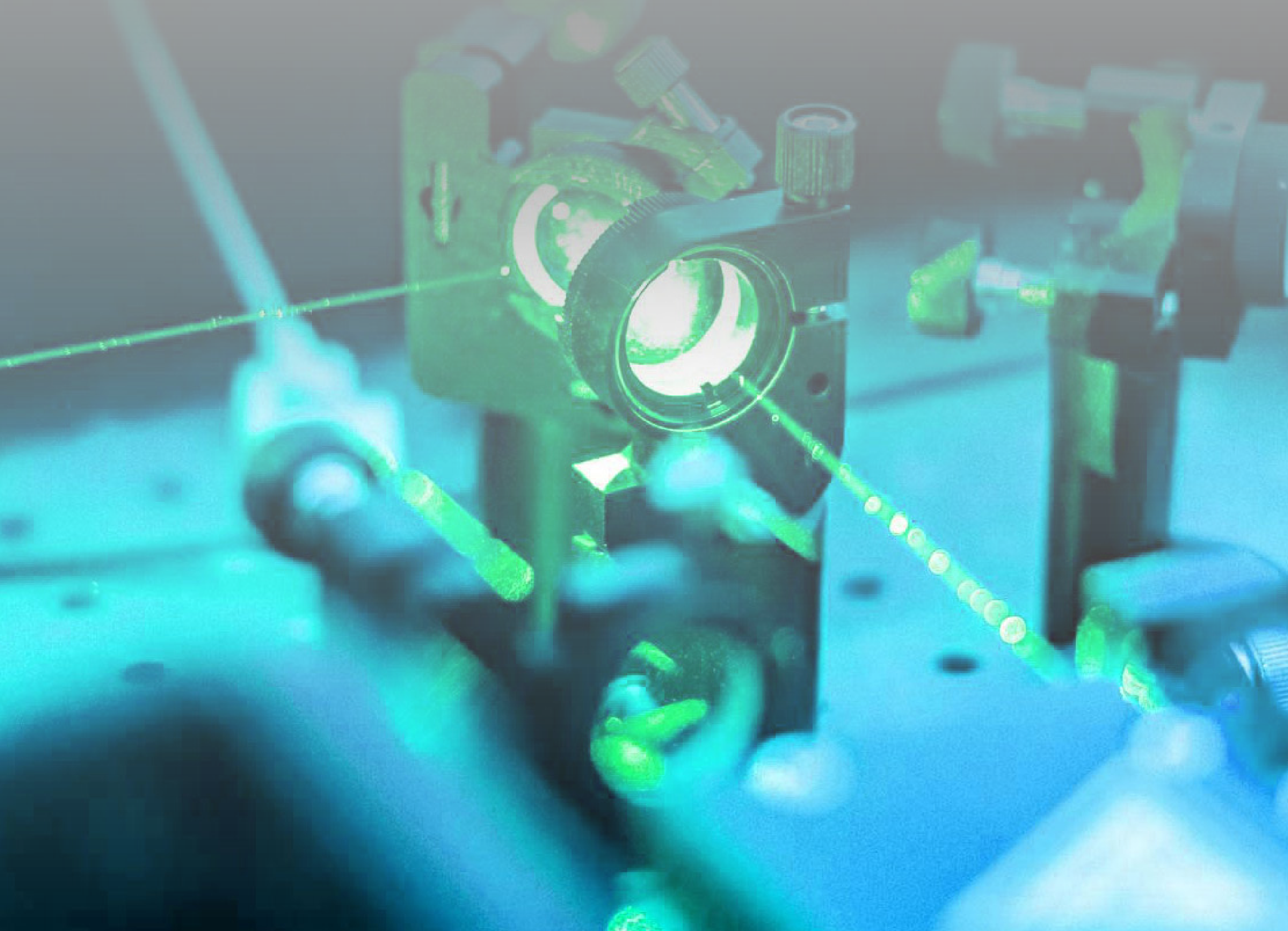
Abstract Book

OPTICS2023

2nd International Conference and Expo on

Lasers, Optics & Photonics

October 09-10, 2023 | Barcelona, Spain



FOREWORD

Dear Colleagues,

It is our pleasure to invite all scientists, academicians, young researchers, business delegates and students from all over the world to attend the **2nd International Conference and Expo on Lasers, Optics & Photonics** will be held in **Barcelona, Spain** during **October 09-10, 2023.**

OPTICS2023 shares an insight into the recent research and cutting edge technologies, which gains immense interest with the colossal and exuberant presence of young and brilliant researchers, business, delegates and talented student communities.

OPTICS2023 goal is to bring together, a multi-disciplinary group of scientists and engineers from all over the world to present and exchange break-through ideas relating to the Lasers, Optics & Photonics. It promotes top level research and to globalize the quality research in general, thus makes discussions, presentations more internationally competitive and focusing attention on the recent outstanding achievements in the field of Lasers, Optics & Photonics.

We're looking forward to an excellent meeting with scientists from different countries around the world and sharing new and exciting results in Lasers, Optics & Photonics.

COMMITTEES

Organising Committee

Anna Backerra	Director-Institute for Theoretical and Applied Micro Magnetics, The Netherlands
Edik U. Rafailov	Aston University, United Kingdom
Zhenguo Lu	National Research Council, Canada
Salman Noach	Jerusalem College of Technology, Israel
Daniel Farkas	University of Southern California, USA
Friedrich Grimm	MD at RES Institute, Germany
Anita Ioana Visan	National Institute for Lasers, Plasma and Radiation Physics, Romania
Haizhong Weng	Trinity College Dublin, Ireland
Sachin Singh	Banaras Hindu University, India

MOCVD Selective Area Growth of Ingaas/Algaas/Gaas Using Shadow Mask for PIC

Akihiko Kasukawa
Furukawa Electric Co., Ltd, Japan

Abstract

Selective area growth (SAG) was intensively investigated in GaInAsP/InP QW lasers in the early 2000's. Most of the work is for realizing the monolithic integration of functional devices with laser source (PIC) such as arrayed DFB lasers, EMLs, lasers with spot-size convertor. Patterned substrate with dielectric mask was mainly used for MOCVD SAG. Conventional SAG using dielectric patterned mask, however, seems to be difficult for Al-containing materials due to poly-crystal deposition on the patterned dielectric, which makes difficult to fabricate lasers. SAG using Si shadow mask seems to be applicable for Al-containing materials, since Si shadow mask is removed after the growth even if III-V materials were deposited on the mask. In this study, we investigate the SAG using Si shadow mask for InGaAs/AlGaAs material for the first time, and the band-bap engineering. Here we will report the experimental results such as thickness distribution by TEM observation and PL measurement using micro-PL analysis.A large band gap energy difference of approximately 100 meV was achieved, which can be used for fabricating PICs in the Al-containing material.The device application using this method will be described.

Biography:

Akihiko Kasukawa received B.S, M.S and Ph.D. degrees in electrical engineering all from Tokyo Institute of Technology. He jointed Furukawa Electric Co., Ltd. At Furukawa, he has been engaged in R&D of long wavelength semiconductor lasers. From 1990 to 1991, he was at Bellcore for developing high performance QW lasers. He conducted R&D of high-power lasers both 980nm and 1480nm for EDFA, widely tunable lasers based on arrayed DFB, and high performance 1060nm VCSELs. He is a Senior Fellow at Furukawa Electric Co., Ltd. He served IEEE Photonics Society as a Board of Governor. He was a General Chair of 28th International Semiconductor Laser Conference (ISLC2022), track chair of Photonics West LASE. He served as a President of Electronics Society of the Institute of Electronics, Information and Communication Engineers (IEICE) of Japan. He is a Fellow of IEEE, Japanese Society of Applied Physics (JSAP) and IEICE of Japan.

High-Speed VCSEL Photonics for Data Center Networks

Fumio Koyama,
Tokyo Institute of Technology Japan

Abstract
The 45 years' research and developments opened up a new world of VCSEL photonics, including, sensors, optical interconnects in data center networks, LiDAR and high power sources. A lot of unique features have been proven. The market of VCSELs has been growing up rapidly and they are now key devices in data center networks. High speed VCSELs have been intensively developed for rapid growth in network traffics. A VCSEL is a key component in hyper-scale 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) has been attracting much attention in datacenter and edge computing networks since CPO brings optics much closer to switch ASICs in a single package, so that power consumption could be saved by reducing the reach. In particular, a VCSEL solution gives us high-speed and low-power consumption, which will meet requirements in CPO. We started the NICT project toward high-speed and low-power consumption CPO transceivers based on VCSEL array and multi-core fiber (MCF), which could deliver advantages on power consumptions and capacity density per module. In this talk, we present our recent activity on high-speed transverse- coupled-cavity (TCC) VCSEL array for co-packaged optics. A single-mode 1060nm metal-aperture VCSELs array is developed, which offers high-density I/O platform with a multi-core fiber. By further increase in the modulation speed of VCSEL and in a number of MCF, we expect a possibility of ultrahigh capacity CPO of beyond 1 Tbps.

Biography:
Fumio Koyama received the Ph.D. degree from the Tokyo Institute of Technology in 1985. He is a specially appointed professor/professor emeritus of Institute of Innovative Research, Tokyo Institute of Technology. His research interest includes VCSEL photonics, photonic integrated devices, optical sensing, and so on. He has authored or co-authored more than 1,000 journal papers and conference papers, including over 100 invited papers. He received various awards, including the IEE Electronics Letters Premium in 1985 and in 1988, the Ichimura Prize in Science for Excellent Achievement in 2004, the Prize for Science and Technology from the MEXT in 2007, IEEE/LEOS William Streifer Scientific Achievement Award in 2008, Izuo Hayashi Award in 2012, Sakurai Kenjiro Memorial Award in 2017, Okawa Prize in 2018, OSA Nick Holonyak Jr. Award and IEICE Achievement Award in 2019. He is Fellow of IEEE, OSA, IEICE and the Japan Society of Applied Physics.

Progress in Quantum Dot Based Technology and Devices: Physics and Applications

Edik U. Rafailov,
Optoelectronics and Biomedical Photonics Group, Aston Institute of Photonic Technologies, Aston University, Birmingham, B4 7ET, UK

Abstract
In recent years, there has been a growing interest in the development of compact and low-cost, versatile, broadly tunable CW and ultra-short pulse laser sources generating light across the near-infrared, visible and THz spectral ranges. In this talk we are presenting the recent progress on the development of novel compact quantum dot based laser sources generating light across broad spectral ranges in CW and ultra-short pulse regimes. We also will demonstrate applicability of such lasers in biomedical photonics field.

Biography:
Prof. Edik U. Rafailov received the Ph.D. degree from Ioffe Institute, Saint Petersburg, Russia, in 1992. In 1997, he moved to St. Andrews University, Scotland, UK and in 2005, he established a new group in Dundee University, Scotland, UK. In 2014, he and his Optoelectronics and Biomedical Photonics Group moved to Aston University, Birmingham, UK. He has authored and coauthored more than 500 articles in refereed journals and conference proceedings, including four books, over ten invited chapters and numerous plenary/invited talks. His current research interests include high-power CW and ultra-short pulsed lasers, generation of UV/visible/IR/MIR and THz radiation, nanostructures, nonlinear and integrated optics, and biomedical photonics. He coordinated the €14.7M FP7 FAST-DOT project development of new ultrafast lasers for biophotonics applications and the €12.5M NEWLED project which aims to develop a new generation of white LEDs. He also coordinated the H2020 FET projects: Mesa-Brain (aims to develop 3D nano-printing technology for functional three-dimensional human stem cell derived neural networks), and recently coordinate NEUROPA (aims to develop novel non-invasive brain theragnostic approaches), and PLATFORMA. He also leads a few other projects funded by EU FP7, H2020 and EPSRC. In 2014 he has been awarded the Lebedev Medal of the Russian Optical Society and in 2022 elected as a Fellow of Optica (former OSA).

Quantum Dot Coherent Comb Laser Enable Millimeter-Wave Over Fiber Wireless Transmission Systems

Z.G. Lu1*, G.C. Liu[1], J.R. Liu[1], P.J. Poole[1], Y.X. Mao[1], K. Zeb[1,2], X.R. Xie[1,3], M. Rahim[1], M. Vachon[1], C.Y. Song[1], J. Weber[1], P. Barrios[1], D. Poitras[1], N. Sabourin[1], S. Chen[1], L. Huang[4], A. Askariann[5,6], X.P. Zhang[3], J.P. Yao[4], and K. Wu[6]

[1]*Advanced Electronics and Photonics Research Centre, National Research Council, Ottawa, ON, Canada*

[2]*Ericsson Canada Inc., Ottawa, ON, Canada*

[3]*Depart. Electrical and Computer Engineering, Concordia University, Montreal, QC, Canada*

[4]*School of Electrical Engineering and Computer Science, University of Ottawa, Ottawa, ON, Canada*

[5]*Ciena Canada Inc., Quebec, QC, Canada*

[6]*Department of Electrical Engineering, Ecole Polytechnique Montreal, Montreal, QC, Canada*

Abstract

Future mobile network systems B5G/6G are strongly expected to heterogeneously realize typically diversified performances, i.e. high-data-rate, high-mobility, low-latency, high-capacity, massive-connectivity and low-energy in order to satisfy the highly diversified application requirements. To achieve those goals the operation band of B5G/6G should be primarily in the millimeter-wave (mmW) range. Generation and distribution of mmW with traditional methods is limited by electronic bottleneck and associated complexity. Consequently broad bandwidth, simple, efficient, and cost-effective photonic mmW-over-fiber (mmWoF) transmission systems are solutions for B5G/6G. The spectral purity of mmW carriers is necessary. Numerous approaches have been proposed to generate pure mmW signals. Compared with other technologies, quantum dot (QD) coherent comb lasers (QD CCLs) have great advantages for mmW generation because QD-CCLs with low power consumption and chip-scale integration capacity with silicon can provide multiple highly correlated and low noise optical channels. Recent years we have developed various InAs/InP QD CCLs operating in the C- and L-bands with channel spacing ranging from tens of GHz to THz [1-2] and an output power up to 50 mW at room temperature. Those QD CCLs have very low relative intensity noise (RIN), ultra-narrow optical linewidth, small timing jitters, compact size, low cost, low power consumption, large volume fabrication capability, and the ability for hybrid

integration with silicon substrates [3]. By using our buried heterostructure (BH) QD CCLs we have experimentally demonstrated an optical-heterodyne mmWoF fronthaul system with a 9-m wireless links through 25- and 50-km single mode fiber (SMF) featuring a high bitrate of up to 36-Gb/s [4]. The capacity of the proposed mmWoF link has a potential to be increased to 92 Gb/s for downlink and uplink transmission with the help of the WDM technique, which can a cost-efficient and promising solution for high capacity and high speed mmWoF fronthaul systems of 5G and beyond wireless networks [5-6]. In this paper, through optimizing epitaxy growth, waveguide design and fabrication process, we will present a free-run five-layer ridge waveguide QD MWL showing the excellent performance of the generated mmW signal of 28.36 GHz with a frequency drift below ± 50 kHz, which is within IEEE's frequency tolerance of < ± 20 ppm. Its mmW beat-note linewidth is down to 2.4 kHz without using any optical feedback scheme. Using this QD MWL we have implemented single- and dual-optical carrier modulation schemes for photonic mmW signals generation and data transmission in the mmWoF fronthaul systems. Both modulation schemes have achieved satisfactory performance showing error vector magnitude (EVM) values below the 3GPP requirements (<12.5%) for 5G and beyond networks. In particular, the single-carrier modulation scheme achieves wavelength flexible and improved EVM performance, whereas the dual-carrier modulation scheme alleviates the path length matching challenges, offering a simple and cost-efficient solution in different usage scenarios.

Acknowledgments:
The authors would like to acknowledge the support of National Research Council Canada's high throughput and secure networks (HTSN) research program.

References:

[1] Zhenguo Lu, et al., "312-fs pulse generation from a passive C-band InAs/InP quantum dot mode-locked laser," Opt. Express, vol. 16, no. 14, pp. 10835-10840, 2008.
[2] Jiaren Liu, Zhenguo Lu, et al. "THz optical pulses from a coupled-cavity quantum-dot laser," Opt. Commun., 285(6), 1323-1325(2012).
[3] Zhenguo Lu, et al., "InAs/InP Quantum Dash Semiconductor Coherent Comb Lasers and their Applications in Optical Networks ", IEEE Journal of Lightwave Technology (Invited Review Paper), 39(12), 3751-3760 (June 2021).
[4] Khan Zeb, Zhenguo Lu, et al. "Broadband Optical Heterodyne Millimeter Wave-over-Fiber Wireless Links Based on a Quantum Dash Dual-Wavelength DFB Laser", IEEE J. Lightwave Technology, 40(12), 3698-3708(June 15, 2022).
[5] Guocheng Liu, et al., "Mode-Locking and Noise Characteristics of InAs/InP Quantum Dash/Dot Lasers" (Invited paper) IEEE J. Lightwave Technology, 41(13), 4262-4270 (July 1, 2023).
[6] Guocheng Liu, Zhenguo Lu, et al., "Monolithic InAs/InP Quantum Dash Mode-locked Lasers for Millimeter-Wave-Over-Fiber Mobile Fronthaul Systems," (Invited paper) IEEE Journal of Selected Topics in Quantum Electronics , 29(6), 19000110(December, 2023).

Biography:

Dr. Zhenguo Lu is a Principal Research Officer, Team Lead of Photonics Devices and Project Leader of National Challenge Program "High-Throughput and Secure Networks (HTSN)" at Advanced Electronics and Photonics (AEP) Research Centre of National Research Council (NRC), Ottawa, Canada. He also serves as an Adjunct Professor at Department of Electrical & Computer Engineering of both University of Ottawa and Concordia University in Canada since 2006. After obtaining his Ph.D. in 1992, he was the recipient of the Alexander von Humboldt (AvH) Research Fellowship to work at Institute of Semiconductor Electronics, RWTH Aachen, Germany from 1993 to 1995. Then he worked at Terahertz Research Centre of Rensselaer Polytechnic Institute, NY, USA for more than two years. Dr. Lu came to NRC as a Research Officer in 1997. From 2000 to 2002, Dr. Lu was the Director of Product Research & Development of BTI Systems Inc., Ottawa, Canada. He has re-joined NRC as a Senior Research Officer in 2002. Dr. Lu is an expert in the field of photonics devices and their applications in optical coherent networks, data center networks, 5G & beyond wireless networks and satellite communications. He has published over 250 refereed journal and conference proceeding papers, and 8 US patents. He has given over 50 invited talks in the international conferences, universities and industry companies. Dr. Lu is a Fellow of the Optica.

Bond-selective microscopy: A new window for life science and material analysis

Ji-Xin Cheng,
Moustakas Chair Professor, Photonics Center, Boston University, USA

Abstract

Providing molecular fingerprint information, bond-selective microscopy fills the gap between label-free light microscopy and dye-based fluorescence microscopy, opening a new window to look at molecules inside a living cell. Yet, detection sensitivity remains a challenge for vibrational spectroscopic imaging. Recently developed mid-infrared photothermal (MIP) microscopy much improves the detection sensitivity by harnessing the large cross section of infrared absorptions. In MIP microscopy, a visible beam is used to probe the local change of refractive index induced by mid-infrared vibrational excitation of specific chemical bonds. Since our first demonstration of depth-resolved MIP imaging of living cells and organisms (Science Advances, 2016), our team has advanced this pump-probe imaging technology in three modalities, namely scanning-based confocal MIP microscopy, camera-based wide-field MIP microscopy, and MIP tomography for high-speed volumetric bond-selective imaging. Since its commercialization into a mIRage system in 2018, MIP microscopy has found very broad applications, spanning the analysis of functional materials, characterization of environmental microplastics, and structural detection of protein aggregation in neurological diseases. MIP microscopy in the silent window (in which endogenous molecules do not vibrate) has allowed click-free bond-selective imaging at same sensitivity and resolution to confocal to fluorescence microscopy.By harness the apparently large energy deposition, very recently developed stimulated Raman photothermal microscopy opens a new way towards highly sensitive bond-selective imaging (Science Advances 2023).

Biography:

Ji-Xin Cheng attended University of Science and Technology of China (USTC) from 1989 to 1994. From 1994 to 1998, he carried out his PhD study on bond-selective chemistry at USTC. As a graduate student, he worked as a research assistant at Universite Paris-sud (France) on vibrational spectroscopy and the Hong Kong University of Science and Technology (HKUST) on quantum dynamics theory. After postdoctoral training on ultrafast spectroscopy at HKUST, he joined Sunney Xie’s group at Harvard University as a postdoc, where he spearheaded the development of CARS microscopy that allows high-speed vibrational imaging. Cheng joined Purdue University in 2003 as Assistant Professor in Weldon School of Biomedical Engineering and Department of Chemistry, promoted to Associate Professor in 2009 and Full Professor in 2013. He joined Boston University as the Inaugural Theodore Moustakas Chair Professor in Photonics and Optoelectronics in summer 2017. Cheng is authored in 300+ peer-reviewed articles with an h-index of 94 (Google Scholar). Cheng and his team has been constantly at the most forefront of chemical imaging in innovation, discovery, and clinical translation. Chemical microscopes based on his innovations, including CARS, hyperspectral SRS, mid-infrared photo thermal microscopes, are installed and used in many countries worldwide. His research has been supported by ~40 million ($) funding from federal agencies including NIH, NSF, DoD, DoE and private foundations including Chan-Zuckerburg Initiative and Keck Foundation. In 2014 He co-founded Vibronix Inc which is devoted to vibration-based imaging technologies and medical device innovations. In 2019, he co-founded Pulsethera aiming to kill superbugs by photolysis of intrinsic chromophores. In addition, Cheng is the Scientific Advisor of Photo thermal Spectroscopy Corp, Pulsethera, and Axorus. Cheng is a Fellow of Optical Society of America, a Fellow of American Institute of Medicine and Biological Engineering, and associate editor of Science Advances. Cheng initiated the inaugural Gordon Research Conference on Chemical Imaging, held in Easton, MA in August 2023. Among his honors, Cheng received the 2020 Pittsburgh Spectroscopy Award from the Spectroscopy Society of Pittsburgh, the 2019 Ellis R. Lippincott Award from Optica, Society for Applied Spectroscopy, Coblentz Society, the 2016 Research Award from Purdue University College of Engineering, and the 2015 Craver Award from Coblentz Society. He was chosen as the Boston University Innovator of Year 2022.

Dual Laser Beam Solution for the Welding of Aluminium and Copper: Applying Artificial Intelligence Techniques for the Automated Process Monitoring

Benat Arejita
Co-Founder-Software & Firmware Electronic and Opto-Mechanic Engineering EXOM, Spain

Abstract
Laser welding technology is rapidly being adopted by emerging and technologically demanding markets such as EV battery manufacturing due to the advantages associated with it. It provides high flexibility and adaptability to complex welding geometries while minimizing microstructural changes in the material due to the low heat application and the low thermal distortion that this technology provides. However, these new applications must overcome challenges for their reliable introduction to the industry. For instance, the control process must consider the different melting points of metals when welding dissimilar materials such as aluminum and copper. Additionally, the materials used in EV battery manufacturing applications typically present high reflectivity values in the wavelengths of the most common industrial laser sources. To overcome these challenges, we present a dual laser beam solution combining a continuous wave laser source passing through a moving optics setup and a static pulsed laser. This setup allows the generation of custom wobbling patterns that project tailored energy distributions designed for the corresponding welding application. In order to provide traceability and automatically monitor the process, a high-resolution CMOS camera and a high-speed infrared (IR) camera are coaxially arranged in the presented scanner head. Two artificial intelligence models are used to monitor the process. On the one hand, the images acquired from the CMOS camera are used to feed a Yolo-v8 model retrained with a custom process image dataset. On the other hand, a custom Long Short Term Memory (LSTM) model has been developed to classify the generated wobbling pattern using the images of the high-speed IR camera. In this way, the presented solution allows a robust automated monitoring system for the welding process.

Biography:

“Telecommunications Engineer with an M.Sc. in Advanced Electronic Systems by the University of the Basque Country, UPV/EHU. He has experience of more than 15 years working as an R&D engineer in several research institutes, focusing his research area on embedded hardware and software, edge computing and edge artificial intelligence, applying these technologies to multidisciplinary areas ranging from autonomous driving and smart mobility to advance manufacturing".

Coupled Aperture Mini–Arrays of Oxide–Confined Vcsels with a Strong Intensity Modulation in A Frequency Range 20–100 Ghz

V. A. Shchukin[a], N. Ledentsov Jr.[a,b], Ł. Chorchosa,b, O. Yu. Makarov[a], V. P. Kaloshaa, J. P. Turkiewicz[b], and N. N. Ledentsov[a]
a VI Systems GmbH, Hardenbergstr. 7, Berlin 10623, Germany
b Warsaw University of Technology, Nowowiejska 15/19, 00-661 Warsaw, Poland

Abstract

Vertical Cavity Surface Emitting Lasers (VCSELs) offer high modulation bandwidth, high energy efficiency and a high production throughput. These properties are particularly advantageous for optical data communication over multimode optical fiber (MMF) due to narrow spectrum, high modulation bandwidth, temperature stability and reliability. Presently 100 Gb/s (PAM4 at 50 Gbaud) oxide confined aperture VCSELs are penetrating datacenters serving extension of copper links. 200 Gb/s PAM4 copper interfaces are due by 2026. Even 200 Gb/s VCSELs are realized1 applying digital signal processing, an improvement in the performance is needed to maintain energy efficiency and enable VCSELs at steadily increasing data rates. We have studied VCSEL arrays with coherently–coupled apertures at a very small pitch (7µm–10µm). Compact mini–arrays of oxide–confined VCSEL apertures of ~3 µm are fabricated applying oxidation through specially designed etch patterns. Recently strong intensity modulation in such devices was reported with resonance bandwidths reaching 75 GHz at high currents2. Streak camera studies were applied to overcome frequency limitations of the PIN detector. After the photoexcitation pulse the lasing intensity oscillated in each of the cavities in antiphase. Single mode fiber was applied to measure the spectra and preferably couple the light from one or another cavity. The related lasing spectra are shown in Figs. 1(a) and 1(b). Two main spectral features are resolved, separated by ~31GHz and representing ant symmetric and symmetric near field states. Conventional –3dB modulation bandwidth reached 26 GHz at 3.5 mA (Fig. 1(c)) defined by the resonance oscillation frequency and damping. A new strong feature at the photon–photon resonance frequency is revealed dominating the spectrum. The feature shifts upon current towards higher frequencies matching the increased

splitting in the lasing spectra. The results agree with streak camera studies in the low current range. High frequency devices by selective light out coupling are possible.

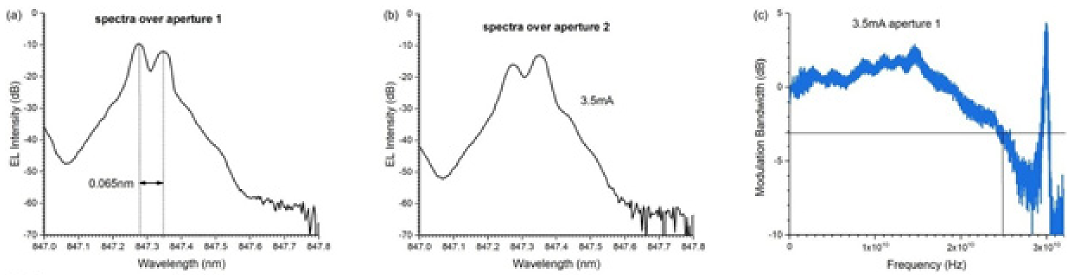


Fig. 1

[1] T. Zuo, T. Zhang, S. Zhang and L. Liu, “50 nm VCSEL–Based Single–Lane 200–Gbps PAM–4 Transmission for Datacenter Intra–Connections,” in IEEE Photonics Technology Letters, vol. 33
(18), pp. 1042–1045, VIS module.
2 M. Lindemann et al., “Coupled Aperture VCSELs Suitable for 100 GHz Intensity Modulation,” 23rd International Conference on Transparent Optical Networks (ICTON), Bucharest, Romania, 2023, pp. 1–4.

Biography:

Dr. Vitaly Shchukin received the Diploma in physics and engineering from St. Petersburg State Polytechnical University, Russia, and the PhD and Doctor of Sciences Degrees in physics and mathematics from Abraham Ioffe Physical Technical Institute of the Russian Academy of Sciences, St. Petersburg, in 1983, 1987 and 1999, respectively. He was with Abraham Ioffe Institute, Technical University of Berlin, NL Nanosemiconductor GmbH (now Innolume GmbH), and Dortmund. He is currently Chief Scientific Officer at VI Systems GmbH, Berlin. He authored and co-authored >250 papers in refereed journals and conference proceedings, over 30 patent families and a monograph. His research topics cover self-organization phenomena at the epitaxy of nanostructures and development of advanced optoelectronic devices with novel functionality including specially designed vertical-cavity surface-emitting lasers, edge-emitting lasers, light-emitting diodes, single photon sources, etc. He is recipient of the State Prize of Russia for Science and Technology in 2001 and of the Abraham Ioffe Prize in 1999 and 2002.

Dual Laser Beam Solution for the Welding of Aluminium and Copper: Applying Artificial Intelligence Techniques for the Automated Process Monitoring

Dr. Benito Allen

Head - Quantum Nano-optoelectronics Laboratory, Institute of Micro and Nano Technology, Spain

Abstract

Laser welding technology is rapidly being adopted by emerging and technologically demanding markets such as EV battery manufacturing due to the advantages associated with it. It provides high flexibility and adaptability to complex welding geometries while minimizing microstructural changes in the material due to the low heat application and the low thermal distortion that this technology provides. However, these new applications must overcome challenges for their reliable introduction to the industry. For instance, the control process must consider the different melting points of metals when welding dissimilar materials such as aluminum and copper. Additionally, the materials used in EV battery manufacturing applications typically present high reflectivity values in the wavelengths of the most common industrial laser sources. To overcome these challenges, we present a dual laser beam solution combining a continuous wave laser source passing through a moving optics setup and a static pulsed laser. This setup allows the generation of custom wobbling patterns that project tailored energy distributions designed for the corresponding welding application. In order to provide traceability and automatically monitor the process, a high-resolution CMOS camera and a high-speed infrared (IR) camera are coaxially arranged in the presented scanner head. Two artificial intelligence models are used to monitor the process. On the one hand, the images acquired from the CMOS camera are used to feed a Yolo-v8 model retrained with a custom process image dataset. On the other hand, a custom Long Short Term Memory (LSTM) model has been developed to classify the generated wobbling pattern using the images of the high-speed IR camera. In this way, the presented solution allows a robust automated monitoring system for the welding process.

Biography:

Dr. Benito Alén received his PhD in Physics in 2004 from the University of Valencia (Spain). Postdoctoral fellow at the Center for NanoScience of the Ludwig Maximilians Universität (CENS, LMU-Munich), the Instituto de CienciasFotónicas (ICFO, Barcelona) and the Instituto de Micro electrónica de Madrid (IMM, CNM-CSIC), since 2012, he leads the Quantum Nano optoelectronics Lab at the Institute of Micro and Nanotechnology, IMN-CSIC. His research interests are on optical spectroscopy, optoelectronics and quantum photonics in arsenide's, phosphides and antimonies.

Process Monitoring of Laser Beam Powder Bed Fusion; Melt Pool, Surface Morphology, and Defects Formation

Toshi-Taka Ikeshoji, Makiko Yonehara, Hideki Kyogoku
Technology Research Association for Future Additive Manufacturing, Japan

Abstract
Laser powder bed fusion (PBF-LB) is an additive manufacturing method capable of producing high-precision and fully dense parts. However, internal defects of PBF-LB-built material are a major obstacle for quality assurance. The defects formation mechanism must be clarified for their mitigation, and the PBF-LB process is required to be improved therefore, we developed an in-situ monitoring system that combines surface morphology measurement by fringe projection and thermal field measurement with a high-speed dichroic thermo-viewer. The thermo-viewer is placed in-axis to the laser system and observes the returned light bifurcated by the splitter. The behavior of the melt pool can be recorded while tracking the laser spot. As results, in a practical multi-track PBF-LB process, a roughness index of the built part surface altered cyclically, consistent with the change in the angle between laser scanning and atmospheric gas flow. The thermo-viewer showed that the melt pool was asymmetrical and spindle-shaped, and that spatter was emitted mainly from the former track side of the melt pool. Furthermore, the roughness of the built-part surface of previous layer affected the stability of the melt pool. Although theoretical prediction of the spattering and internal defects formation, in-situ monitoring equipment will provide knowledge to elucidate spattering and internal defects formation.

Biography:
Dr. Toshi-Taka Ikeshoji is participating in TRAFAM, a Japanese national project for manufacturing metal 3D printers, and is engaged in elucidating the phenomena around the molten pool of the laser powder bed fusion and predicting the occurrence of defects by numerical analysis. He has published various results in PBF-LB fabrication of pure copper and PBF-LB fabrication of Inconel718 under high-speed laser scanning conditions. Current task is the building of the monitoring & feedback system of powder bed fusion to mitigate the internal defects. He received his PhD from the University of Tokyo for a research of aerospace materials and engaged in the research of brazing and joining technology in Tokyo Institute of Technology for more than 10 years. His research was mainly on the aerospace materials, for example, a heat resistance super alloy, ceramics, and carbon composites. *TRAFAM = Technology Research Association for Future Additive Manufacturing.

All passive Tm:YLF/KGW Raman Laser for SWIR Applications

Salman Noach[1 *], Nachmen Gelbach, Menachem Honig, Rotem Nahear
[1] *Department of Applied Physics, Electro-optics Engineering Faculty, Jerusalem College of Technology, Jerusalem, Israel*

Abstract

Many new applications including medical microsurgery, welding material processing, and environmental gas detection, are exists at the 2-3 micron spectral range [1]. Although there are some rare-earth ions that enables such laser sources as Tm, Ho, Cr, those suitable lasers do not tailor the entire spectral range and the level of energy per pulse requirements. Solid state Raman lasers are one of the efficient and useful methods to extend the spectral span of high brightness sources [2]. During last few years, it was also implemented in the SWIR, using BaWO4, YVO4 and diamond crystals as Raman gain medium [3, 4, and 5]. Having high damage threshold, modest thermal lensing KGd(WO4)2 (KGW) is another Raman crystal, so far mainly implemented in the visible and the close NIR (1064nm, 532nm). This crystal has two different Raman shifts (901 cm- and 768 cm-1), enable to achieve two different stokes wavelengths, depending on the input polarization orientation. Although the KGW has lower Raman gain compere to the mentioned Raman crystals, in our former works we show the potential of implementation KGW also in the SWIR [6,7]. At this work, for the first time, an all passive KGW/Tm:YLF laser that, achieved 1.1mJ per pulse with an efficacy of 33% is presented . The compactness of the laser with other properties such as the level of energy per pulse associated with it, is necessary for many applications and increase its potential for new applications in the future.

[1] A. Godard, "Infrared (2-12 μm) solid-state laser sources: a review", Comptes Rendus Physique 8, 1100-1128 (2007).

[2] H. Pask, "The design and operation of solid-state Raman lasers", Progress in Quantum Electronics 27, 3-56 (2003).

[3] O. Kuzucu, "Watt-level, mid-infrared output from a BaWO4 external-cavity Raman laser at 2.6 μm", Optics Letters 40, 5078 (2015).

[4] P. Cheng, J. Zhao, F. Xu, X. Zhou and G. Wang, "Diode-pumped mid-infrared YVO4 Raman laser at 2418 nm", Applied Physics B 124, (2017).

[5] Giorgos Demetriou, Alan J. Kemp, and Vasili Savitski, "100 kW peak power external cavity diamond Raman laser at 2.52 μm," Opt. Express 27, 10296-10303 (2019)

[6] Uzziel Sheintop, Daniel Sebbag, Pavel Komm, Shaul Pearl, Gilad Marcus, and Salman Noach, "Two-wavelength Tm:YLF/KGW external- cavity Raman laser at 2197 nm and 2263 nm," Opt. Express 27, 17112-17121 (2019).

[7] Eytan Perez, Uzziel Sheintop, Rotem Nahear, Gilad Marcus, and Salman Noach, "Efficient all-solid-state passively Q-switched SWIR Tm:YAP/KGW Raman laser," Opt. Lett. 45, 5409-5412 (2020)

Biography:

Professor Salman Noach received his PHD in physics at 2003 from the Hebrew University Jerusalem ISRAEL. At 2007 he returned back to academy, after few years in photonic industry, at the "Jerusalem College of Technology" and founded the Solid State Lasers Laboratory there. The lab is mainly engaged in applied research and development of CW and pulsed solid-state lasers, nonlinear optics, Raman wavelength shifting and Optical amplifiers in the SWIR and mid IR range. The results of the lab research were the object of many publications in high-ranked journals in the optics and laser community and two patents. He is a senior member of OPTICA and member of SPIE.

Passive Symmetry Breaking of the Space–Time Propagation In Cavity Dissipative Solitons

Avi Pe'er, Idan Parshani, Leon Bello, Mallachi Elia Meller
Department of Physics and BINA Institute of Nanotechnology, Bar-Ilan University, Ramat Gan 52900, and Israel

Abstract

Dissipative solitons are fundamental wave-pulses that preserve their form in the presence of periodic loss and gain. The canonical realization of dissipative solitons is Kerr-lens mode locking in lasers, which delicately balance nonlinear and linear propagation in both time and space to generate ultrashort optical pulses. This linear-nonlinear balance dictates a unique pulse energy, which cannot be increased (say by elevated pumping), indicating that excess energy is expected to be radiated in the form of dispersive or diffractive waves. Here we show that Kerr-lens mode-locked lasers can overcome this expectation. Specifically, by breaking the spatial symmetry between the forward and backward halves of the round-trip in a linear cavity, the laser can modify the soliton in space to incorporate the excess energy. Increasing the pump power leads therefore to a different soliton solution, rather than to dispersive/diffractive loss. We predict this symmetry breaking by a complete numerical simulation of the spatio-temporal dynamics in the cavity, and confirm it experimentally in a Kerr-lens mode-locked Ti:Sapphire laser with quantitative agreement to the simulation. The simulation opens a window to directly observe the nonlinear space-time dynamics that shapes the soliton pulse, and possibly to optimize it.

Biography:

Prof. Avi Peer is an expert in quantum optics and laser physics. My research aim is to harness the optical bandwidth resource for optical science and technology on the quantum and classical level, using broadband, highly multimode, correlated light. At the quantum level I explore ultra-broadband squeezed light and time-energy entangled photons for applications of ultrafast quantum communication and squeezing-enhanced sensing. With classical optics I explore the coherent dynamics of mode-locked pulsed lasers and coupled parametric oscillators towards new sources of frequency-combs and for precision ultrafast measurement. Avi Peer is a faculty member of the Physics department and BINA center for nanotechnology In Bar Ilan University Since 2008. He received his PhD from the Weizmann Institute (2005) in physics and completed post-doctoral research at JILA, University of Colorado.

Octave-Spanning Integrated Soliton Frequency Combs Generation with Simple Dual-mode Microresonators

Haizhong Weng,[1,3] Adnan Ali Afridi,[1] Jia Liu,[2] Huilan Tu,[2] Qiaoyin Lu,[2] Weihua Guo,[2] and John F. Donegan[1,4]

[1] School of Physics, CRANN and AMBER, Trinity College Dublin, Dublin 2, Ireland

[2] Wuhan National Laboratory for Optoelectronics, and School of Optical and Electronic Information, Huazhong University of Science and Technology, 1037 Luoyu Road, Wuhan 430074, China

Abstract

Kerr soliton frequency combs, generated within optical microresonators, exhibit exceptional properties with applications spanning from precision metrology to quantum information technology. However, the challenge of thermal instability during soliton formation has impeded widespread utilization of coherent microcomb sources. In this study, we present a straightforward method to access broadband soliton micro combs, addressing this hurdle. Our approach involves leveraging a neighbouring auxiliary mode, positioned at the red- detuned side of the main pump mode. This auxiliary mode effectively counteracts thermal effects, stabilizing soliton formation. This innovation streamlines soliton micro comb generation without necessitating additional auxiliary laser or RF components. We demonstrate the effectiveness of this method using dual-mode aluminum nitride (AlN) and silicon nitride (Si3N4) mirroring resonators, achieving octave-spanning single-solitons. This illustrates the versatility of our approach. Furthermore, we extend the soliton existence range beyond 10 GHz through adiabatic pump wavelength tuning, achieving a two-orders-of- magnitude enhancement compared to conventional dual-pumping methods. Our scheme allows for turn-key soliton generation with a high success rate due to wide soliton steps. We investigate the temperature-dependence of soliton behavior and find that our approach readily yields multi-solitons and soliton crystals, featuring enhanced repetition rates and conversion efficiencies exceeding 40%. These findings highlight the potential of dual-mode microresonators to facilitate the creation of reliable, dynamic, cost-effective, and user- friendly self-referenced soliton frequency combs.

Biography:

Haizhong Weng is a Research Fellow at the School of Physics, Trinity College Dublin. He holds a Ph.D. in Microelectronics and Solid Electronics from the Institute of Semiconductors, Chinese Academy of Sciences. With a decade of research experience in semiconductors, optoelectronics, and integrated photonics, he has authored 34 journal publications and 23 conference papers. Dr. Weng's research focuses on microcavity lasers, microresonator frequency combs, and optical communication.

Sensitive, Fast, and Inexpensive Millimeter/Terahertz Wave Upconversion Imaging Using Glow Discharge Plasma Devices as Detectors

N.S. Kopeika[1], A.R. Kurup[2], A.Abramovich[2], Y. Yitzhaky[1], H.Altan[3], and D.Rozban[2]
[1]Ben-Gurion University of the Negev, Beer-Sheva, Israel
[2]Ariel University, Ariel, Israel
[3]Middle East Technical University, Ankara, Turkey

Abstract
Millimeter wave and terahertz imaging are topics of great interest especially for security, wireless communication, and biomedical applications. A major limitation in development of this field is the lack of inexpensive, fast, and high sensitivity detectors. One possible solution is the use of neon indicator glow discharge plasma lamps, which can fulfill all these requirements. Cost is about half a dollar each, speed is close to that of light, and sensitivity is close to that of the much more expensive types of detectors. Focal plane arrays (FPA) of such devices are quite inexpensive. High speed and sensitivity are obtained using these devices in up conversion mode, in which the incident MMW/THz radiation is detected from increases in light intensity emitted by the glow discharge detectors (GDD). The input is the incident MMW/THz wave and the output is the increased GDD up converted optical wave intensity which is detected by fast avalanche photodiode or CMOS detectors. A single APD or CMOS detector can image the entire GDD focal plane array image. Oversampling can greatly improve image quality versus diffraction limitations. Furthermore, we have recently found that if the MMW/THz image is focused onto a single GDD instead of an array that GDD can act as an area detector for MMW/THz images like photographic film acts like an area detector for optical images. In such cases a GDD FPA may not be needed.

Biography:
N.S. Kopeika was born in Baltimore in 1944. He received B.Sc., M.Sc., and Ph.D. degrees in Electrical Engineering from the University of Pennsylvania in 1966, 1968, and 1972, respectively. He joined Ben-Gurion University of the Negev in 1973. He chaired the Department of Electrical and Computer Engineering [1989-1993], and in1994 was named Reuven and Francis Feinberg Professor of Electro optics. He was the first chair of the Department of Electro optics and Photonics Engineering 1999-2005, which grants graduate degrees only. He and Shlomi Arnon were awarded the JJ Thomson Award by the IEE in 1999 for their outstanding paper. In 2001

he was awarded the Glant Prize for excellence in teaching. He is a Fellow of SPIE (2000). He has published over 200 papers in international reviewed journals and over 180 papers at various conferences. Recent research involves development of a novel inexpensive focal plane array camera for terahertz imaging. Other areas of research include: interactions of electromagnetic waves with plasmas, the opt galvanic effect, environmental effects on optoelectronic devices, imaging system theory, propagation of light, images, and wireless communication through the atmosphere, image processing and restoration from atmospheric, motion and vibration blur, lidar, and target acquisition. He is the author of the textbook A SYSTEM ENGINEERING APPROACH TO IMAGING published by SPIE Press [first printing 1998, second printing 2000], He also co-authored with Nathan Blaunstein, Shlomi Arnon, and Arkadi Zilberman APPLIED ASPECTS OF OPTICAL COMMUNICATION AND LIDAR (CRC Press 2010), and co-edited with Nathan Blaunstein OPTICAL WAVES AND LASER BEAMS IN THE IRREGULAR ATMOSPHERE (CRC Press 2018).

Applications of Hyperspectral Imaging Technique for Monitoring Tissue Oxygenation

Mihaela Antonina CALIN1, Dragos MANEA1, Sorin Viorel PARASCA2,

[1]National Institute of Research and Development for Optoelectronics – INOE 2000, Magurele, Romania

[2]Emergency Clinical Hospital for Plastic, Reconstructive Surgery and Burns, Bucharest, Romania

[3]Carol Davila University of Medicine and Pharmacy, Bucharest, Romania

Abstract

The assessment of tissue oxygenation plays an important role both in the diagnosis of diseases and in the monitoring of medical treatments, providing important information related to their blood supply.Methods currently used in clinical practice can only assess tissue oxygenation levels through localized measurements and in direct tissue contact.Hyperspectral imaging is a non-contact technique that has demonstrated its potential in assessing tissue oxygenation.This technique is able to provide both spatial and spectral information useful for quantifying tissue oxygen levels by using appropriate statistical analysis methods and generating oxyhemoglobin, deoxyhemoglobin, and oxygen saturation distribution maps.This study presents our experienceinhyperspectral imaging and tissue oxygenationmonitoring.It describes the potential of hyperspectral imaging to assess photobiomodulation therapy and hyperbaric oxygen therapy-induced changes in pathological and normal tissue oxygenation, as well as in the assessment ofperfusion of skin flaps.The results showed that hyperspectral imaging is an effective method for monitoring the oxygenation of superficial or even deep tissues.In conclusion, hyperspectral imaging could be considered as a valuable tool for clinical monitoring of tissue oxygenation that could support physicians in making correct treatment decisions.

Biography:

Dr. Mihaela Antonina Calin is currently working as senior researcher 1st degree at the National Institute of Research and Development for Optoelectronics - INOE 2000, Bucharest, Romania. Dr. Mihaela Antonina Calin received her PhD in physics from the University of Bucharest, Faculty of Physics, Romania. Dr. Mihaela Antonina Calin has authored 65+ scientific papers published in journals indexed in ISI Web of Knowledge, 50+ international conference proceedings papers/presentations, 2 co-authored books and 1 unique author book with 1296 citations (web of science, h- index 14). Her publications reflect her research interests in biomedical imaging, tissue optics, and laser-tissue interaction. Dr. Mihaela Antonina Calin has also participated in 11 national and international projects, is a reviewer for five prestigious journals, and a member of the Editorial Board for American Journal of Optics and Photonics. Her research interests include: (i) biomedical optics (optical and thermal properties of living matter, light-matter interactions, optical and hyperspectral imaging); (ii) signal modeling and processing for hyperspectral imaging; (iii) combination of physics-based modeling with statistical tools; and (iv) model recognition and machine learning for biomedical applications.

Computer-Assisted Method for Quantification of Melanin Content in Common Skin Nevi Based on Hyperspectral Imaging Technique

Dragos Manea[1], Mihaela Antonina Calin[1], Sorin Viorel Parasca[2,3]
[1]National Institute of Research and Development for Optoelectronics – INOE 2000, Magurele, Romania
[2]Emergency Clinical Hospital for Plastic, Reconstructive Surgery and Burns, Bucharest, Romania
[3]Carol Davila University of Medicine and Pharmacy, Bucharest, Romania

Abstract

The determination of melanin content is important for the diagnosis and monitoring of skin conditions, especially skin cancers such as melanoma.Moreover, monitoring the changes in melanin content could help to better understand and shed light on the genetic and environmental factors that can affect the health of the skin.This paper proposes a new computer-assisted method for quantification of melanin content based on hyperspectral imaging combined with an appropriate statistical analysis method.The method uses the modified Beer-Lambert law and nonlinear regression to calculate the melanin content in each pixel of the hyperspectral image and generate melanin distribution maps.The method was tested on normal skin and common nevi.The results obtained were quite good (Cnormal skin∊ 2-6 µg/ml and Cnevus>25) demonstrating the ability of our non-invasive method to in vivo determine melanin content in both pathological and normal skin.In conclusion, the proposed method could be considered as a new useful tool for the determination of melanin content and a more accurate diagnosis and monitoring of skin conditions.

Biography:

Dragos Manea is currently working as a scientific researcher at National Institute of Research and Development for Optoelectronics INOE 2000, Magurele, Romania since 2016. He is currently a Ph.D. student with interests in software development and artificial intelligence. Dragos Manea completed his Masters in Medical Physics from the University of Bucharest, Faculty of Physics. Areas of activity includes: software development with medical applications, modeling and data processing for hyperspectral imaging , the application of statistical elements in combination with physics-based modeling, the application of machine learning methods for biomedical applications and, a good understanding and working experience with different fundamental elements and concepts of medical image processing and analysis using artificial intelligence techniques.

Lasers, Optics and Photonics for Biomedicine – A Translational Story

Daniel L. Farkas,
Department of Biomedical Engineering, University of Southern California, Los Angeles; The Brain Window, Inc., Acceleritas Corp. and Clinical Photonics Corp., Sherman Oaks CA, USA

Abstract

In order to have the bench-to-bedside dream of translational research become a reality, we need to develop biophotonic approaches that, while technologically sophisticated, allow deployment into a clinical setting [1]. Our focus area is where light (an exceptional investigative tool) and patient meet[2], and improvements that yield better outcomes by identifying and addressing obstacles preventing the timely clinical adoption of laboratory-based advances, not the least of which is the difficulty of studying very small entities (molecules, cells) within the human body, especially quantitatively, dynamically, and preferably without contrast agents. How and where we look becomes critically important, especially if one targets (as one should) early diagnosis; for this, new tools and strategies are needed. We proposed and implemented a multimode [3] approach to biomedical optical imaging at all levels, featuring hyperspectral imaging, and optimized for earlier, more quantitative and reproducible detection of abnormalities and a tighter spatio-temporal coupling between such diagnosis and intervention. Addressing major areas of unmet need in the clinic with these new approaches could yield important improvements in disease management. Our work on cancer[4], stem cell [5], vascular [6] and neuro (highlighting very early detection of Alzheimer's Disease) [7] applications will be described, with emphasis on the new technologies and strategies needed to achieve the desired imaging performance, and their physics and engineering underpinnings. Thoughts [8,9] about better ways for academia, the clinical and the corporate world to work together for innovative biophotonic solutions and their use in addressing major disease will be briefly outlined.

References:

1. Farkas, D.L. et al. (2003) Global Surgery 2003: 21-25; (2006) 2006: 56-58; Frykman, P. et al. (2008) J. Biophotonics 1: 97-103; Gerstner, A. et al. (2012) J. Biophotonics, 5: 225-262.
2. Fujimoto, J. and Farkas, D.L. (editors) (2009) Biomedical Optical Imaging, Oxford Univ. Press; Farkas, D.L. (2009) in Principles and Practice of Surgical Oncology, Lippincott, W. & W. pp. 18-28.
3. Farkas, D.L. et al. Ann. Rev. Physiol. 55: 785-817; Chung, A. et al. (2005) Curr. Surgery, 62: 365-370; (2006) Cytometry, 69A: 142-6; Hwang et al. (2011) Biomed. Opt. Express 2:

356-64; (2011) Molec. Imaging & Biology, PMID21874388; (2012) PLoS One, 7: e34463.
4. Hu, J. et al. (2006) Cancer Res., 66: 8887-96; Xu, Q. et al. (2009) Br. J. Cancer, 21: 303-11; Agadjanian, H. et al.
(2009) PNAS, 106: 6105-10; (2012) Noanomedicine, 7: 335-352; Ramanujan, V.K. et al. (2010) J. Cell Sci. Ther.,
1: 1000102; (2010) Br. Cancer Res. Ther. 126: 345-54; Hwang et al. (2011) JBO 16: 066007; (2011) Molec.
Pharmac. 8: 2233-43; (2012) JBO 17: 015003; Farkas, D.L. and Becker, D. (2001) Pigment Cell Res., 14: 2-8; Vasefi, F. et al. (2014) Scientific Reports (a Nature journal), 4: 4924. 1-10; (2016) J. Biomed Opt. 21(11):114001
5. Askenasy, N., Farkas, D.L. et al. (2002-2011) Stem Cells, 20: 301-310; 21: 200-207; 25: 3194-3203;
J. Autoimmun. 33: 83-91; 255-259; Immunol. Invest. 36: 713-738; Stem Cells Devel. 20: 569-582.
6. Wachman et al. (1997) Biophys. J. 73: 1215-22; 1223-31; Farkas et al. (1998) Comp. Med. Imag. Graphics 22:
89-102; Talavera, A.D. (2008) JBO, 13: 064017; (2009) Tissue Eng. A 15: 3193-3200.
7. Wachman, E. et al. (2004) J. Neuroscience, 24: 2877-85; Koronyo-Hamaoui, M. et al. (2009) J. Neurochem. 111:
1409-24; (2011) NeuroImage, 54Supl 1: S204-17; Vasefi F. et al. (2017) Neurophotonics. 4(1):011010.
8. Farkas, D.L. (2003) Nature Biotechnology, 21: 1269-1271.
9. Farkas, D.L. (2021)Molecules, 26: 6651.

Biography:
Vitaly Shchukin received the Diploma in physics and engineering from St. Petersburg State Polytechnical University, Russia, and the PhD and Doctor of Sciences Degrees in physics and mathematics from Abraham Ioffe Physical Technical Institute of the Russian Academy of Sciences, St. Petersburg, in 1983, 1987 and 1999, respectively. He was with Abraham Ioffe Institute, Technical University of Berlin, NL Nanosemiconductor GmbH (now Innolume GmbH), and Dortmund. He is currently Chief Scientific Officer at VI Systems GmbH, Berlin. He authored and co-authored >250 papers in refereed journals and conference proceedings, over 30 patent families and a monograph. His research topics cover self-organization phenomena at the epitaxy of nanostructures and development of advanced optoelectronic devices with novel functionality including specially designed vertical-cavity surface-emitting lasers, edge-emitting lasers, light-emitting diodes, single photon sources, etc. He is recipient of the State Prize of Russia for Science and Technology in 2001 and of the Abraham Ioffe Prize in 1999 and 2002.

The Principle of the Laser According To Twin Physics

Anna Backerra
Institute of Theoretical and Applied Micro Magnetism, Maastricht, The Netherlands

Abstract

Twin physics is a new physical model in which the basic features of quantum mechanics and relativity theory are combined to a manageable, complementary description, reaching from sub-atomic to astronomic phenomena. The most important characteristics are the consideration of space as a finite physical item, the use of an elementary unit of potential energy and the use of geometry to make the results more accessible. The developed formalism is based on the concept that determinate and indeterminate aspects of phenomena are mutually independent. They occur joined in nature such that one of both dominates an observation and the other occurs as a small disturbance. The laws of Maxwell emerge from these basics but, different from the classical view, the obtained magnetic fields are in the physical reality restricted to finite spaces. The resulting descriptions could be identified with elementary particles, the four forces of nature and many other well-known phenomena. In particular we found descriptions of four distinct types of electrons, having features being unknown in classical physics. The first is a free electron; the second is a ground electron being one of the first two in a molecule; the third is a chemical electron being the most regular one in molecules; the fourth is a plasma electron.

The description of a plasma electron changes into that of a photon by taking a mirrored time description. The photon consists of a four- dimensional magnetic vector, attached to a point of space existing asymmetrically in a spherical magnetic space. In the center of this magnetic space, a potential electron is located. As soon as a mass approaches this system close enough, the photon will be annihilated and the potential electron will appear as an actual electron. So, the absorption of the photon does not speed up an already existing electron, as is supposed in classical physics, but the photon transforms into a massless electron. Thus, as soon as a photon comes close enough to a proton, the proton will be transformed into an elementary solar cell.

After an introduction of twin physics without going deep into the theoretical basics, the description of a plasma electron and its transformation into a photon will be shown. Using these results, the generation of laser light will be explained, as well as the reason why it stays coherent over a long distance.

Biography:

Backerra has graduated in theoretical physics at the Eindhoven University of Technology in The Netherlands and worked for three years at Philips Research Laboratories. She continued independently, making a search for complementary physics. To develop a way of complementary thinking she studied composition at the Conservatory in Enschede and in Saint Petersburg (Russia). After that she constructed a complementary mathematical language and applied this on physics, obtaining twin physics. The surprisingly diverse results are published in 13 papers in Physical Essays, Applied Physics Research, Advances in Nanoscience and Nanotechnology, Int. J. of Nanotechnology & Nanomedicine and Nano Progress. They may be downloaded at www.itammagnetics.com. The most recent article is titled 'Electron creation by photon annihilation'. The results are combined in the book 'Twin physics, the complementary model of phenomena', Lambert Academic Publishing, www.morebooks.shop; soon it will appear in a revised and updated form.

Manufacturing and Testing of All-Silica Fibers Resistant To UV and Gamma Radiation

Andrey Grishchenko
CeramOptec SIA, Livani, Latvia

Abstract

The all-silica optical fibers were shown to be suitable light guides for power applications in near IR, visible and UV spectral regions. Improvement of fiber resistance to UV and gamma irradiation is an important task for the development of modern energetics and laser technique. This study examined the influence of the composition of the core material [1,2,3], preform production technology [4] and posttreatment with hydrogen on the optical stability of the all-silica optical fibers to UV radiation. Elaborated fiber coating, consisting of carbon and polyimide layers, allows hydrogen saturation at 250°C but shows excellent hermeticity at room temperature.

Comparative study of the light guides not saturated with hydrogen showed that silicas with both high and low content of hydroxyl groups might have sufficient initial UV transparency and resistant to UV irradiation. Of much greater importance is the occurrence of defects in the structure of silica causing absorption in the region of 200–400 nm as well as presence of Si-H and Si-Cl groups, which act as precursors for defects with absorption peaks at 214nm and 330 nm. The method of deposition of a reflective layer had a significant effect on the incidence of defects and Si-H groups in the fiber core. The most significant effect on induced loss was caused by hydrogen treatment of the fibers.

The findings of this study provided strategies of UV stable and low loss all-silica fibers production for wavelength region 200nm – 1060nm.Hydrogen, absorbed in silica structure, significantly in-crease loss in longer wavelength spectral region (see Fig. 1).

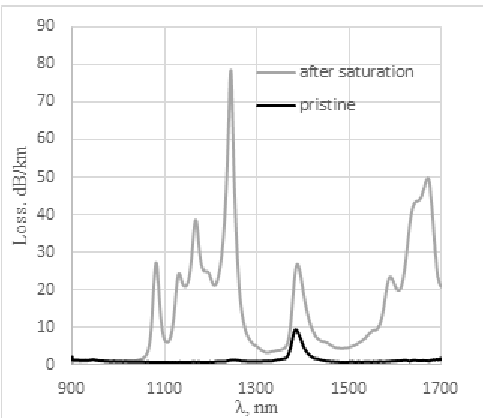


Fig. 1: Spectral attenuation curves of hydrogen in fiber 200/220/245P. Core material: Low OH sili-ca.

Further development of UV and radiation resistant fibers for longer wavelength could be done in Ceram Optec SIA based on low OH, halide-free silica and possible replacement of hydrogen with deuterium.

Heraeus Conamic, “Pure Silica Rods for Specialty Fiber Applica-tions”https://www.heraeus.com/media/media/hca/doc_hca/products_and_solutions_8/optical_fiber/Pure_Silica_Rods_EN.pdf
1. Ohara Quartz CO., Ltd., “Synthetic Quartz”,https://www.ohara-quartz.co.jp/English/products.html
2. Corning LTD., “Optical Materials Product Infor-mation”,https://www.corning.com/media/worldwide/csm/documents/HPFS_Product_Brochure_All_Grades_2015_07_21.pdf
3. Grishchenko A., “Effect of the preform fabrication process on the properties of all-silica fibers”, Quantum Electronics, 47, pp. 1115 – 1119, 2017

Keywords:
All-silica performs manufacturing, chlorine free silica, OH content, optical fibers, solarization, UV-induced loss, hermetic carbon coating, and hydrogen treatment.

Biography:
Andrey Grishchenko is a Head of R&D at CeramOptec SIA. He received his PhD degree from The Institute of Inorganic Chemistry in Latvia in 1993. Starting in2000, Andrey’s studies were dedicated to optical fibers and their manufacturing technologies. He joined CeramOptec SIA in 2011 to initiate all-silica performs manufacturing in Latvia. His current interests are related to the development of medical solutions based on all-silica fiber products, studies of defects formation in all-silica fibers, and optimization of manufacturing technologies for increased fiber durability. Recent acquisition of Ampliconyxoy requires intensive development of techniques for active tapered fiber manufacturing.

Beam Steering With the Enhanced Hyperprism

Tatjana Gric[1, 2*], Edik Rafailov[3]
Department of Electronic Systems, Vilnius Tech, Vilnius, Lithuania
Semiconductor Physics Institute, Center for Physical Sciences and Technology, Vilnius, Lithuania
Aston Institute of Photonic Technologies, Aston University, Birmingham B4 7ET, UK

Abstract
To the best of our knowledge topological change of the iso-frequency surface of hyperbolic metamaterials paves the way for the unique capabilities aiming to engineer propagation of the wave. Herein, an enhanced semiconductor-based hyperprism structure is presented aiming to seek for the optical switching and beam steering dependencies. Based on the outcomes of the numerical simulations one may conclude that by engineering the doping level of the semiconductor-based hyperprism, a maximum adjustable angle of 1.4 rad can be obtained. It has been concluded that changes in doping level allow for a variety of fascinating phenomenon.

Keywords:
Semiconductor; hyperprism; metamaterial.

Biography:
Professor Tatjana Gric (female), since 2003 has been engaged in the investigation of waveguide devices (waveguide modulators, filters etc.), namely on proposing their electrodynamical analysis of various complex structures (e.g., tissue-like structures). Another major goal of her studies is plasmonics as the examination of the interaction between electromagnetic field and free electrons in a metal. The optically-active nanostructures have been simulated and their fundamental photonic properties have been explored. During past few years she has been working on the investigation of the nanostructured composites and their fascinating properties. She has authored and co-authored over 70 articles in refereed journals and conference proceedings. She also holds 1LT patent.

Dual-beam delay-encoded Doppler optical coherence tomography for retinal blood flow measurement

Jun Zhang
School of Electronics and Information Technology, Sun Yat-sen University, Guangzhou 510006, China
School of Artificial Intelligence, Guilin University of Electronic Technology, Guilin 541004, China

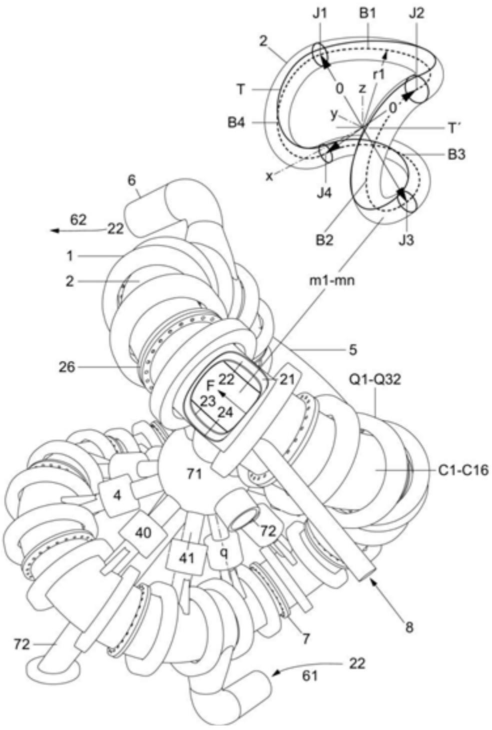
Abstract
Abnormalities in eye perfusion have been linked to a number of sight-threatening diseases. Phase resolved Doppler optical coherence tomography could uniquely provide depth resolved retinal blood flow information in addition to morphological images. The drawback of using a conventional single-beam DOCT system is the potential for imprecise flow velocity measurements, which are significantly influenced by the Doppler angle established between the incident beam and the orientation of the blood vessel.

In this work, a dual-beam Doppler SDOCT system for measurement of absolute retinal blood flow was presented. A beam displacer splits a beam of detection light into two probe beams in the sample arm that are delay-coded with different optical path lengths using a glass plate, which avoids the crosstalk between two channels. With this technique, only one spectrometer is required. The in vivo study demonstrates the ability of the Doppler OCT system to measure the retinal blood flow.

Patent Application Quantum Mechanical Device for A Fusion Reactor

Prof. Dipl.-Ing. Friedrich Grimm
Züricher Strasse 18, D-70376 Stuttgart

Abstract



The invention relates to a fusion reactor (1), having a center point (M) at the intersection of a space defined by axes (x, y, z) and adapted for stable electromagnetic confinement of a plasma volume (2) in a plasma vessel (20) surrounded by a plurality of Helmholtz coils (Q1-Qn). The plasma volume (2) has a central magnetic field line (m1) that reveals four respectively equal arcs (B,B') with four vertices (V1-V4) and four connecting points (J1-J4), arranged with a radius (r1) around the center point (M) and is surrounded by eccentric magnetic field lines (m2-mn) in concentric layers (L1-Ln) of the plasma volume (2), wherein the magnetic field lines (m1-mn) are each formed as endless loops (3),
and the plasma vessel (20) is connected to a cooling system (4), a heating system (5), a hydraulic system (6), a carrier system (7) and an injection system (8). In the fusion reactor (1), the Helmholtz coils (Q1-Qn) force annular oscillations of the plasma volume (2) with two periods (T,T') through a quantum mechanically effective chiasm (X), where a twofold change of the electron spin (S,S') at at least one zero line (0,0') of the individual ring oscillations

causes harmonic annular oscillations with equal path lengths (g,g') for the ions (+,-) in both halves of the endless loops (3).

What is claimed is :

1. A fusion reactor (1) having a center point (M) at the intersection of a space defined by the axes (x,y,z) and adapted for stable electromagnetic confinement of a plasma volume (2) in a plasma vessel (20) surrounded by a plurality of Helmholtz coils (Q1-Qn), which plasma volume (2) has a central magnetic field line (m1) arranged with a radius (r1) around the center point (M) and composed of four equal arcs (B,B') with four vertex points (V1-V4) and four connecting points (J1-J4) which is surrounded in several concentric layers (L1-Ln) by eccentric magnetic field lines (m2-mn) wherein the magnetic field lines (m1-mn) are each formed as endless loops (3) and the plasma vessel (20) is provided with a cooling system (4), a heating system (5), a hydraulic system (6), a support system (7) and an injection system (8), in which fusion reactor (1) the Helmholtz coils (Q1-Qn) are forcing annular oscillations with two periods (T,T') within the plasma volume (2) in that a quantum- mechanically effective chiasm (X) of the magnetic field lines (m1-mn), which are each formed as endless loops (3), is used to cause the electron spin (S,S') to change twice at at least one zero line (0,0') of each individual annular oscillation, so that equal path lengths (g,g') for the ions (+,-) in both halves of the endless loops (3) formed by the magnetic field lines (m1-mn) result in harmonic annular oscillations and the stable confine- ment of the plasma volume (2) in the plasma vessel (20) enables the continuous operation of the fusion reactor (1), wherein ionized nuclei of deuterium and tritium are guided in the plasma volume (2) exactly on the magnetic field lines (m1-mn) and collide with one another at a velocity of more than 1000 km/s and at temperatures of 100 to 200 million degrees Celsius and fuse to form helium in a chain reaction with the release of large amounts of thermal energy.

2. A fusion reactor (1) according to claim 1,
in which the plasma vessel (20) is constructed from a plurality of arc-shaped vessel modules (C1-Cn) which are either circular or oval in cross-section and are arranged between an inner radius (r6) and an outer radius (r7) around the center point (M) concentrically to the central magnetic field line (m1) with the radius (r1) around the center point (M) and can be screwed or welded together to form four arc-shaped assemblies, wherein the plasma volume (2) follows the cross-section of the plasma vessel
(2) and has an electro-magnetically effected distance (d) to an inner shell (23) of the plasma vessel (20) and the Helmholtz coils (Q1-Qn) are associated with the individual vessel modules (C1-Cn) and have a radial distance (d') to the plasma vessel
(20) as well as longitudinal distances (d'') to one another which are definable by sector angles of the radius (r1) around the center point (M).

3. A fusion reactor (1) according to claim 2,
in which the plasma vessel (20) is designed as a double-shell, finned heat transfer helix (21) with an inner shell (23) and with an outer shell (24), the shells (23, 24) and the vessel modules (C1-Cn) being connected to one another in a manner which is resistant to bending, shear and torsion by radial flange connections (26) and to a sealing ring (27) in a pressure-tight and steam-tight manner and receiving a phase-change heat transfer fluid (22) which is conducted at a lower inlet (61) of the heat carrier helix (21) in the return flow from a heat sink to a heat source (60) facing the plasma volume (2) and formed by the inner shell (23) of the plasma vessel (20) and is conducted again at an upper outlet (62) of the heat carrier helix (21) in the forward flow to the heat sink, wherein in the vessel modules (C1-Cn) of the support system (7) steam- and water-tight openings of the injection system (8) are provided for a continuous supply of the fuel of the fusion reactor (1) formed by deuterium and tritium.

4. A fusion reactor (1) according to claim 1,
in which the heating system (4) comprises a plurality of microwave tubes (40) which have a support profile (41) with a longitudinal central axis (q) aligned with the center point (M), and are connected between the coils (Q1-Qn) to the vessel modules (C1-Cn) in a redundant arrangement in such a way that a window (42) of the microwave tubes (40) opens a connection to the plasma volume (2) enclosed in the plasma vessel (20) and to be heated, wherein an alternating operation of the microwave tubes (40), which are present in excess number, enables a continuously operable heating of the plasma volume (2).

5. A fusion reactor (1) according to any of the preceding claims, in which the Helmholtz coils (Q1-Qn) concentric with the magnetic field line (m1) are surrounded on all sides by a cooling system (5) and are insulated from the plasma vessel (20) by a high vacuum, the modules of the cooling system (5) being designed to cool the individual windings of the Helmholtz coils (Q1-Qn) down to minus 270° Celsius in order to enable superconductivity.

6. A fusion reactor (1) according to one of the preceding claims, in which the hydraulic system (6) comprises a circuit for a two- phase heat transfer fluid (22) consisting of water, which in the return flow at a lower inlet (61) enters a finned heat transfer helix (21) formed between the inner and outer shells (23, 24), and leaves the heat transfer helix (21) as prestressed water at an upper outlet (62) and is conducted in the forward flow to a steam turbine with cooling tower acting as a heat sink and returns to the heat source (60) as condensed water at the lower inlet (61), wherein the inner shell (23) of the heat transfer helix (21) absorbs the heat radiated by the plasma volume (2) and the shells (23,24) and longitudinal fins (25) of the heat transfer helix (21) transfer the heat convectively to the water.

7. A fusion reactor (1) according to one of the preceding claims, in which the individual supporting members of the supporting system (7) are formed by the modular assemblies of the fusion reactor (1) itself, the microwave tubes (40) having hollow profiles (41) with longitudinal central axes (q) and being aligned as truss rods with the center point of the reactor (1) and being connected, on the one hand, to the two-shell heat transfer helix (21), which is designed as a annular beam which is rigid in bending, sheaannular and torsion, and, on the other hand, to a heat transfer helix (21) which is concentric with the center point (q), torsion rigid annular beam, and on the other hand to a hollow sphere node (71) arranged concentrically to the center point (M), so that a space framework (70) is formed which is aligned with the center point (M) and introduces the loads of the fusion reactor (1) via installable central supports (72) into a load-bearing foundation soil.

8. A fusion reactor (1) according to one of the preceding claims, in which the arcs (B,B') of the central magnetic field line (m1) surrounding the center point (M) either are four equal circular arcs (B1-B4) with four vertices (V1-V4) which are connected to one another at four connection points (J1-J4), or are four equal parabolic arcs (B'1-B'4), with only the four connection points (J1-J4) are spaced from the center (M) by the radius (r1), while the four vertices (V1-V4) are spaced from the center (M) by a larger radius, and at least one zero line (0,0') of the annular oscillations defines radial planes of the plasma volume (2) both at the circular arcs (B) and at the parabolic arcs (B'), at which the eccentric magnetic field lines (m2-mn) form a stable path for the ions (+,-) as general sine and cosine annular oscillations and in each case change from the outside to the inside of the plasma volume (2) and vice versa, wherein at the radial planes of the plasma volume (2) defined by the vertices (V1-V4) the magnetic field lines (m1-mn) reach a maximum elongation (E1-En) of the annular oscillations and reverse.

9. A fusion reactor (1) according to one of the preceding claims, in which either the zero line (0) at a diameter (D) between the connection points (J1,J3) of the magnetic field line (m1) or the zero line (0') at a diameter (D') between the connection points (J2,J4) of the magnetic field line (m1) forms a joint between the two periods (T,T') of the annular oscillations, wherein in the individual layers (L1-Ln) of the plasma volume (2) the annular oscillations are in each case characterized by layer- specific amplitudes (A1-An), elongations (E1-En), wavelengths (λ1-λn) and frequencies (f1-fn) with a frequency band of 50 Hz on the outside of the plasma volume (2) up to several kilo Hz in the region of the central magnetic field line (m1) and the chiasm (X) of the magnetic field lines (m1-mn) at at least one zero line (0, 0') within the two periods (T, T') of the annular oscillations is characterized by exactly equal path lengths (g, g') for the ions (+,-) in the mirror-image opposite halves of the endless loops (3), so that the symmetry condition of the equal path lengths (g,g') can only be fulfilled if the electron spin (S,S') at the at least one zero line (0,0') reverses twice with the magnitude 0, 5, and with the formation of a helical and an elongational magnetic field component within two periods (T,T') of the annular oscillations a dynamic equilibrium of the electromagnetic forces in the mirror-symmetrically opposing halves of the plasma volume (2) can be established.

10. A fusion reactor (1) according to one of the preceding claims, in which the chiasm (X) of the endless loops (3) formed by the magnetic field lines (m1-mn) causes harmonic annular oscillations, the ionized nuclei of deuterium and tritium each covering half of the endless loop (3) in one period (T,T') of a annular oscillation in the individual layers (L1-Ln) of the plasma volume (2) and requiring two periods (T, T') of the annular oscillations in order to return with the same direction of rotation of the electron spin (S,S') to the beginning of the endless loop (3) and wherein within the two periods (T,T') of

the annular oscillations equal path lengths (g, g') are possible only if the chiasm (X) of the magnetic field lines (m1-mn) with a twice change of the electron spin (S,S') in the individual layers (L1-Ln) of the plasma volume (2) in each case at at least one zero line (0,0') of the annular oscillation causes a regular change of the ions (+, -) from the respective outer side to the respective inner side of the plasma volume (2) and vice versa, so that the symmetry condition of the same path lengths (g,g') in each layer (L1-Ln) of the plasma volume (2) can be fulfilled with the harmonic annular oscillations.

11. A fusion reactor (1) according to one of the preceding claims, in which the plasma volume (2) has a maximum radius (r5) at its outer surface and the ions (+,-) on the outer magnetic field lines (m5) form two halves of an endless loop (3) with equal path lengths (g,g') within two periods (T, T') of the annular oscillation each with a frequency (f5) greater than 50 Hz, wherein the chiasm (X) of the magnetic field lines (m1-mn) with a change of the electron spin (S,S') of at least one zero line (0,0') leads to the fact that the ions (+,-) each between the connection points (J1,J3) or (J2, J4) of the central magnetic field line (m1) in planes of the plasma volume (2) aligned radially with respect to the center point (M) change from the outside to the inside of the plasma volume (2) either with a left-hand or right-hand twist, wherein the radii (r5-r1) of the radial layers (L5-L1) of the plasma volume (2) decrease with increasing proximity to the central magnetic field line (m1) and the frequencies (f5-f1) of the annular oscillations increase exponentially and wherein the line fidelity of the ions (+,-) is strengthened with each zero crossing and the change of the electron spin (S,S') twice at a zero line (0,0') between the two periods (T,T') of the annular oscillations in such a way that the formation of instabilities of the plasma volume (2) is regularly interrupted.

Quantum mechanical device for a fusion reactor

The invention relates to a quantum mechanical device for electromagnetic plasma confinement in a fusion reactor, wherein a theoretical part of the invention specifies symmetry conditions by which the electromagnetically excited fluid dynamics of the plasma can be understood as a ring annular oscillation, which enables a dynamic equilibrium within the high-energy state of a fusion plasma and wherein a constructive part of the invention includes a building instruction for the fabrication of the quantum mechanical device as an integrated overall system of modularly designed assemblies and functional elements, which enables a temporally unlimited plasma confinement in a plasma vessel of the fusion reactor. The fusion reactor according to the invention has a center point at the intersection of a space defined by longitudinal, transverse and vertical axes and is designed for stable electromagnetic confinement of a plasma volume in a plasma vessel surrounded by a plurality of Helmholtz coils. The plasma volume has a central magnetic field line arranged with a radius around the center and constructed from four equal arcs with four vertices and four connection points, which is surrounded in several concentric layers by eccentric magnetic field lines, whereby the magnetic field lines are each formed as endless loops. The plasma vessel is connected to a cooling system, a heating system, a hydraulic system, a support system and an injection system. According to the invention, within the plasma volume annular oscillations with two periods are forced by the Helmholtz coils, using a quantum-mechanically effective chiasm of the magnetic field lines, which are each formed as terminal loose loops, to effect a twofold change of the electron spin at at least one zero line of the individual annular oscillations, in such that equal path lengths for the ions in both halves of the endless loops formed by the magnetic field lines result in harmonic annular oscillations and the stable confinement of the plasma volume in the plasma vessel enables the

continuous operation of the fusion reactor, where ionized nuclei of deuterium and tritium in the plasma volume are guided exactly on the magnetic field lines and collide at a velocity of more than 1000 km/s and at temperatures of 100 to 200 million degrees Celsius and are fused to helium in a chain reaction releasing large amounts of thermal energy. The central magnetic field line of the plasma volume is composed of four equal arcs each, which either have four equal circular arcs with four vertices and are connected to each other at four connection points, or have four equal parabolic arcs and only the four connection points with the radius of the central magnetic field line are spaced from the center, while the four vertices are spaced with a larger radius from the center point and the at least one zero line of the annular oscillations defines radial planes of the plasma volume at both the circular and the parabolic arcs, at which eccentric magnetic field lines form a stable path for the ions as sine and cosine annular oscillations and respectively change from the outside to the inside of the plasma volume and vice versa, wherein at the radial planes of the plasma volume defined by the vertices the magnetic field lines reach a maximum elongation of the annular oscillation and reverse. The plasma volume is divisible at at least one zero line into two periods of annular oscillations, wherein a zero line of the annular oscillations is formable either at a first diameter between the opposing first and third connecting points of the central magnetic field line or at a second diameter between the second and fourth connecting points of the central magnetic field line between the two periods of the annular oscillations. The annular oscillations are characterized in each of the individual layers of the plasma volume by layer-specific amplitudes, elongations, wavelengths and frequencies with a frequency band ranging from 50 Hz on the outside of the plasma volume to several kilo Hz in the region of the central magnetic field line. The chiasm of the magnetic field lines causes exactly equal path lengths for the ions in the mirror-image opposite halves of the endless loops at the respective zero line within two periods of the annular oscillation. The symmetry condition of equal path lengths can only be fulfilled if the electron spin at the at least one zero line reverses with the magnitude of 0,5 twice results in the formation of a helical and an elongational magnetic field component within two periods of the annular oscillations a dynamic equilibrium of the electromagnetically effected forces in the mirror-symmetrically opposite halves of the plasma volume can be established. The chiasm of the endless loops formed by the magnetic field lines causes harmonic annular oscillations, whereby the ionized nuclei of deuterium and tritium each cover one half of the endless loop in one period of the annular oscillation in each individual layer of the plasma volume and require two periods of the annular oscillations in order to return to the beginning of the endless loop with the same direction of rotation of the electron spin and whereby within the two periods of the oscillations the same path lengths are only possible if in the individual layers of the plasma volume the chiasm of the magnetic field lines with a twice repeated change of the electron spin of the annular oscillations at at least one zero line causes a regular change of the ions from the respective outside to the respective inside of the plasma volume and vice versa, so that by means of harmonic annular oscillations the symmetry condition of the same path lengths can be complied with in each layer of the plasma volume. At its outer surface, the plasma volume has a maximum radius, with the ions on the outer magnetic field lines passing through the two halves of the endless loops with equal path lengths within two periods of annular oscillation, each at a frequency greater than 50 Hz. The zero line can be formed either between a first and a third junction point or between a second and a fourth junction point of the central magnetic field line and defines at the junction points planes of the plasma volume radially aligned to the center point at which the chiasm of the magnetic field lines causes a change of the nuclear spin number at the zero line so that

electrically charged particles change from the outside to the inside of the plasma volume either with a left- or right-hand twist. As the proximity to the central magnetic field line increases, radii of the radial layers of the plasma volume decrease, while the frequencies of the annular oscillations increase exponentially. The line fidelity of the ions is strengthened with each zero crossing and the change of the electron spin at a zero line twice between the two periods of the annular oscillations in such a way that the formation of instabilities of the plasma volume is regularly interrupted. The fact that the hot center of the plasma volume is concentric with the central magnetic field line is consistent with the assumption of an exponential increase in the frequency of the annular oscillations with increasing proximity to the central magnetic field line. The effect of magnetic compression of the plasma volume can be explained by the strong magnetic field emanating from the Helmholtz coils and with the symmetry conditions of the invention, which include a law of formation for the expression of harmonic annular oscillations. At the zero-crossing of each period of the annular oscillation, the electron spin in the plasma volume changes, so that with each zero-crossing a reorientation or a kind of re-set of the magnetic dynamic flux of the electrically charged ions on the magnetic field lines is given, whereby with increasing frequency the ions are given no time, for example under the influence of gyroscopic effects or any asymmetries of the magnetic field, to deviate from the path given by the magnetic field lines.

State of the art

Under the extreme pressure of gravity, the ionized nuclei of hydrogen fuse into helium in the sun and in stars that are self- luminous through space and time. If nuclear fusion could be reproduced on earth, sufficient energy would be available for the further cultural and industrial development of mankind. The fusion of deuterium and tritium produces a helium nucleus, a neutron and large amounts of usable energy. The exothermically released energy of one gram of hydrogen is equivalent to the combustion heat of eleven tons of coal. After the Wendelstein 7X stellarator set a world record this year with an energy confinement time of eight minutes, fusion research has come a significant step closer to the goal of taming and harnessing the sun's fire on Earth. The fusion of atomic nuclei holds the promise of being able to provide energy in unlimited quantities in the future to satisfy the world's hunger for energy without harming the climate. Fusion reactors are designed to fuse atomic nuclei in a controllable thermonuclear reaction. Preferably, the nuclei of the heavy isotopes of hydrogen - deuterium and tritium - are fused to form helium under high pressure and heat in an ionized gas where electrons and nuclei have separated. Despite decades of research, fusion reactors capable of generating electricity on a power plant scale, which is urgently needed worldwide to counter the threat of climate catastrophe, are still not available. A mass difference between two fusion partners present as atomic nuclei and the fusion products is a prerequisite for the conversion of matter into energy to satisfy Einstein's equation $E = m c^2$. The mass of the two fused nuclei must be greater than the mass of the resulting nuclei and ions.

This mass difference is particularly large between the heavy isotopes of hydrogen deuterium and tritium and the helium produced in fusion. Another advantage of the hydrogen isotopes is, that the electrical repulsion to be overcome for fusion is very low for these two fusion partners, since they each carry only a single elementary charge. The so-called Coulomb barrier, which describes the electrical repulsion of the positively charged atomic nuclei, must be overcome before the fusion process can start. Beyond this barrier, the distance between the nuclei is so small that the attraction prevails and the nuclei fuse together due to the strong interaction. Therefore, a mixture of equal parts of deuterium and tritium is very suitable as a fusion fuel. In the case of fusion reactors with an electromagnetic

plasma confinement, a distinction is made between the tokamak type and the stellarator type. In a tokamak, only pulsed operation at intervals is possible due to the ohmic heating with inductively driven current, whereas in a stellarator, stationary operation is possible due to the heating with microwave tubes outside the plasma vessel and the microwave tubes can be formed as gyrotrons or klystrons, which transfer their energy by high- frequency oscillation directly to the charged ions in the plasma, which in turn collide with other ions and thus increase the temperature of the plasma. Various methods have been developed for this purpose, with which the energy can be transferred either to the electrons or to the ions of the plasma. Both designs use a ring-shaped plasma vessel in which only a few grams of deuterium and tritium are injected into the gas as fuel for nuclear fusion. Fusion of these light atomic nuclei releases large amounts of energy. This requires an airless plasma vessel holding several cubic meters of gas, in which the gas is heated to 100 to 150 million degrees Celsius to separate electrons and atomic nuclei and then ignite an electrically conductive plasma. Another advantage of the hydrogen isotopes is that the electrical repulsion to be overcome for fusion is very low for these two fusion partners, since they each carry only a single elementary charge. The so-called Coulomb barrier, which describes the electrical repulsion of the positively charged atomic nuclei, must be overcome before the fusion process can start. Beyond this barrier, the distance between the nuclei is so small that the attraction prevails and the nuclei fuse together due to the strong interaction. Therefore, a mixture of equal parts of deuterium and tritium is very suitable as a fusion fuel. In fusion reactors, with an electromagnetic plasma confinement, a distinction is made between the tokamak type and the stellarator type. In a tokamak, only pulsed operation at intervals is possible due to the ohmic heating with inductively driven current, whereas in a stellarator, stationary operation is possible due to the heating with microwave tubes outside the

plasma vessel and the microwave tubes can be formed as gyrotrons or klystrons, which transfer their energy by high-frequency oscillation directly to the charged ions in the plasma, which in turn collide with other ions and thus increase the temperature of the plasma. Various methods have been developed for this purpose, with which the energy can be transferred either to the electrons or to the ions of the plasma. Both designs use a ring-shaped plasma vessel in which only a few grams of deuterium and tritium are injected into the gas as fuel for nuclear fusion. Fusion of these light atomic nuclei releases large amounts of energy. This requires an airless plasma vessel holding several cubic meters of gas, in which the gas is heated to 100 to 150 million degrees Celsius to separate electrons and atomic nuclei and then ignite an electrically conductive plasma. Superconducting coils are arranged around the ring-shaped plasma vessel and generate a magnetic field of up to 12 Tesla, so that the plasma is confined on magnetic field lines at a distance from the inner wall.

Contact of the plasma with the inner wall of the plasma vessel must be avoided at all costs, as the rapidly cooling plasma will bring the fusion process to a halt. The nuclear reaction is highly exothermic and is initiated by the collision of the ionized nuclei of deuterium and tritium. The released neutrons release their energy as heat at the inner shell of the plasma vessel, so that it can be used for electricity generation. At an appropriately doped inner shell, tritium can be obtained from this process as a reaction product for the fusion process taking place in a chain reaction. After electrons and nuclei have separated from each other within the plasma, which is comparable to a high vacuum, the plasma ignites at a temperature of 100 million degrees Celsius and the ionized nuclei of deuterium and tritium fuse to form helium, releasing unimaginably large amounts of thermal energy. However, in order to generate energy on a power plant scale, a very large number of ions must fuse in a chain reaction without any further energy being supplied from the outside. Unfortunately, this results in undesirable convection currents within the plasma volume, so that the fusion temperature can only be maintained for a few seconds. A problem that occurs in fusion reactors of the tokamak type and also in the stellarator type concerns instabilities within the plasma volume, which are caused by different coil arrangements of the magnetic cage and become noticeable with irregularities in the layer structure and with sensitive disturbances in the layer structure of temperature and density of the plasma volume and convective, uncontrollable flows in the plasma volume, which limit the energy confinement time even before the fruits of nuclear fusion can be harvested as energy surpluses.

In order to maintain the chain reaction of nuclear fusion, an injection system is required with which new fuel is constantly injected into the plasma vessel to replace fuel that has already been used. Advantageously, the chain reaction stops by itself when the supply runs out, so that, unlike nuclear fission in a nuclear power plant, there is no danger from a fusion reactor.

Accidents such as explosions or meltdowns do not occur during fusion.

As early as 1915, Albert Einstein and the Dutch physicist Wander Johannes de Haas were able to show in an experiment that an iron rod enclosed by an electric coil experiences an angular momentum when an electric current is switched on. This so-called Einstein- de Haas effect is considered the first proof of electron spin. At the Karlsruhe Institute of Technology (KIT) and the Institut Néel of the CNRS Grenoble, this effect was demonstrated in 2016 using the example of a single molecule and reformulated as the "quantum Einstein-de Haas effect".

Stephen Hawking, in his book "A Brief History of Time", gives the following explanation for spin: "A particle with a spin of 0 is a point: it looks the same from all directions. A particle with a spin of 1, on the other hand, is like an arrow: it looks different from different directions. Only with a complete rotation (360 degrees) the particle looks the same again. A particle with a spin of 2 is like an arrow with a tip at each

end. It looks the same again after half a rotation (180 degrees). Correspondingly, particles with higher spin look the same again when you make rotations of smaller fractions of a complete revolution. Moreover, there are particles which do not look the same again after one revolution: Rather, two complete rotations are necessary for this! The spin of such particles is indicated with 1/2."A phase relation describes in physics and technology the interaction of oscillations which are shifted in their phase angles against each other in such a way that their period durations agree, but the times of their zero crossings do not.

The French physicist Jules Antoine Lissajous (1822-1880) is considered to be the discoverer of two-dimensional curves that result from the superposition of two harmonic oscillations of different frequencies at right angles to each other. In physics lessons at the Gottlieb Daimler Gymnasium in Stuttgart Bad Cannstatt, an oscilloscope was used as early as 1968 to explain alternating currents using the example of a Lissajous figure. "Project Matterhorn" was the code name for controllable thermonuclear processes begun by Lyman Spitzer at Princeton University during the Cold War. As early as 1951, Spitzer outlined the basic concept for the development of a stellarator, a device for confining and heating ionized hydrogen gas to release fusion energy for electricity generation. With support from the U.S. Atomic Energy Commission and Princeton University, Project Matterhorn was launched in 1951. Spitzer's fusion research was housed at Princeton's Forrestal Campus, where Princeton physicist John Wheeler was conducting nuclear weapons research. Spitzer's research was code-named "Matterhorn S" and Wheeler's "Matterhorn B." Project Matterhorn performed crucial research that contributed to the development of the hydrogen bomb. When nuclear weapons research ceased in 1958, the project was decommissioned and in 1961 became the Princeton Plasma Physics Laboratory, which still exists today.

References:

Nature Communications (DOI: 10.1038/ncomms11443).
- Stephen Hawking (ed.): A Brief History of Time (trans. from English by Hainer Kober), 23rd ed. Hamburg 2018,
- G. S. Goudsmit, G. E. Uhlenbeck: Spinning Electrons and the Structure of Spectra, in Nature. Vol. 117, 1926, pp. 264-265,
- Max Jammer: The Conceptual Development of Quantum Mechanics, McGraw-Hill, New York 1966, p. 150,
- Lyman Spitzer Jr: The Stellarator Concept, in:
Physics of Fluids, Jg. 1958, Volume 1, Issue 4, p.253-264,
- Marc Ganzhorn/ Svetlana Klyatskaya/ Mario Ruben/ Wolfgang Wernsdorfer: Quantum Einstein-de Haas effect, in: Nature Communications, Vol.7, Art.No.11443, 2016.
- Hartmut Zohm: Big bang, universe and life, published 5.3.23, YouTube link: https://www.youtube.com/watch?v=19bEPuPYPgo

Task

Based on the presented prior art, the invention faces the task to find a quantum mechanical device for a plasma guided in a plasma vessel on magnetic field lines, which enables the stationary operation of a fusion reactor substantially simplified in its construction, so that energy from nuclear fusion can be used as soon as possible as an unlimited energy source to counteract the worldwide threatening climate catastrophe. The specification of a scalable, modular and serially producible construction system, which enables the rapid construction of fusion power plants according to the invention at suitable locations worldwide, is also part of the task of the invention, as is a novel integration of the individual systems of the fusion reactor, which consists of a heating system for the plasma volume, a cooling system for the superconductivity of the coils, a hydraulic system for the transfer of heat to a useful system, a support system for the transfer of loads to a load-bearing foundation and an injection system for the injection of the fuel. The integration of these systems follows, on the one hand, the idea of spatial disentanglement and, on the other hand, the development of synergies between the individual different systems in the overall fusion reactor system. Finally, the task of the invention consists in the formulation of electromagnetic symmetry conditions to create high-frequency annular oscillations which, with a twofold change of the electron spin between two oscillation periods of the electrically charged particles within the plasma volume, periodically interrupt with each zero crossing the emergence of undesired irregularities of the magnetodynamic plasma flow and thus enable the permanent operation of the fusion reactor. These tasks are solved with the features of the main claim.

The invention relates to a quantum mechanical device for steady- state electromagnetic plasma confinement in a fusion reactor. The fusion reactor has a center point at the intersection of a space defined by longitudinal, transverse and vertical axes and is configured for stable electromagnetic confinement of a plasma volume in a plasma vessel surrounded by a plurality of Helmholtz coils. The plasma volume has a central magnetic field line spaced at a radius from the center and constructed of four equal arcs with four vertices and four connection points, which is surrounded by eccentric magnetic field lines in a plurality of concentric layers, the magnetic field lines each being formed as continuous loops. The plasma vessel is connected to a cooling system, a heating system, a hydraulic system, a support system and an injection system. In the fusion reactor according to the invention, the Helmholtz coils are forcing annular oscillations of the plasma volume with two periods by causing the electron spin to change twice at at least one zero line of the annular oscillations by means of a quantum-mechanically effective chiasm of the magnetic field lines, which are each designed as endless loops, so that equal path lengths for the ions in both halves of the endless loops formed by the magnetic field lines result in harmonic annular oscillations and the stable confinement of the plasma volume in the plasma vessel enables the stationary operation of the fusion reactor, wherein the ionized nuclei of deuterium and tritium in the plasma volume are guided exactly on the magnetic field lines and collide with each other at a velocity of more than 1000 km/s and at temperatures of 100 to 200 million degrees Celsius and fuse to helium in a chain reaction with release of large amounts of thermal energy.

Further advantageous embodiments and tasks of the invention are apparent from the subclaims.

More specifically, the following symmetry conditions are realized on a fusion reactor having the following tasks:

Specification of a quantum mechanical device for a complete revolution of the ionized nuclei of deuterium and tritium, with a nuclear spin number of 0.5, within one annular oscillation, with two periods,

Specification of a continuous loop for the central magnetic field line of the plasma volume of a fusion reactor, in which at least four connection points of four identical arcs of the continuous loop have an equal radius around the center of the fusion reactor,

- indication of a central magnetic field line of the plasma volume which is distant from the center of the fusion reactor in the case of four circular arcs having a constant radius,
- indication of a plasma vessel which can be inscribed, including an array of Helmholtz coils, in the shell volume of a virtual hollow sphere,
- Specification of a magnetic field geometry formed by harmonic annular oscillations,

- specification of a zero line, for all ring annular oscillations with two periods, which is identical with the time axis,
- indication of a plurality of identical vessel modules for the plasma volume, which can be connected to each other by means of screw connections,
- specification of a plasma vessel composed of four identical modules arranged on a radius around the center of the fusion reactor,
- Specification of a three-dimensional infinite loop which satisfies the symmetry conditions of a two-dimensional Lissajous figure for the magnetic field lines of the plasma volume,
- Specification of a finned heat transfer helix with an upper outlet for the forward flow of a two-phase heat transfer fluid to a heat sink and with a lower inlet for the return flow of the heat transfer fluid to the heat source formed by the heat transfer helix in a circulation system,
- Specification of a quantum mechanical device for a steady-state electromagnetic confinement of a plasma volume by means of a ring annular oscillation with two periods,
- Specification of a ring oscillation for ions on magnetic field lines, which are arranged mirror-symmetrically opposite to each other at the at least one zero line between two periods of the ring oscillation causing, by means of the quantum mechanically effective chiasm, equal path lengths for the ions on the magnetic field lines,
- Indication of a twofold change of the electron spin for the ionized nuclei of deuterium and tritium in the plasma volume,
- Specification of harmonic annular oscillations in the individual layers of the plasma volume built up concentrically around the central magnetic field line,
-Indication of two alternative positions of the zero line as a joint between the two periods of annular oscillations,
- Indication of a reset effect of the ionized particles guided in the plasma volume, in each case at four zero crossings of the annular oscillations,
- Indication of a phase shift of the zero crossings of the two periods of the annular oscillations, each by half a period length,
- Specification of a stable path formed by sine and cosine annular oscillations of the magnetic field lines for electrically charged particles of the plasma volume,
- Use of a nuclear spin number of 0.5 for the formation of a helical and an elongational magnetic field component with two
changes of the electron spin within two periods of the annular oscillations,
- Specification of a self-supporting construction from the individual subsystems of the fusion reactor.

The anatomy of the annular oscillations

In the fusion reactor according to the invention, the nuclei of the heavy isotopes of hydrogen deuterium and tritium are guided exactly on the magnetic field lines and collide with each other at velocities of more than 1000 km/s and at temperatures of 100 to 200 million degrees Celsius to fuse into helium, releasing large amounts of thermal energy. The central magnetic field line of the plasma volume is composed of four equal arcs each, which either have four equal circular arcs with four vertices and are connected to each other at four connecting points or consist of four equal parabolic arcs and only the four connecting points of the parabolic arcs with the radius of the central magnetic field line are spaced from the center, while the four vertices are spaced from the center with a larger radius and the at least one zero line defines radial planes of the plasma volume both at the circular arcs and at the parabolic arcs, at which eccentric magnetic field lines form a stable path for the ions as sine and cosine ring annular oscillations and respectively change from the outside to the inside of the plasma volume and vice versa, wherein at the radial planes of the plasma volume defined by the vertices the magnetic field lines reach a maximum elongation of the ring annular oscillation and reverse. The plasma volume is divided into two periods at at least one zero line of the ring annular oscillations, the zero line forming a joint between the two periods of the ring annular oscillations either at a first diameter between opposing the first and the third connection points of the central magnetic field line or at a second diameter between the second and the fourth connection points of the central magnetic field line. The ring annular oscillations are characterized in each of the individual layers of the plasma

Unpolarized light: Poincaré Sphere Engineering - From Natural Light Via Quantum Optics to Applications

Prof. Dr. Wolfgang Elsäßer
Institute of Applied Physics, Technische Universität Darmstadt (Germany) and School of Physics, Trinity College Dublin, Dublin 2 (Ireland) and Istituto di elettronica e di ingegneria dell'informazione e delle telecomunicazioni del Consiglio Nazionale delle Ricerche (IEIIT-CNR) 10129 Torino (Italy)

Abstract
We start by having a look into nature and motivate the concept of unpolarized light. We then discuss polarization in terms of Stokes vector, Stokes parameters and the Poincaré sphere. The categorization into temporally and spatially unpolarized light is the basis for the further investigations.For temporally unpolarized light we investigate the Stokes vector correlations which allow a classification of unpolarized light in terms of the invariances of the Stokes parameters.We demonstrate that light emitted by an erbium-doped fibre amplifier represents type-I unpolarized light. Spatially unpolarized lightis then generated by exploiting the birefringent properties of a Cornu Depolarizer. The investigations of the spatially resolved Stokes parametersdemonstrate that this type oflight consists of a spatial superposition of the manifold of all purely linearly polarized states encompassing completely the equator of the Poincaré sphere, thus so-called equator states.Finally, the accompanying invariance under the influence of a half-wave plate suggests that this is type II unpolarized light. The idea of full Poincaré sphere engineering by generating on-demand meridian and great-circle polarization states is realized by successive waveplate applications. Finally, we show that this concept of unpolarized light allows realizing a secure communication scheme, Ghost Polarization Communication. These investigations demonstrate that Polarization is even more than 170 years after Sir Gabriel Stokes a fascinating topic.

Biography:
Wolfgang Elsäßer was born in Pforzheim, Germany. He received the diploma degree in Physics from the Technical University of Karlsruhe in 1980, the Ph.D. degree in Physics from the University in Stuttgart in 1984, and a Habilitation degree in Experimental Physics from the Philipps-University Marburg in 1991. From 1981 to 1985, he was with the Max-Planck-Institute for Solid State Research Stuttgart. From 1985 to 1995, he was with the Philipps-University Marburg. Since 1995, he is Full Professor in the Institute of Applied Physics,

Darmstadt University of Technology, Germany working in the field of Semiconductor Optics. In 2022 he hasbeennominatedasAdjunct Professor in the School of Physics of Trinity College Dublin, Ireland and in April 2022as Associato all' Istituto di elettronica e di ingegneria dell'informazione e delle telecomunicazioni del Consiglio Nazionale delle Ricerche (IEIIT-CNR) in Torino, Italy. He is a member of the German Physical Society (DPG), Member of the European Physical Society and actually elected member of the council of the EPS and a Senior Member of IEEE. He was awarded with the Otto-Hahn-Medal (1985), the Werner-von-Siemens-Medal (1985), the Rudolf-Kaiser Prize (1991) and the IEE J.J. Thomson Premium (1995). His research interests can be best described by "Photonics and Quantum Optics of Semiconductor Emitters".

Squeezing-Enhanced Raman Spectroscopy

Avi Pe'er, Yoad Michael, Yitzhak Jonas, Leon Bello, Yasmin Shahar, Michael Rosenbluh

Department of Physics and QUEST center for quantum technology, Bar-Ilan University, Ramat Gan 5290002, Israel

Abstract

Raman Spectroscopy is a powerful tool for the identification of molecular species. Yet, Raman spectroscopy has one major drawback - the relative weakness of the Raman response, which results in a signal that is often obscured by other light-matter interactions. The sensitivity of all Raman spectroscopy schemes to date, such as Coherent Anti-Stokes Raman Spectroscopy (CARS) or Stimulated Raman Spectroscopy (SRS), is inherently limited by shot-noise. We present a squeezing-enhanced Raman spectroscopy scheme that employs quantum two-mode squeezed light to achieve sub-shot-noise sensitivity, along with enhancement of the Raman gain, and inherent background suppression. Our setup deploys two crossed optical parametric amplifiers (OPA), with a Raman sample in-between, which forms a quantum nonlinear SU1,1 interferometer – a major platform for quantum sensing, which I will discuss in detail.

Biography:

Prof. Avi Peer is an expert in quantum optics and laser physics. My research aim is to harness the optical bandwidth resource for optical science and technology on the quantum and classical level, using broadband, highly multimode, correlated light. At the quantum level I explore ultra-broadband squeezed light and time-energy entangled photons for applications of ultrafast quantum communication and squeezing-enhanced sensing. With classical optics I explore the coherent dynamics of mode-locked pulsed lasers and coupled parametric oscillators towards new sources of frequency-combs and for precision ultrafast measurement. Avi Peer is a faculty member of the Physics department and BINA center for nanotechnology In Bar Ilan University Since 2008. He received his PhD from the Weizmann Institute (2005) in physics and completed post-doctoral research at JILA, University of Colorado.

An Integrable Optical Imaging Approach to Overcome Kit-Specificity in Lateral Flow Diagnostics

Ilgim Efeturk[1,*], Ege Gokce Savas[2], Ekrem Tinaz[3], Hakan Bozkurt[1], Hulya Ayar Kayali[2,3,4], Canan Varlikli[1,5]

[1]*Department of Photonics, İzmir Institute of Technology, Urla, 35430 İzmir, Turkiye*

[2]*İzmir International Biomedicine and Genome Institute, Dokuz Eylul University, 35340 İzmir, Turkiye*

[3]*Izmir Biomedicine and Genome Center, 35430 İzmir, Turkiye*

[4]*Department of Chemistry, Division of Biochemistry, Faculty of Science, Dokuz Eylul University, 35160 İzmir, Turkiye*

[5]*Department of Photonics Science and Engineering, The Graduate School, İzmir Institute of Technology, Urla, 35430 İzmir, Turkiye*

Abstract

The Lateral Flow Immunoassay (LFIA) stands out as a highly successful paper-based platform[1] for on-site chemical target detection. Alongside other point-of-need diagnostics, LFIA marks a shift from sample-to-lab to lab-to-sample, enhancing decision-making speed. In clinical diagnostics, traits of LFIAs make it attractive, expediting patient care through swift diagnosis and treatment choices. The appeal stems from its speed, simplicity, cost-effectiveness, and suitability for non-experts[2]. But in contrast to more complex laboratory assays, lateral flow tests are designed to identify specific biomolecules, such as antigens or antibodies, making a one-size-fits-all imaging solution impractical.The distinctive approach of LFIAs, which are customized for specific biomolecular targeting, offers a challenge in implementing a globally integrated optical imaging system. This is especially important given the propensity of kits to use self-branding approaches. However, this approach may result in financial limits, restricting access for both medical professionals and patients. To address this, an innovative field of study focuses on breaking free from the kit-specific concept and developing a universal optical imaging platform. A system like this, which can be integrated with multiple biomolecule-specific detection techniques, has the potential to strengthen advanced diagnostics. This change in approach could improve the practicality and economic significance of lateral flow studies by overcoming the restrictions of brand-bound imaging equipment, providing rapid findings without sacrificing accuracy.In this context, the observed samples of this study were classified

into 2 categories: (1) aqueous forms of 1:1, 1:2, 1:10, and 1:100 dilutions of CdTe QD with a stock concentration of 3.5 mg/ml diluted with borate buffer at pH 7.5, and (2) dry forms embedded in conjugate pads with a volume of 4 µl at the identical dilutions.Comparative photoluminescence analysis was performed using a 405 nm light source, sample holder, 490 nm LP dichroic mirror, and photodetector, and it was determined that the glass fiber medium reduced the emission signal by 21.3 times. Aggregation-induced emission appears as the QD concentration of the studied sample increases, which can play a vital role in identifying the level of illness in the body with redshift spectra and offer ways to understand QD behavior. Despite the restrictions of XRD and spectrofluorometry analysis due to very small sample sizes, the established system offers promising results. This technology, which is simple to use, affordable, and can be included in any LFIAs on the market in the future, has enormous potential in rapid and emergency diagnoses as well as R&D investigations.

Keywords:
Lateral Flow Immunoassay; Integrable Optical Imaging; Quantum Dot Fluorescence; Next-Generation Diagnostics

References:
[1] Wei-Huai Chiu, Wei-Yi Kong, Yuan-Hui Chueh, Jyun-Wei Wen, Ciao-Ming Tsai, Chitsung Hong, Pang-Yen Chen, Cheng-Hao Ko, Using an ultra-compact optical system to improve lateral flow immunoassay results quantitatively, Heliyon, Volume 8, Issue 12, 2022, e12116, ISSN 2405-8440, https://doi.org/10.1016/j.heliyon.2022.e12116.
[2] Di Nardo F, Chiarello M, Cavalera S, Baggiani C, Anfossi L. Ten Years of Lateral Flow Immunoassay Technique Applications: Trends, Challenges and Future Perspectives. Sensors. 2021; 21(15):5185. https://doi.org/10.3390/s21155185

Biography:
Ilgim Efeturk is one of the first full students of Turkey's first Department of Photonics which was founded in 2015 and serves undergraduate education since in 2019. She is one of the few founding members of the IZTECH Optics and Photonics Society (IZTECH-OPS). In addition to being Representative of IZTECH Department of Photonics and Representative of IZTECH Faculty of Science, she is the first female President of the Student Council in the history of her university, which was founded in 1992 and has 6500+ students. In addition to these, she is the Founder and President of IZTECH Quality Community, which was established in December, 2022, in order to disseminate the quality culture in higher education and R&D fields.

She was awarded as one of the 20 Women Scholars to be supported financially and academically in 2022, selected worldwide by Optica (formerly OSA). She became the first Turkish student to be selected for this scholarship supported by major companies such as Google, Intel and Meta to empower the next generation of women leaders in optics and photonics. In addition, she is one of the 53 female students and is the first & only photonics student supported academically under the WE-inTech Program which was officially launched by Arçelik Global in Turkiye, Arctic in Romania, Defy Appliances in South Africa and Dawlance in Pakistan, and made available for the first time on a global scale to support women in new-generation research and development fields.

Ilgim successfully completed her internship within the scope of the Eastern Anatolia Observatory in Erzurum, which hosts Turkiye's largest and first NIR telescope with a diameter of 4 meters and she worked on the AO+RC+aO+DR optical performance of the DAG Telescope, especially on astrooptics which includes the adaptive optics & derotator system. She currently conducts various studies on optics, entrepreneurship, and leadership.

Plasmon-Assisted Hot Electron Generation in GoldCoated Inverted Silicon Pyramid Arrays

Dr. Luis Alberto Pérez
Institut de Ciencia de Materials de Barcelona, Spain

Abstract

The current climate emergency presents us with the dilemma of seeking ingenious solutions to deeply rooted problems in society. In the energy landscape, the production of clean energy is one of the cornerstones for changing the matrix based on the burning of fossil fuels and, consequently, reducing greenhouse gas emissions into the atmosphere.

Gold nanostructures are known for their ability to excite surface Plasmon's, which are collective oscillations of electrons on the metal surface. When this Plasmon's decay the stored energy can be internally transferred, generating highly energetic carriers: "hot electrons".Hot electrons are high-energy electrons that can play a crucial role in various applications, from photo catalysis to light detection. The interface between Gold layers deposited onto arrays of inverted silicon pyramids, creates an environment conducive to the hot electrons transfer and current generation.

This study seeks to understand in detail how the Plasmon's generated in the gold nanostructures interact with the silicon pyramid structures to efficiently produce hot electrons above the silicon bandgap. In this sense making use of photons in the spectral region in which silicon is transparent. The findings from this research could have significant implications for the development of more efficient plasmonic and nanophotonic devices and the improvement of solar energy conversion.

Biography:

Luis Alberto Pérez obtained his PhD in Chemistry at INFIQC-National University of Córdoba, Argentina (2015). Following a postdoctoral stage in Argentina, where he focused on graphene and graphene-derived 2D materials, he relocated to ICMAB (Barcelona, Spain) in 2018, shifting his research focus to the study thermal transportat the nanoscale.In 2019, he was awarded a Marie Curie fellowship to develop plasmonic devices for the hot electrons generation. His research interests focus on light-matter interaction, nanostructures synthesis and electrodynamic simulations.He is currently working on the fabrication of chiral metasurfaces, the ordered assembly of colloidal nanoparticles, and the study of CO_2 photocatalytic reduction driven by hot electrons.

2 µmGaSb-Based Semiconductor Laser Sources and its Integration with Si Photonics

C.Y. Liu1*, X. Li[2*],J. X. BRIANSIA[2], J. W. Wang[2], X. Guo[2], W. J. Wang[2]Z. L. Qiao[2], and H.Wang[1,2]
[1] *Temasek Laboratories, Nanyang Technological University, 637553, Singapore*
[2] *School of Electrical and Electronic Engineering, Nanyang Technological University, 639798, Singapore*

Abstract

The 2 µm wavelength band is attracting increased attention due to its potential in a wide variety of applications in medicine, sensing, and communication [1,2]. To realize these applications, highperformance and reliable laser sources are essential. In this presentation, we will summarize our recent work on 2 µmGaSb-based laser sources, which includes the following:
1. Monolithic single-section GaSblasers. The fabricated lasers can work in continuous wave (CW) mode up to at least 80 °C. The lowest threshold current density reaches ~96 A/cm2, which suggests very good material quality.
2. Monolithic two-section mode-locked lasers (MLLs). By reversely biasing a section of the lasers, the saturable absorber can be formed to achieve passive mode locking. In addition to the mode locking characterization, modal gain and high temperature characteristics, as well as different working regimes of the MLLs were also investigated.
3. Mode-locked lasers integrated with silicon photonic chips with feedback loop. The phase noise of passively mode-locked lasers is normally high, in a chip-scale form factor. To solve this issue, a feedback loop is normally adopted [3].We designed a mode-locked laser integrated with silicon photonic chips with controllable feedback loop. With this scheme, significant phase noise reduction was realized for GaSb-based passively mode-locked semiconductor lasers.
4. Hybrid III-V/silicon tunable external cavity lasers. We developed a hybrid III-V/silicon external cavity tunable laser. A semiconductor optical amplifier (SOA) was used for light amplification, while the silicon double-ring vernier filter acts as the wavelength selective component. A tuning range of >66 nm with an output power of >28 mWwere achieved, which are the highest values for a 2 µm laser of this type.

Keywords:
Quantum Well Lasers, Silicon Photonics, Mode-Locked Laser, Hybrid Integration

References:

[1] J. X. B. Sia, X. Li, W. Wang, Z. Qiao, X. Guo, J. Zhou, C. G. Littlejohns, C. Liu, G. T. Reed, and H. Wang, "Sub-kHz linewidth, hybrid III-V/silicon wavelength-tunable laser diode operating at the application-rich 1647-1690 nm," Opt. Express 28, 25215-25224 (2020).

[2] X. Li, J. X. B. Sia, W. Wang, Z. Qiao, X. Guo, G. I. Ng, Y. Zhang, Z. Niu, C. Tong, H. Wang, and C. Liu, "Phase noise reduction of a 2 μm passively mode-locked laser through hybrid III-V/silicon integration," Optica 8, 855–860, (2021).

[3] D. Arsenijević, M. Kleinert, and D. Bimberg, "Phase noise and jitter reduction by optical feedback on passively mode-locked quantum dot lasers," Appl. Phys. Lett. 103, 231101 (2013).

Biography:

CHONGYANG LIU received the Ph.D. degree in semiconductor photonics in 2004 from Nanyang Technological University (NTU), Singapore. From October 2009 to January 2012, he was awarded a Humboldt Fellowship (for experienced researcher) from Alexander von Humboldt Foundation for doing research in the Technische Universität Berlin, Germany in Prof. Dieter Bimberg's group. He is currently a Principal Investigator with Temasek Laboratories, NTU, Singapore. His research interests include design, fabrication, and characterization of high power quantum well lasers, ultrafast quantum dot lasers, microwave photonics as well as their integration with Si photonics. He has authored and co-authored more than 120 technical articles in these fields so far.

Active Devices by MOCVD for Si-photonic integrated circuits

Kei May Lau
Hong Kong University of Science and Technology, Hong Kong

Abstract

Si photonics has been developed to enable the next generation tele- and data-communications systems, taking advantage of the mature silicon CMOS technologies. It is also fueling various applications such as imaging, sensing, spectroscopy, quantum science and optical metrology. To efficiently couple light between active and passive components for Si photonic integrated circuits, we developed a novel lateral aspect ratio trapping (LART) technique to grow lasers and high-speed photodetectors on patterned commercial SOI substrates for integrated Si photonics. Multimode and single-mode lasing from lateral quantum wells (QWs) as the gain media using LART have been achieved in the 1433 -1630 nm band with varying dimensions of lasers. High-performance PDs coupled to Si tapers were also constructed on the monolithic InP/SOI platform with laterally grown p-i-n structures and show open eye diagram exceeding 100 Gb/s. The talk will introduce a platform for Si photonic integrated circuits by selective area epitaxy using metalorganic chemical vapor deposition.

Biography:

Kei May Lau is a Research Professor at the Hong Kong University of Science & Technology (HKUST). She received her degrees from the University of Minnesota and Rice University and served as a faculty member at the University of Massachusetts/Amherst before joining HKUST in 2000. Lau is a Fellow of the IEEE, Optica (formerly OSA), and the Hong Kong Academy of Engineering Sciences. She is also a recipient of the IPRM award, IET J J Thomson medal for Electronics, Optica Nick Holonyak Jr. Award, IEEE Photonics Society Aron Kressel Award, US National Science Foundation (NSF) Faculty Awards for Women (FAW) Scientists and Engineers, and Hong Kong Croucher Senior Research Fellowship. She was an Editor of the IEEE Transactions on Electron Devices and Electron Device Letters, an Associate Editor for the Journal of Crystal Growth and Applied Physics Letters. Lau's research work is focused on the development of monolithic integration of semiconductor devices and systems on industry-standard silicon substrates.

Laser Performance and Design for Low Noise Trapped-Ion Quantum Computing

Matthew Bohn
Fellow at Quantinuum, USA

Abstract
Quantinuum has developed the world's most powerful quantum computer as measured by the industry standard benchmarking Quantum Volume (QV). Quantinuum uses trapped ion technology employing lasers for state-prep, cooling, ionization, repumping, single-qubit gates, two-qubit gates and measurement. Unique to Quantinuum is our QCCD architecture that enables all to all connectivity between any two qubits in the trap. I will present an overview of the lasers and optical systemsinvolved in our trapped ion quantum computer, focusing on the two qubit gate laser, its design and construction, and recent upgrades to mitigate phase noise in the laser system. Quantinuum currently uses Yb171+ as the qubit ion and Ba137+ as the sympathetic cooling ion. The primary S-P dipole transition used in Yb171+ occurs at 369.5 nm, which is a challenging wavelength for lasers and optics. We use a Mølmer–Sørensen gate that couples the S-P transition via a two photon Raman process at 366 nm. The gate laser is a custom patented system leveraging Toptica tapered amplifiers and second-harmonic cavities as building blocks. I will present data on the laser phase noise, the enhancement of the phase lock, two qubit fidelity and quantum volume measurements.

Biography:
Dr. Matthew Bohn was completed his PhD from the University of New Mexico in 1998 studying under Prof. Jean-Claude Diels. Numerous papers on short pulsed ring laser gyroscopes and terahertz spectroscopy including an invited book chapter. Numerous patents in the last 6 years related to quantum computing.

Upcoming Event

3rd International Conference and Expo on

Lasers, Optics & Photonics

October 21-23, 2024 | Edinburgh, UK