSELs with surface microstructures. Simulation shows that it can boost mode modulation capabilities, power, and efficiency, potentially allowing the single mode VCSELs to surpass 60% efficiency. Using this technique, single-mode VCSEL lasers with a output power of 20.2 mW, a side-mode suppression ratio greater than 35dB, a 42% electro-optical efficiency, and a 9.8° divergence angle (at 1/e2) under continuous-wave (CW) operation were demonstrated, which is , to the best of the author's knowledge, the highest single-mode CW power recorded for a single-mode VCSEL to date.

Short Bio

Dr Jun Wang is the CTO of Suzhou Everbright Photonics Co. and a distinguished professor of Sichun University.
He received a Ph.D. degree in Engineering Physics from McMaster University, Canada in 1997. Since 1992, he has been studying or working on compound semiconductor materials and diode laser devices in several companies and institutions, including SLI, Spectra-Physics, Lasertel nLight and Everbright Photonics. He has led or participated in a number of research and development programs in the area of high power semiconductor lasers. He has more than 60 publications reporting record results on efficiency, output power and reliability of diode lasers.

Perspective on Future VCSEL Transmission over Anti-resonant Hollow-core Fiber

Dawei Ge
Department of Fundamental Network Technology, China Mobile Research Institute, Beijing 100053, China
Email: gedawei@chinamobile.com, gedawei@pku.edu.cn

Abstract

With the brust of AI large model, conventional data centers are now transforming into intelligent computing centers with more GPUs and network devices responsible for interconnections. Due to the rapidly increasing scale of GPUs, the transmission distance and capacity grow simultaneously. VCSEL, as the dominant optical module option for DCN, is facing great pressure from other approaches like Silicon photonics (SiFo) due to its reach limitation. The fundamental problem comes from the extremely impure data channel of multimode fiber (MMF). Antiresonant hollow-core fiber (AR-HCF) have witnessed steady progress in attenuation reduction (<0.1dB/km), as well as additional advantages like ultra-low nonlinearity, ultra-wide transmission window, low chromatic dispersion, and minimum latency, showing great potential on providing extremely pure data channel. In this talk, the concept of VCSEL transmission over AR-HCF will be introduced, featuring the benefits of extending VCSEL transmission reach and lowering overall latency.

Short Bio

Dawei Ge is now a Research Scientist with China Mobile Research Institute. He obtained Ph.D. in optical communications from Peking University in 2020. He is now in charge of high-speed WDM network technological strategy and advanced optical communication research in China Mobile. His current research interests include antiresonant hollow-core fiber and its transmission system design, B800G optical fiber communications and OTN/WDM networks. He has authored or co-authored more than 80 journal and conference articles, including ECOC/OFC top-scored papers, ECOC PDP, ACP PDP, IEEE WCM, JLT, OL etc. He involves in the Young Elite Scientist Sponsorship Program by China Association for Science and Technology.

Energy-Efficient High-Speed Vertical-Cavity Surface-Emitting Lasers for Data Communication

Si-Cong Tian
Bimberg Chinese-German Center for Green Photonics & Key Laboratory of Luminescence Science and Technology, Chinese Academy of Sciences & State Key Laboratory of Luminescence and Applications, Changchun Institute of Optics, Fine Mechanics and Physics, Chinese Academy of Sciences
Email: tiansicong@ciomp.ac.cn

Abstract

The explosive growth of internet use leads to an explosion in the energy consumption of data centers. Vertical-cavity surface-emitting lasers (VCSELs) are key enabling devices meeting the requirements of optical interconnects in such data centers up to a few hundred meters of single or multimode fiber due to their simplicity, low cost, and large data rates. Achieving larger bit rates and at the same time reducing or at least optimizing energy consumption are the present goals of the research and development of VCSELs. In this talk, first, the energy consumption as a function of bit rate for standard oxide confined aperture high-speed VCSELs designed by us are compared. Second, novel approaches for VCSEL design (called MuHA and MAV) will be presented, shifting the current saturation barrier to yet never obtained large current values leading to a strong reduction of thermally induced band gap shift as a function of current.

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[2] G. Larisch, S. C. Tian, and D. Bimberg, patent granted in EU and USA, EP4007092B1, EP3961829B1, US11936163B2, US12100935B2.

Short Bio

Si-Cong Tian received his B. Sc. and Ph. D. degrees in Physics from Jilin University, China, in 2007 and 2012, respectively. From 2016-2017 he studied at Arkansas University, US, as a visiting scholar. Currently, he is a Professor at the Bimberg Chinese-German Center for Green Photonics, CIOMP, CAS, China. His research interests include high-speed vertical-cavity surface-emitting lasers and high-brightness semiconductor lasers.

Development of GaN-based VCSELs

Baoping Zhang, Yang Mei, Leiying Ying, Wei Ou, Tao Yang, Yachao Wang
Xiamen University & Southern University of Science and Technology, China
Email: bzhang@xmu.edu.cn

Abstract

High quality GaN based Fabry Pérot (FP) microcavity (MC) was prepared. By combining the lateral confinement effect, discrete photonic states caused by three-dimensional confinement were observed. By utilizing these MCs, vertical cavity surface emitting lasers (VCSELs) with a minimum wavelength of 276 nm (deep ultraviolet) and a maximum wavelength of 565 nm (yellow green light) were achieved. This technology has also been used to produce resonant cavity light-emitting diodes (RCLEDs) in the green and red spectral range using nitride semiconductors. In the green, large size high-power RCLEDs and RCLEDs emitting two orthogonally and linearly polarized light were realized. In the red, RCLED s emission up to 670 nm were demonstrated.

Short Bio

Baoping ZHANG Graduated from the Department of Physics at Lanzhou University, obtained a master's degree from the 13th Research Institute of China Electronics Technology Group, and a doctoral degree from the Department of Engineering at the University of Tokyo in Japan. He used to work at RIKEN and Sharp Corporation in Japan from 1994 to 2005. In 2006, he was appointed as a distinguished professor at Xiamen University and currently serves as a professor at Southern University of Science and Technology. So far, he has led national 863 projects, national key research and development plan projects, key and general projects of the National Natural Science Foundation of China, and basic science challenge projects of the Science and Technology Bureau. At present, he is mainly conducting research on third-generation semiconductor GaN materials and devices. He was selected by Elsevier as one of the China Highly Cited Scholars from 2014 to 2023. He is serving as an Executive Editor of Semiconductor Science and Technology.

High speed HCG VCSELs

Jiaxing Wang
Shenzhen Berxel Photonics, China
Email: jiaxing.wang@berxel.com

Abstract

Multimode vertical cavity surface emitting lasers (VCSELs) are attractive for short-reach optical interconnects used in data centers and AI computing due to their low power consumption and cost effectiveness. However, the modulation bandwidth bottleneck as well as the chromatic dispersion are limiting VCSEL's transmission volume and distance. High contrast meta-surface (HCM) technology such as high contrast grating (HCG) could be used to control the transverse modes, enhance the bandwidth and improve the beam quality. HCG VCSEL's supreme advantages in 3D sensing and high-power application will also be discussed.

Short Bio

Jiaxing Wang received his PhD degree in Electronic Engineering from Tsinghua University. He was postdoc and associate research scientist at UC Berkeley, and now is R&D VP at Shenzhen Berxel Photonics, China.

Progress of High-speed Datacom VCSELs and High-power LiDAR VCSELs at Vertilite

Ryan Rao
Vertilite Co., Ltd., Changzhou City, Jiangsu Province, China
Email: Ryan.Rao@vertilite.com

Abstract

With the booming of AI datacenters, high-speed VCSELs demand is growing rapidly. We'll present the progress of 50G and 100G PAM4 VCSEL at Vertilite. Some preliminary results towards 200G VCSEL will also be shared.

This presentation will also report progress in mass production of high-power-density, small-divergence-angle and high-reliability multi-junction VCSELs for LiDAR. Several examples of VCSEL applications and future trends in different LiDAR systems (spot, 1D addressable, 2D addressable etc) will also be discussed.

Short Bio

Dr. Ryan Rao is the Co-founder and Chief Product Officer at Vertilite, where he leads the team for customer technical support and new product introduction, and achieved a milestone of shipping 250 million VCSEL chips with zero field failure. He graduated from Stanford University with a PhD degree in 2008, and has worked on the development and production of optoelectronic chips for many years.

High-speed VCSEL: from high temperature to cryogenic temperature (4K)

Anjin Liu
Institute of Semiconductors, Chinese Academy of Sciences, Beijing, China
Email: liuanjin@semi.ac.cn

Abstract

The applications such as artificial intelligence (AI) and cloud computing demand advanced computing systems with high computational power and high power efficiency. 850-nm vertical-cavity surface-emitting lasers (VCSELs) are the key laser sources for the short-range optical interconnect in the AI clusters with CMOS technology and cryogenic computing such as single-flux-quantum (SFQ) superconducting computing and quantum computing. In this talk, I will first introduce the modulation performance of the 850-nm oxide-confined VCSEL at 85 ℃. The VCSEL can reach a modulation bandwidth of larger than 25 GHz and a NRZ data rate of 50 Gbps at 85 ℃. Then I will present our progresses on the cryogenic 850-nm oxide-confined VCSEL for cryogenic computing. The cryogenic VCSEL with an optical oxide aperture of 6.5 μm in diameter can operate in single fundamental mode with a side-mode suppression-ratio of 36 dB at 3.6 K. The small signal modulation measurements at 298 K and 292 K show the fabricated VCSEL has the potential to achieve a high modulation bandwidth at 4 K.

A. Liu et al., Photonics Res. 7, 121-136 (2019); J. Zhang et al., Photonics Res. 10, 1170-1176 (2022); C. Hao et al., Opt. Express 30, 22074-22087 (2022). A. Liu et al., J. Semicond. 45, 050501 (2024); A. Liu et al., J. Semicond. 45, 102401 (2024).

Short Bio

Anjin Liu received Bachelor degree in 2006 from Huazhong University of Science and Technology, Wuhan, China, and Ph.D. degree from Institute of Semiconductors, Chinese Academy of Sciences (CAS), Beijing, in 2011. From 2012 to 2015, he was a Postdoc Fellow in Fraunhofer Heinrich Hertz Institute and Technical University of Berlin (Bimberg group) in Germany. In 2016 he joined Institute of Semiconductors, CAS, and now he is a professor. His research interests include VCSELs, semiconductor lasers, and vertically integrated photonics. He has authored or coauthored about 60 papers in scientific journals. He is recipients of Alexander von Humboldt Postdoctoral Research Fellowship and State Technological Invention Award.

High Speed VCSEL Application for AI Optical Interconnects

Pan Cao
Hisilicon Optoelectronics Dept., Huawei Technologies co. Ltd., China
Email: pan.cao@huawei.com

Abstract

Since the fast growing demand for accurate machine learning models, the data size is skyrocket over recent years. Therefore, optical interconnection demand of AI clusters is accelerating development, where the high bandwidth, low latency, low energy-per-bit, and high availability are requirements for AI workloads. The intra-data center optical link includes few meters to tens of meters transmission distance, where the connection volumes are much higher than other distances. For this scenario, VCSEL is the best solution since its low power dissipation and low cost. 100G/lane VCSEL goes to massive production recently. For 200G/lane, there are different technologies under development. We will introduce the requirement of future AI interconnection and the progress of different high speed VCSEL technologies

Short Bio

Dr. Pan Cao received the Ph.D. degree in EE from Shanghai Jiao Tong University, China, in 2014. After graduation, he joined HiSilicon Opto-Electronics as a technical staff. Currently, he is a technical expert of Hisilicon Opto-Electronics and in charge of next generation optical chip and optical module technologies. In last few years, he had contribution in innovation works, including 100GB EML, 100GB+silicon modulators, and 100Gbps VCSEL. He has more than 30+ publications in journal and internal conferences, and holds more than 10 Chinese patents.

Electronic-Photonic Co-designed VCSEL-Based Chipsets for AI Computing Interconnects

Dr. Nan Qi
Institute of Semiconductors, Chinese Academy of Sciences
Email: qinan@semi.ac.cn

Abstract

The emerging AI computing asks for high bandwidth, high-density and low-power interconnects. Multi-mode vertical-cavity surface-emitting laser (VCSEL)-based optical interconnects can enable high-bandwidth connectivity while extending the reach to tens of meters. While pluggable linear-drive optical modules are widely used in the data center, the co-packaged VCSEL-based optical engine enables higher density optical I/O for the xPU chiplets. The co-design of electronic integrated circuits (EIC) with photonic devices are critical to boost bandwidth, compensate nonlinearity and improve power efficiency. Based on that, the Co-packaged Optics (CPO) becomes one of the most promising techniques to enable high density and low power chip-level optical interconnects. The integration of large-scale arrayed VCSELs with high-density customized EICs are attracting more attention for AI interconnects.

This talk focuses on the custom electronic integrated circuits design, including the high-speed driver, TIA and data recovery circuits, especially the electronic-photonic co-designed VCSEL-Based chipsets for new generation AI computing interconnects. Recent works will be introduced, and the future developing trends will be analyzed.

Short Bio

Dr. Nan Qi received the PhD from Tsinghua University in 2013. From 2013 to 2017, he was with Oregon State University, Corvallis, OR, and Hewlett-Packard Labs, Paloalto, CA, USA, respectively. Since 2017, he has been with the Institute of Semiconductors, Chinese Academy of Sciences, and the State Key Lab of Superlattices and Microstructures. His research focuses on the integrated circuits for optical communication, and photonic-electronic convergence communication chips. He has led more than 10 national major projects including the NSFC and MOST grants. Dr Qi is a member of IEEE SSCS, CAS and Photonics, and has published more than 80 academic papers.

Modulation of VCSELs: Breaking the Limit of Relaxation Oscillation

Cun-Zheng Ning, Hui Li, Chuyu Zhong, Jian Feng, Shupeng Deng, Zhao Chen, Xing Zhang, Wei Miao
Shenzhen Technology University
Email: ningcunzheng@sztu.edu.cn

Abstract

Rapid expanding applications such as AI-related computation have exacerbated demands for higher modulation speed of semiconductor lasers such as VCSELS. At the same time, design optimization for high-speed modulation of semiconductor lasers has reached the saturation stage where significant progress in modulation speed becomes more and more difficult. It is high time to focus on different mechanisms and go beyond the limit imposed by the relaxation oscillation. In this talk, experimental as well as simulation results exploring inter-mode and inter-VCSEL couplings would be presented.

Short Bio

Cun-Zheng Ning is a Chair Professor at Shenzhen Technology University. Between 2006 and 2021, he was a professor of electrical engineering at Arizona State University. He was a Professor at Tsinghua University between 2015-2022. His many achievements have been widely reported in news media and tech magazines such as Science or Nature Photonics. He was recognized for the first white laser demonstration as "The Best of Tech in 2015" and the "Top 10 Engineering Achievements" by Popular Science. MIT Technology called the first plasmonic nanolaser by Ning and Hill "the first to overcome the wavelength constraints on the size of lasers". Dr. Ning is a winner of several awards including NASA and NASA Contractor Awards, NASA Space Act Patent Awards, CSC Technical Excellence Award, and IEEE/Photonics Society Distinguished Lecturer Award (2007-2009), and most recently the Humboldt Research Award. Dr. Ning is also a Fellow of the Optical Society (OSA), IEEE, and the Electromagnetic Academy.

Recent Advances in Vertical-External-Cavity Surface-Emitting Lasers

Xing Zhang
Ace Photonics Company Ltd., China
Jilin Provincial International Joint Research Center of Advanced Laser Chip Technology, China
Wuxi University, China
Email: zhangx@acephoton.com

Abstract

Optically pumped vertical external cavity surface emitting laser (VECSEL) is a high-performance semiconductor laser that exhibits significant characteristics and high-performance advantages due to its unique structure and working principle. This laser can provide high output power, single frequency laser, wavelength tunability, and excellent beam quality. VECSEL is suitable for multiple research fields such as nonlinear optics, spectroscopy, and quantum optics. The optical pumping mechanism reduces the thermal load of the chip and improves the stability and reliability of the device. In terms of technological innovation applications, VECSEL has also shown outstanding performance in the fields of quantum information, industrial processing, and detection. In this presentation, I will introduce the research progress we have made in VECSEL

Short Bio

Xing Zhang received his PhD degree in Condensed Matter Physics from Changchun Institute of Optics, Fine Mechanics and Physics, Chinese Academy of Sciences, China. He is now with Ace Photonics Company Ltd., China, and also with the Jilin Provincial International Joint Research Center of Advanced Laser Chip Technology, China and Wuxi University, China.

Dynamic performance and energy efficiency of wafer fused VCSELs

Prof. Leonid Karachinsky
ITMO University

Abstract
TBA

Short Bio

Prof. Leonid Karachinsky, Deputy Director and professor at the Institute of Advanced Data Transfer Systems, ITMO University. Leading Researcher at the Laboratory of Single-Photon Detectors and Generators. Alexander von Humboldt Fellowship (Advisor: Prof. Dr. Dieter Bimberg, Technical University of Berlin), visiting scholar of PIFI of CAS (Host: Bimberg Chinese-German Center for Green Photonics). His research direction is high-speed long-wavelength VCSELs fabricated by MBE and wafer fusion. He has more than 140 publications in international peer-reviewed journals. H-index is 23 (Google Scholar). He participated as PI in more than 20 projects.

Over 20 % wall plug efficiency of GaN-based vertical-cavity surface-emitting laser

Tetsuya Takeuchi
Meijo University, Japan
Email: take@meijo-u,ac,jp

Abstract

GaN-based VCSELs have been developed towards novel light sources in retinal scanning displays, adaptive headlights, visible light communication systems, and point-of-care testing devices. Recently we demonstrated an over 20 % wall plug efficiency of an on-wafer GaN-based vertical-cavity surface-emitting laser (VCSEL) showing a wavelength of 418 nm. The wall plug efficiency of 21.3 % was obtained with the threshold current of 2.5 mA and the maximum differential external quantum efficiency of 54.9 %. The following three key technologies play an important role to achieve such a high wall plug efficiency. The first one is an in situ cavity length control during the epitaxial growth of a VCSEL layer structure by using an in situ reflectivity spectra measurement. The second one is an GaInN underlying layer just below the GaInN MQWs for higher internal quantum efficiency even at high current density (~kA/cm2). The last one is a small aperture of 5 μm for higher thermal roll-over point. Details will be given in the talk.

Short Bio

Tetsuya Takeuchi received Ph. D from Meijo University in 1999. After working for some companies, he joined again Meijo university as an associate professor in 2010, and a professor in 2015. He has been involved in epitaxial growths of III-V compound semiconductors and designs/fabrications of LEDs, tunnel junctions, and VCSELs.

Research progress of novel surface-emitting semiconductor lasers: from classical to quantum (topological)

Yao Xiao
Sichuan University, China
Nanyang Technological University, Singapore
Email: yxiaophys@163.com,n2208255a@e.ntu.edu.sg

Abstract

Vertical-cavity surface-emitting lasers (VCSELs) offer several key advantages, including two-dimensional integration scalability, excellent beam quality, low power consumption, high reliability, fast modulation speeds, and tunable wavelengths. These attributes have led to their widespread application in areas such as optical communications and sensing. In recent years, with the rapid advancements in artificial intelligence and quantum technologies, there has been a growing demand for light sources with higher modulation rates, improved beam quality, enhanced single-mode power, and narrower linewidths. One persistent challenge in laser physics is achieving high power while maintaining high beam quality in single-mode lasers. The recent progress in micro/nano-fabrication technologies and the introduction of quantum physics concepts into optics have spurred the development of novel surface-emitting semiconductor lasers, based on microstructures, which promise to address this challenge. In our research, we have progressed from traditional surface-emitting semiconductor lasers to more sophisticated designs, including non-trivial photonic crystal lasers and topological photonic crystal lasers. Furthermore, we have extended the operational wavelength range from the near-infrared to the mid-infrared region. Currently, our fabricated 940 nm PCSEL (Photonic Crystal Surface-Emitting Laser) device achieves a pulsed output power of 10W, with a slope efficiency of 0.43 W/A and a threshold current density of 0.59 kA/cm^2. Even under full current, the device maintains a single-mode spectrum with a side-mode suppression ratio exceeding 50 dB and a far-field beam pattern with a divergence angle of 1.3°, displaying a clean single-lobe profile.

Short Bio

Yao Xiao PhD student at Sichuan University, currently working in joint training at Nanyang Technological University, main research field is surface emitting semiconductor lasers, including: VCSEL, VECEL, PCSEL, topological photonic crystal laser, Non-Hermitian photonics device.

The Importance of Highly Energy Efficient VCSEL Drivers for Optical Links

Friedel Gerfers
Technische Universität Berlin, Germany
Email: Friedel.Gerfers@tu-berlin.de

Abstract

The energy efficiency of VCSEL diodes has reached record-breaking levels of less than 100 fJ/bit, offering an attractive solution for cost- and energy-efficient ultra-wideband fibre-optic communication links. However, state-of-the-art CMOS and SiGe-based direct modulation VCSEL drivers are lagging significantly behind this trend. Therefore, modelling and design innovations in the field of NRZ and highly linear PAM-4 VCSEL drivers are crucial to achieve sub-pJ/bit combined efficiencies.

In this paper, we focus on the design of high-efficiency CMOS-based VCSEL drivers for NRZ and PAM-4 modulation formats. To optimize the TX system architecture, it is important to understand the (non-linear) VCSEL behavior in detail. Therefore, an accurate non-linear VCSEL model is developed and implemented in an EDA-compatible Verilog-A language. Correlations show excellent agreement between the model and measurements. Based on this model, both a NRZ voltage mode driver and a PAM-N DAC driver have been designed, fabricated and characterized in a 22nm FDSOI CMOS process. Measurements confirm the excellent BER/SNR and energy efficiency of up to 370 fJ/bit @ 60 Gbit/s (VCSEL+driver).

Short Bio

Friedel Gerfers received his Dr.-Ing. from the Albert-Ludwigs University of Freiburg, Freiburg im Breisgau, Germany, in 2005.

He gained his first industrial experience at Philips Semiconductors in Starnberg, Germany. From 2006 to 2014, he worked in the USA, CA at Intel Research, Aquantia, Integrated Device Technology (IDT), Inphi and Apple Inc, California, USA.

In 2015, he was appointed as a full professor at the Technical University of Berlin, where he has headed the Chair of Mixed Signal Circuit Design ever since. In recognition of his achievements, he was awarded the Einstein Professorship for Mixed Signal Circuit Design in 2019.

Dr. Gerfers is co-founder of IC4X GmbH, Berlin (2018) and Niederrhein Technologies, CA, USA (2009). He is currently on the scientific advisory board of the research institutes IHP, FBH and FMD Germany.

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晶片尺寸：4寸、6寸及不规则小片
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高反膜HR
增透膜AR

装调、封装 (Assembly & Packaging)

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测试与可靠性 (Testing & Reliability Verification)

全自动芯片测试、高频芯片测试
可靠性验证：老化实时监测、温循、高温高湿




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VERTILITE 纵慧芯光

Company Profile

Vertilite Co., Ltd. ("Vertilite") was founded in 2015 and has been offering vertical-cavity surface-emitting laser (VCSEL) chips and related modules of leading performance, as well as comprehensive technical support and services. Vertilite is dedicated to being the most reliable business partner of global customers. Vertilite products have now been widely deployed in the fields of consumer electronics, automotive electronics and optical communication.

Vertilite, headquartered in Changzhou, has several subsidiaries in Shanghai, Shenzhen, Taiwan, Gyeonggi-do, San Jose and Singapore, aiming to provide services for local customers. The Changzhou facility houses state-of-the-art MOCVD epitaxial technology for 6-inch GaAs wafer growth as well as comprehensive backend packaging, testing, and qualification capability for bare VCSEL chips and related modules. The MOCVD line enhances Vertilite's capability of cutting-edge VCSEL technology and enables manufacturing competitiveness as well as supply sustainability. Vertilite is able to mass-produce products for customers in fields of consumer electronics, automotive electronics, optical communication and HBT epitaxy. Over 250 million VCSELs have been shipped out by the end of June, 2024, and no field failure is reported. Customized designs and engineering solutions are readily available to meet customers' diverse technical specifications.

Research & Development

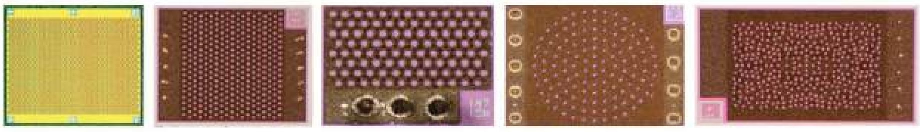
Vertilite was started by several Ph.D. graduates from Stanford University. Leading R&D and technology personnel graduated from Stanford, Duke, Yale, Tsinghua, Peking and Chinese Academy of Sciences and have extensive industrial experience in chip design, epitaxial growth, wafer processing and module packaging. Vertilite has successfully released multiple series of products with superior performance and shipped to customers.

Consumer Electronics

Application scenarios »

Face/gesture recognition
3D stereoscopic imaging
Proximity sensor
AR/VR
Eye-tracking

VCSEL Chips »



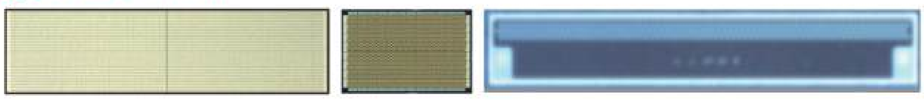
Part Number	Wavelength	Test current (mA)	PN junction	Zone	Power (typical) (mW)	PCE (%)	Full Beam Divergence (D86) (degree)
CAS850F001	850	1400	1	1	1200	40	20
CAS905F001	905	1000	6	1	5000	25	19
CAC940D001	940	250	1	1	210	36	23
CAC940K013	940	2800	3	1	6500	48	23
CAS808G002	808	3500	1	1	2700	38	22

Automotive Electronics

Application scenarios »

LiDAR
IR illumination
Driver monitor system

VCSEL Chips »



Part Number	Wavelength	Test current (A)	PN junction	Zone	Power (typical) (W)	PCE (%)	Full Beam Divergence (D86) (degree)
CAS905P001	905	60	6	1	250	23	16
CAS940P001	940	15	8 or 6	56	100W per zone	30	23
CAC940M009	940	-	5	288	-	-	-

Optical Communication

Application scenarios »

Data center
Video link

PN:CAS850A008 4X50G PAM4 VCSEL
PN:CAS850A011 4X100G PAM4 VCSEL

HBT Epitaxy

Application scenarios »

Mobile
Wireless router

Typical products

6 inch HBT Epitaxy

Sales Contact: sales@verilite.com

长春光机所大功率半导体激光团队
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Ace Photonics Co., Ltd.(长光时空)specializing in the development and fabrication of high-performance semiconductor lasers, primarily for VCSELs and VECSELs of the spectral range 750-1550nm.

Ace Photonics was established in 2018 in Changchun, China.

Ace Photonics is a team of professionals who graduated from Changchun Institute of Optics,Fine Mechanics and Physics, Chinese Academy of Sciences. Ace Photonics specialists have long term experience in design and fabrication of semiconductor lasers, both for industrial and R&D purposes.

Our Advantages

① Technological accumulation in the design and fabrication of GaAs-based and inP-based VCSELS.

② Experience in laser chip processes, such as inductively coupled plasma etching, wet oxidation and BCB process.

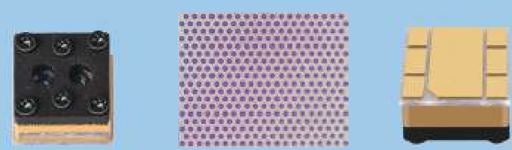
③ Customized VCSEL or VECSEL module products development can be carried out for the special applications.

Product

Single mode VCSEL

790nm high-power | 790nm VCSEL | 890nm VCSEL

Multi-mode VCSEL



VCSEL module | VCSEL array chip | bonding pad

VECSEL Module

VECSEL module

Narrow linewidth semiconductor laser

10XXnm | 1550nm

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No.1759 Mingxi Road, Changchun, Jilin

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Ace Photonics

老鹰半导体
ZJEAGLES COMSEMI

浙江老鹰半导体技术有限公司

老鹰半导体成立于2018年4月，注册资本3500万元，一期投资7亿元人民币。公司专注于垂直腔面发射激光器 （VCSEL）芯片及器件的研发、生产和销售，建有全球领先的仿真设计平台、高级别测量实验室和车规级可靠性试验室。

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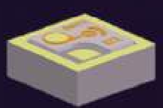
老鹰半导体VCSEL产品介绍

高速数据通信系列

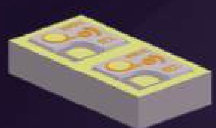


100G PAM4 VCSEL

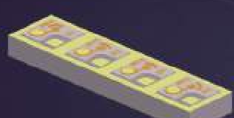
50G PAM4 VCSEL

25G VCSEL

10G VCSEL



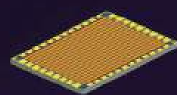
1 X 2 阵列



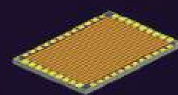
1 X 4阵列

老鹰半导体面向数据中心光通信提供850nm VCSEL光源，单通道速率涵盖10G、25G、50G、100G，同时支持1*2、1*4的阵列，赋能100G、400G、800G及更高速率的短距离数据传输。

车载激光雷达系列



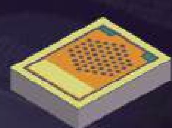
二维可寻址 12x36通道



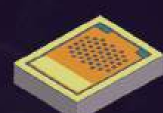
二维可寻址 8x24通道

一维可寻址 56通道

一维可寻址 48通道



单通道52孔



单通道46孔

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AQ-2000

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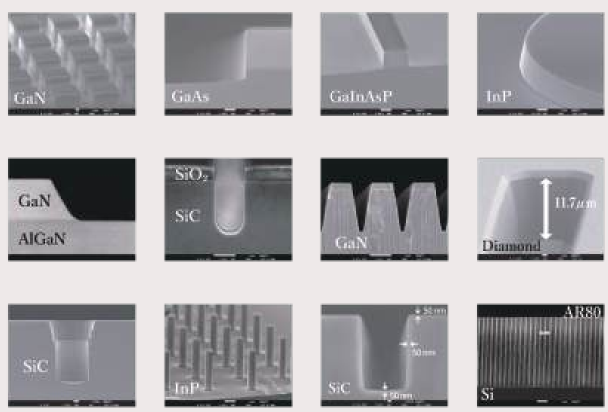
- Plasma Cleaning
- UV Ozone Cleaning

WHO WE ARE

Established in 1979, Samco began as a garage start-up in Kyoto, aiming to provide cutting-edge semiconductor and electronic component manufacturing systems globally. Over time, it has evolved into a leading global corporation with state-of-the-art technological capabilities and a widespread presence. Our commitment to growth prioritizes "thin-film technology" as our core expertise.



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AIXTRON

关于爱思强 / About AIXTRON

AIXTRON爱思强是半导体产业领先的沉积设备供应商。公司成立于1983年，总部设在德国黑措根拉特（靠近亚琛），并在亚洲、美国及欧洲设有子公司及销售办事处。爱思强的技术解决方案被全世界广泛的客户所使用，以制造先进的电子和光电子应用元件，这些元件乃基于化合物、硅或有机半导体材料。该元件被广泛用于创新应用、技术及行业，其中包括LED应用、显示技术、数据存储、数据传输、能源管理和转化、通讯、信号灯和照明技术以及其他尖端技术。

请浏览我们的网站www.aixtron.com，了解AIXTRON爱思强 (法兰克福证券交易所：AIXA，国际证券号码：DE000A0WMPJ6) 的更多信息。

AIXTRON SE is a leading provider of deposition equipment to the semiconductor industry. The Company was founded in 1983 and is headquartered in Herzogenrath (near Aachen), Germany, with subsidiaries and sales offices in Asia, United States and in Europe. AIXTRON's technology solutions are used by a diverse range of customers worldwide to build advanced components for electronic and opto-electronic applications based on compound, or organic semiconductor materials. Such components are used in a broad range of innovative applications, technologies and industries. These include LED applications, display technologies, data storage, data transmission, energy management and conversion, communication, signaling and lighting as well as a range of other leading-edge technologies.

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上海市长宁区华山路1568号
南丰大厦1101室
邮编：200052
电话+86 21 64453226
传真：+86 21 64453742
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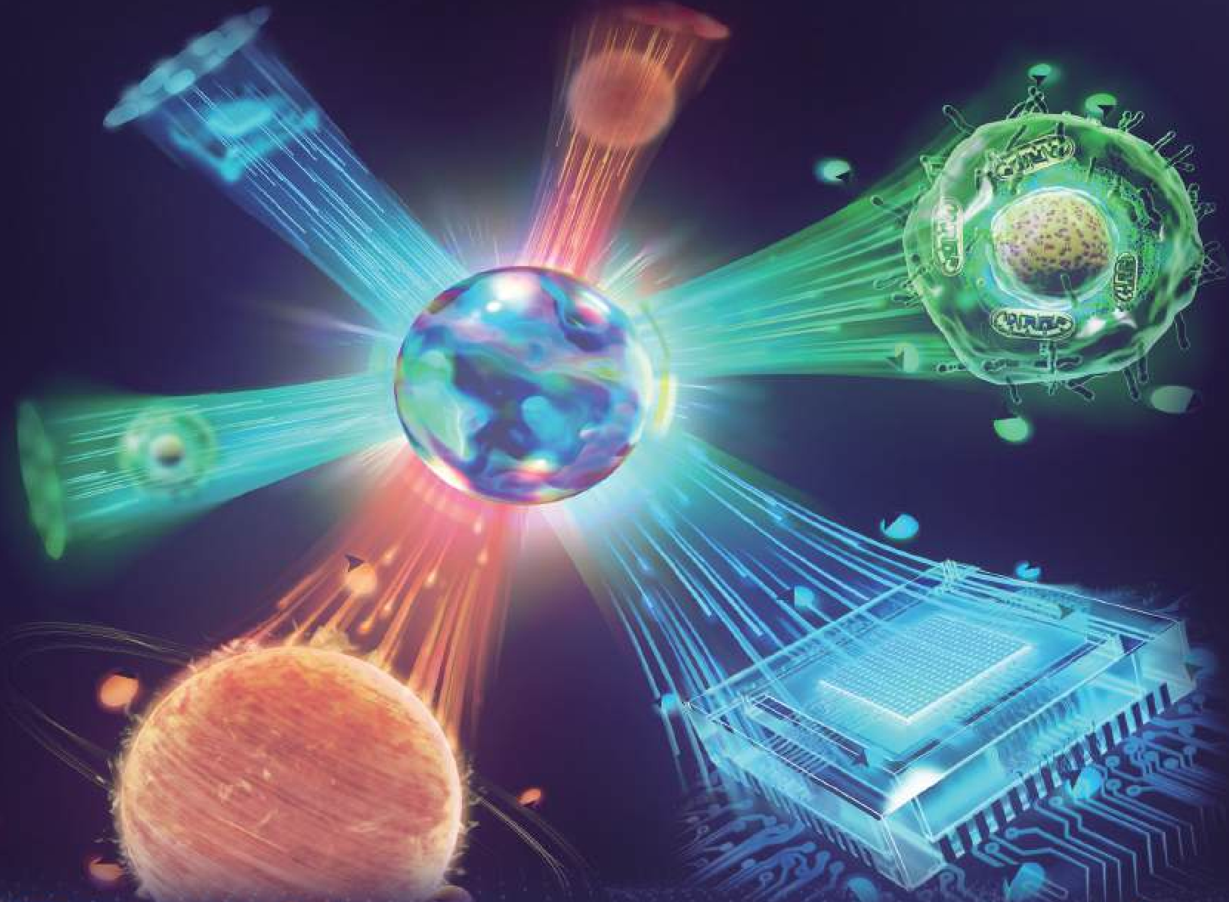

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