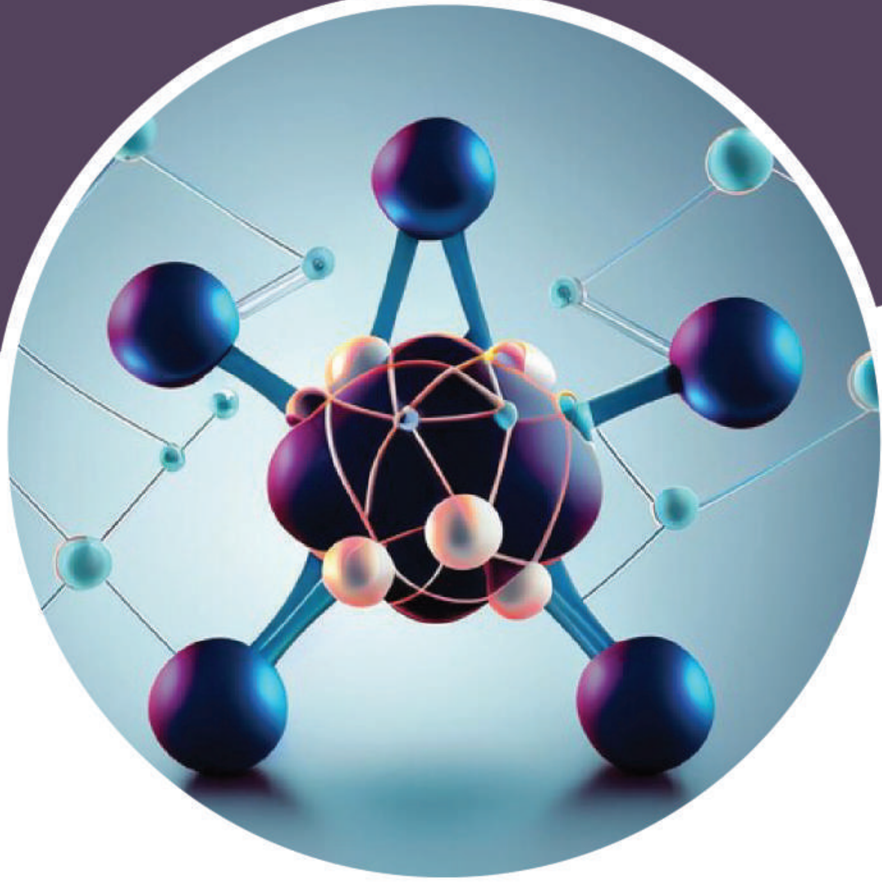
Spectrum Conferences & Expos

Abstract Book

ISLOP2024 & ISG2DM2024



2nd International Summit on

Lasers, Optics and Photonics

&

2nd International Summit on

Graphene & 2D Materials

April 22-23, 2024 | Munich, Germany

FOREWORD

Dear Colleagues,

It is our pleasure to extend a warm invitation to all scientists, academicians, young researchers, business delegates, and students from around the globe to participate in the 2nd International Summit on Lasers, Optics and Photonics (ISLOP2024) and the 2nd International Summit on Graphene & 2D Materials (ISG2DM2024), scheduled to take place in Munich, Germany from April 22-23, 2024.

ISLOP2024 & ISG2DM2024 will provide a platform to explore recent research and cutting-edge technologies, attracting a diverse and enthusiastic audience of young and talented researchers, business delegates, and student communities.

The primary objective of ISLOP2024 & ISG2DM2024 is to bring together, a multidisciplinary gathering of scientists and engineers from across the globe to share and exchange groundbreaking ideas in the fields of Lasers, Optics and Photonics, as well as Graphene and 2D Materials. The summit aims to foster high-quality research and international collaboration, facilitating discussions and presentations that are globally competitive and highlighting recent notable achievements in these fields.

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, Graphene and 2D Materials.

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AI Based Visual Inspection System For Mass Production

Julius Lawson Daku
optoPartner, 79 av. Aristide Briand, Arcueil, France

Abstract:

For over 20 years, optoPartner has been integrating intelligence and profitability into industrial instruments and equipment, especially in optics and photonics. Our customers range from major corporations to start-ups. A few years ago, a consortium led by optoPartner was selected by the European Union to address the societal and economic issue of avoidable production losses in mass production industries, especially in the agri-food industries. This gave rise to Spotteur®, an AI based visual inspection system perfectly suited to mass production.
This talk will present the specific features of mass production that make it beyond the reach of the plethora of standard visual inspection systems. We will also see why artificial intelligence is a necessity and not just a buzzword. We will also look at the challenges involved in industrializing such a visual inspection system.
To sum up: preventing waste is the best way to recycle!

Keywords: AI, Artificial Intelligence, Visual Inspection, Mass Production.

Biography:

Dr. Julius LAWSON DAKU completed his PhD in quantum mechanics and atom interferometry with highest honour in 1997. He then switched to the industry where he designed and developed innovative algorithms and approaches for instrumentation and physical simulation. Then he founded optoPartner, a company dedicated to bringing complex instruments, especially photonics ones, to the state of the art regarding their embedded intelligence and their integration into their environment. He is also vice-president of the Optics and Photonics Hub of Systematic, the French cluster dedicated to the deep tech ecosystem.

Advancements of Shape Tolerance in Large ZERODUR® Optics Production

Christian Reis[1], Peter Hohmann[1,*]
Development and Application Processing Mainz, SCHOTT Advanced Optics, Hattenbergstrasse 10, 55232 Mainz, Germany

Abstract:

When precision matters, ZERODUR® is the material of choice for many different optical applications. Due to its near zero coefficient of thermal expansion (CTE) ZERODUR® remains stable in harsh environments like applications in space or temperature sensitive applications as in Lithography. Therefore, it is a favourable mirror substrate material with low requirements for thermal management in the optical system. Today, many applications aim for more light to be collected and therefore numerical aperture must increase. Beside the possibility to produce large optical systems by a combination of smaller optical elements, this very often results in larger ZERODUR® parts. Despite the size of the mirror substrate, narrow tolerances still must be met to allow for high optical quality with low aberrations.

Since ZERODUR® is a glass ceramic it belongs to the group of hard and brittle materials. The main processing technologies for bringing ZERODUR® mirror substrates in shape are grinding and lapping. Since cost is a driving factor for almost every application, the main goal is to bring the mirror substrate as close as possible to the final geometry with faster processing steps of grinding instead of slower and more precise shaping technologies like lapping. Recently, we could show, that thorough data analytics and process understanding for CNC shaping of ZERODUR® results in a factor 3 better shape tolerance than with our standard processing parameters. To achieve this, two main points had to be investigated. Temperature influence on shape tolerance and precision of on-machine tactile measurement to allow for shape correction without unmounting and mounting of the part. A ZERODUR® mirror substrate was processed using a D64 grinding wheel on a rotating table. By thorough analysis of temperature data and adaption of processing protocols according to different temperature states of the machine, we could find an optimal parameter set for processing. With these, we were able to produce a 1.6 m diameter spherical ZERODUR® mirror substrate with below 15 µm hull curve tolerance within reasonable time and therefore cost. The remaining shape error was uniformly

distributed over the full surface and could not be linked to a specific parameter yet. Further analysis is ongoing to aim for 5 µm hull curve tolerance, which saves a lot of time in subsequent lapping processes to come to a final high precision shape in the future.

Keywords: Grinding, Data Analytics, ZERODUR®.

Biography:

Christian Reis was born in 1981 in Germany. He started his studies of Biochemical Engineering at the University of Stuttgart in 2002 with a scholarship from the 'Foundation of German Economy'. During his studies, he got international research experience at Harvard Medical School in Boston from 2006 to 2007. After receiving his diploma, Christian started his professional career in 2008 at Fraunhofer, the leading society for applied research. There he worked as a development and test engineer at the Institute for Manufacturing Engineering and Application. Since then, Christian was interested in usage of data to drive process developments and worked very close with production teams in different companies. While working at Fraunhofer, he received his Ph.D. in mechanical engineering from the University of Stuttgart in 2017.

Photonics in the Scope of Identity Access Management in Heterogenous IT Infrastructures

Xenia Bogomolec
CEO & Founder-Quant-X Security & Coding GmbH, Germany

Abstract:

Entropy plays an essential role in securing interconnectivity of devices, digital applications and users. I am presenting Quant-ID, a technology transfer project by Quant-X, the Fraunhofer IPMS, the University of Regensburg and MTG AG, for the integration of entropy based on photonics to globally used identity access management protocols.

Biography:

Xenia Bogomolec is an Information Security Manager with a background in Mathematics and IT. In the past years, she was mostly responsible for the coordination and QA of information security standards in highly regulated organizations. Since 2022, she also steers Quant-ID (https://Quant-id.de), a consortium project for the implementation of digital identities that are resistant to Quantum attacks which is funded by the German Government.

Advancing Precise Control of Electromagnetic Radiation: An Innovative Nanophotonic Structures for Mid-Infrared

Sara Sharif[1]*, Mike Banad[1]
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Abstract:

The precise control of electromagnetic radiation in the mid-infrared range is crucial for various modern applications, including quantum optical computing, optical neuromorphic computing, environmental monitoring, thermal emission, spectroscopy, and solar energy harvesting. However, the behavior of electromagnetic waves and materials in this range often exhibits complex, non-linear effects, making accurate predictions challenging through trial-and-error methods. Designing nanophotonic structures for these purposes can be highly intricate, with numerous parameters to consider, and subtle interactions between different layers and materials can significantly affect performance.

To overcome these challenges, our research employs rigorous electromagnetic simulations, specifically utilizing the finite-difference time-domain (FDTD) method in conjunction with an optimization algorithm. We advocate for the adoption of a state-of-the-art genetic algorithm with inverse design principles to reverse-engineer structures that meet specific objectives. These objectives primarily include achieving maximum absorption at the desired wavelength with high precision, minimal loss, and minimal structure size. Our approach incorporates advanced materials, particularly focusing on two-dimensional materials and organic materials, to enable precise control of the minimum layer thickness necessary for targeted absorption control within the specified wavelength range.

In our optimization efforts, we fine-tune different structures to achieve absorption peaks within the 3-5 µm range, with adjustments made in increments of 0.25 µm to accommodate various applications. One of the optimized structures, illustrated in Figure 1, features multilayer

configurations consisting of graphene as active layers and hBN as passive insulator layers, sandwiched between Ws2 layers. Each layer's thickness has been carefully optimized to ensure a total thickness of less than 1 µm. This optimized structure demonstrates maximum total absorption at 3.34 µm when the chemical potential in graphene layers is zero, while nearly no absorption occurs when the chemical potential equals one.

Our research findings reveal that the proposed optimized aperiodic structures of graphene/hBN layers are both thin (less than 1 µm) and lightweight. Importantly, these structures provide precise control over the intensity, tunability, and switchability of mid-infrared radiation and heat dissipation. One notable potential application for such a structure is on the surface of satellites. The key feature of this proposed structure lies in its ability to dynamically manipulate the target electromagnetic spectrum to safeguard vulnerable circuits and devices. Specifically, it can protect electronic devices from overheating or overcooling caused by extreme environmental conditions. For example, when the satellite faces the sun, the structure can dissipate generated heat and reflect solar radiation to prevent overheating. Conversely, when the satellite is not facing the sun, it can be electrically tuned to retain generated heat and absorb radiated heat from the sun, preventing electronics from freezing.

In summary, the precise manipulation of mid-infrared electromagnetic radiation has far-reaching implications across various contemporary applications. Our research showcases innovative approaches, leveraging advanced materials and optimization techniques, to achieve maximum control over electromagnetic radiation in this range. This work not only holds promise for enhanced performance in quantum and optical applications but also offers practical solutions for thermal management in challenging environmental conditions, such as those experienced by satellites.

Keywords: Electromagnetic Radiation Control, Nanophotonic Structures, Inverse Design, Genetic Algorithm.

Biography:

Dr. Sarah Sharif is an assistant professor in the School of Electrical and Computer Engineering at the University of Oklahoma. Before OU, she was a postdoctoral research associate at the University of Illinois Urbana-Champaign. Her Ph.D. research developed Stochastic Optimization and Machine Learning Techniques for Photonic Nanostructures and Quantum Optical Systems. She has a Ph.D. in Electrical Engineering with a minor in Physics, two M.Sc. in Natural Science (Physics) and Electrical Engineering, and a graduate certificate in Material Science. Dr. Sharif has over 10 years of industrial experience as a research and development engineer. She was also an active member of the LIGO group from 2018 to 2020. Dr. Sharif is a director of the Quantum Nanophotonics Engineering Technology & System (QNETS) group, where they are actively working on the next generation of optical and quantum optical devices and systems at the University of Oklahoma.

Design, Simulation and Applications of 3D-Printed Micro-Optics

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Institute of Applied Optics (ITO) and Research CenterSCoPE, University of Stuttgart, Stuttgart, Germany

Abstract:

Femtosecond direct laser writing as a 3D-printing technology has transformed the field of micro-optics. Over the last decade, complexity and surface quality of printed optical components have ever increased from simple micro-lenses to multi-elementsystems [1], printed spectrometers [2] and OCT-probes [3]. This rapid development reflects the large potentialand application range of 3D-printing technology. Especially medical applications, like OCT, fluorescence or endoscopy require small scale optical systems with high fidelity. But similar,industrial metrology or imaging applications can profit from the many degrees of freedom and miniaturization potential of this technology.

However, the almost unlimited design freedom regarding surface shape, microstructures, apertures and geometryhas to be controlled during the optical design processunder limiting manufacturing and material constraints. Due to the small size of only 10-1000 micron, moreover diffraction effects need to be considered by appropriate wave-optical simulations.

This paper highlights relevant aspects in the design and simulation of 3d-printed systems. It presents multipledesign examples, ranging across micro-optical imaging-, illumination- and sensing-systems for various applications.

References:

[1] Thiele, S., Arzenbacher, K., Gissibl, T., Giessen, H., & Herkommer, A. M. „3D-printed eagle eye: Compound microlens system for foveated imaging" Science advances3(2) (2017), e1602655.

[2] Toulouse, A., Drozella, J., Thiele, S., Giessen, H., & Herkommer, A. "3D-printed miniature spectrometer for the visible range with a 100× 100 µm2 footprint." Light: Advanced Manufacturing 2(1) (2021), 20-30.

[3] Li, J., Thiele, S., Quirk, B. C., Kirk, R. W., Verjans, J. W., Akers, E., ... & McLaughlin, R. A. “Ultrathin monolithic 3D printed optical coherence tomography endoscopy for preclinical and clinical use”
Light: Science & Applications, 9(1) (2020), 1-10.

Biography:

Alois Herkommer received his PhD in physics in 1995 from the University of Ulm in the area of quantum optics. In 1996 he joined Carl Zeiss in Oberkochen and worked on the optical design of high performance lithographic and metrology systems. From 2000 to 2005 he was with the optical design group at Carl Zeiss Laser Optics GmbH. Afterwards he headed the illumination design group and later the systems design group at the Carl Zeiss SMT GmbH. In 2011he joined the Institut fÃ¼r Technische Optik at the University of Stuttgart.

Impacts of Mutual Phase Interactions on Crystal Polarity and Photocatalytic Hydrogen Production

Jrjeng Ruan
National Cheng Kung University, Taiwan.

Abstract:

Various secondary molecular interactions subject to molecular polarity have been well known as essential factors behind theorganization behaviors and electrooptical responses of dispersed molecules.Considering dispersed phase domains of organic and inorganic components,including amorphous and crystalline phases, the phase polarity has not been recognized able to initiate mutual polarization/interactions.In our research, theantiparallel interactions of crystal dipoles have been studied as the responsible background to guide crystal growth with certain polarization orientation. With the existence of phase interactions, ZnO crystalline nanorods were found to grow preferentially with polarization orientations antiparallel to these of surrounding polymer ferroelectric lamellarcrystals, viewed also as a new type of epitaxial relationship. Furthermore, the piezoelectric responsesand dielectric constants of dispersed crystals consequently increase by one order of magnitude1. Accordingly, the dipole-dipole interactions among polar phases, especiallycrystalline phases, have been unveiled able to serve as a factor of crystal engineering for crystal growth, which is able to adjust the electro-optical features of phase domains.

Following the tailoring of FTOsubstrate roughness via the deposition of PMMA molecules, various degrees of coalescence and thus thickening of PVDF-TrFE lamellar crystals have been achieved. The crystal surface potentials and piezoelectricresponses of lamellar crystals are found subject to reached lamellarthickness, exhibiting the relationship between crystal dimension and crystalpolarity for the first time.

With the further spread of P3HT-wrappedMoS2 or graphene quantum dots on PVDF-TrFE ferroelectric lamellar crystals,the piezoelectricity and phase polarity of stacked ferroelectric polymer crystals are dramaticallyenhanced, unveiling mutual interactions between ferroelec-

tric lamellar crystals and deposited 2D materials. Furthermore,depending on reached crystal polarity/surface potentials of underneathferroelectric polymer crystals, the capability of P3HT-wrapped MoS_2 incatalyzing hydrogen evolution upon water splitting under the irradiation of visiblelight is able to be activated and enhanced.

The impacts of phase evolution and dispersion on phase interactions have beeninvestigated in this research, which are disclosed able to adjust phase polarity. The adjustment of phase interactions appears as a new strategyto enhance the role of phase polarity in the field of photocatalysis via visible lights, in addition to the applications related to dielectric properties.

Keywords: Phase Interactions, Phase Polarity, Photocatalytic Hydrogen Evolution.

Biography:

Jr-Jeng Ruan is a professor at the National Cheng Kung University (NCKU). Their research interests include the organization and ordering assembly of 2D molecules, small organic molecules, and polymers.

Magnetic Effects in Organic Field-Activated Light Emitting Device

David Carroll
Center for Nanotechnology and Quantum Materials Department of Physics
Wake Forest University
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Abstract:

Light emitting devices based on field-induced polarization currents are capable of high intensity emission with very high power efficiencies. These devices typically use large AC fields applied to a thin film organic emitter to create excitons and ultimately light. Recently, we have observed that the onset of high power efficiencies correlates with the appearance of negative magnetoresistance in the organic emitter. This suggests that the internally coupled magnetic field of the device is playing a role in spin singlet selection of the injected currents. Here we examine the insertion of 2D quantum dots (nanoplates) into the emitter to determine how this might modify our picture of exciton formation. We show that the magnetic response of the additional nanophase can result in an additive effect on singlet selection in the emitter yielding a significant enhancement of the singlet to triplet population ratios. We believe such nanophase composites may present a potential route to realizing optical gain in electrically driven organic devices for the first time.

Biography:

Jacopo Catani is Senior Researcher at the National Institute of Optics (CNR-INO) in Sesto Fiorentino (Italy) and leads a research group (https://owc.ino.cnr.it) on Optical Wireless (OWC) and Visible Light Communications (VLC). His research interests include VLC for Intelligent transportation systems, Li-Fi applications, and free-space optical (FSO) communications.

Mathematical Modeling of Freeform Optical Systems with an Application in Laser Beam Shaping

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2: Signify Research, High Tech Campus 7, 5656AE Eindhoven, The Netherlands

Abstract:

The key problem in computational illumination optics is: given the light distribution of a source and the desired energy distribution at a target, what is the optical system (lens, reflector or combination thereof) that does the job? To find these optical components there are basically two approaches: a) direct methods and b) inverse methods.

In direct methods an optical component is designed in a CAD tool and the target light distribution is calculated using ray tracing. We follow many rays from the source to the target using the laws of optics (Snell's law, law of reflection), and determine the light distribution at the target. If the obtained light distribution differs from the desired one, the CAD geometry is adjusted, and a new light distribution is calculated. Because of the iterations, this is typically a slow process.

Alternatively, the problem is solved as an inverse problem. A partial differential equation can be derived that describes the shape of the lens or reflector. Our mathematical model is based on the principles of geometrical optics, formulated in terms of the optical map connecting source and target domain, and energy conservation. This leads to a fully nonlinear partial differential equation of Monge-Ampère type, subject to the transport boundary condition. We show the derivation of this equation for several model problems.

Our numerical method for finding the optical surface(s) is an iterative least-squares solver. We illustrate the model and solver by a numerical experiment on laser beam shaping, where an incident Gaussian source distribution is transformed into a uniform top hat illuminance.

Keywords: Freeform Optics, Optical Design, Monge-Ampère Equation, Optimal Transport.

Biography:

Martijn Anthonissen works at Eindhoven University of Technology in the Computational Illumination Optics group. This is one of the few mathematics groups worldwide working on optical design problems from illumination optics. The group has a healthy portfolio of PhD positions and close collaborations with industrial partners. The group has three research tracks: nonimaging freeform optics, imaging optics and improved direct methods.

Towards TAMSELs: Tamm Assisted MetaSurface Emitting Lasers

Edmund Harbord[1,*]
Quantum Engineering Technology Laboratories, School of Electrical, Electronic, and Mechanical Engineering, University of Bristol, Bristol , BS8 1UB, United Kingdom

Abstract:

Vertically emitting laser are extremely attractive semiconductor technology: they can be tested at wafer level (unlike edge emitting lasers (EELs) that need to be diced and require extremely flat cleaved facets to operate), they are highly compact, and can be modulated more rapidly than EELs. The global market for VCSELs was worth $1.4 billion in 2020, and is expected to grow to $5.7 billion by 2029. We propose a new concept in surface emitting lasers – combining optical Tamm states with metasurfaces to form a new, highly compact, surface emitting lasers, with the capacity to reduce manufacturing time by 40%, while simultaneously introducing the ability for post-growth tuning of the wavelength and far field of the devices.

Tamm optical states – sometimes called Tamm plasmons – are formed at the interface between a distributed Bragg reflectors and a nanoscale layer of metal[1]. Unlike conventional surface plasmons, the majority of the mode is located in the lossless dielectric layer; they have a parabolic dispersion within the light cone, so can be coupled to without momentum matching; and can be excited with both TE- and TM- polarized light. By laterally sculpting the metal layer to form micron-scale metal disks, it is possible to confine the light underneath the metal, creating a highly compact cavity. By tuning the size of the disk, it is possible to control the wavelength of the optical mode. This has been incorporated into devices to demonstrate photodetectors[2], Light Emitting Diodes[3], and single photon sources[4] – however, the absorption in the metal of the vertically emitting devices restricts the efficiency of these devices for both classical and quantum photonics.

By instead patterning the metal to form a meta-surface, we both reduce the amount of metal and increase the active volume of the device. Coupling between surface plasmons[5] and the Tamm plasmon mean we gain the ability to control the operation wavelength and the far field of the mode.

In this talk, I will explain the formation of Tamm optical states, as well as demonstrating our work incorporating Tamm states into resonant cavities and photodetectors in the technologically important telecommunications O band, as well as a technique for rapidly simulating structures I will also discuss progress towards realising a Tamm Assisted MetaSurface Emitting Laser (TAMSEL) and the challenges towards doing so, as well as the application space that TAMSELs would make possible.

[1] Parker et al., PRB 100 (16), 165306 [2] Harbord et al., APL 115 (17) [3] Symonds et al., APL 122, 261105 (2023) [4] Gazzano et al., APL 100, 232111 (2012) [5] Lopez-Garcia et al., Appl. Phys. Lett. 104, 231116 (2014)

Keywords: Surface Emitting Lasers, Tamm Optical States, Metasurfaces.

Biography:

Edmund Harbord is currently a senior lecturer in Quantum Communications Technologies at the University of Bristol, and has a background in semiconductor quantum photonics. He is interested in how the quantum devices can enhance the physical layer in telecommunications systems. After reading physics at the University of Oxford, he received his PhD in semiconductor dots from Imperial College London. Following a career break, when he was awarded a Daiwa Scholarship, he joined the laboratory of Prof. Yasuhiko Arakawa at the University of Tokyo as a Specially Appointed Foreign Researcher, before being awarded a JSPS Fellowship. Returning to the UK to join Ruth Oulton's EU FET-Open project SPANGL4Q, he was a Researcher Co-Investigator on EPSRC funded project SPIN SPACE, before being appointed to a lectureship at Bristol. His New Investigator Award "Tamm Assisted Metasurface Emitting Lasers for sensing and datacomms" has recently been funded by EPSRC. He is an elected member of the committee Quantum Electronics and Photonics group at the Institute of Physics.

Key Enabling Technologies for the Next-Generation Optical Access Networks

Jinlong Wei*
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Abstract:

This report will outline the historical technological evolution of fixed networks and focus on the main technical key performance indicator (KPI) requirements of fixed optical access networks in different eras. An innovative frequency division multiplexing tree fiber access network architecture is proposed to address the bandwidth, delay, cost and time synchronization issues faced by emerging cloud applications such as connected autonomous vehicles, smart factories, and AR/VR. This architecture aims to provide a technical base for smooth transition of optical fiber access network technology and inter-generational upgrade of user experience.

Biography:

Dr. Wei is currently a research professor at Peng Cheng Laboratory, Shenzhen, China. He received a PhD from the University of Wales, UK in 2011. His research interests include optics communications, photonic switching/signal processing, advanced modulation/coding, digital signal processing, algorithms, and machine learning. He edited one book and (co-)authored over 180 peer-reviewed journal/conference papers including Nature Electronics (IF = 34.3), Photonics Research, OFC, ECOC, etc, as well as over 20 invited. He has experimentally demonstrated a few world first real-time and offline optical communication systems for Data- and Tel-communications applications, which was reported by various scientific and technical media and organizations. He holds several US/European patents. Prof. Wei is a Marie Curie fellow and a senior member of IEEE and Optica (formerly OSA).

The Physical Layer Secure Communications and Quantum Key Distribution (QKD) Systems Using Photonics

Atilla Hasekioglu*, Orkun Hasekioglu
BILGEM, TUBITAK , Zeki Acar Caddesi No:1, Gebze , Kocaeli, Turkiye

Abstract:

Following the establishment of the fundamentals of quantum physics, there have been a number of applications exploiting the properties of quantum mechanics such as quantum superposition, measurement uncertainty and entanglement. In the recent Nobel Prize in Physics, it was once again highlighted the impact of the entanglement characteristic of quantum particles and the evolution of our comprehension of the nonclassical and nonlocal correlations observed in entangled particles.

Especially, in the area of secure data communications and encryption, such applications are already being introduced as commercial products. In particular, Quantum Key Distribution (QKD) and Quantum Random Number Generation (QRNG) are two of the critical applications enabling cryptographic and physical layer security in data communications systems. The international standards development organizations, such as, IEEE, ETSI and ITU, are considering including such technologies as part of the 6G wireless communications standards.

In QKD, security is ensured by the laws of physics and, in principle, unbreakable by an eavesdropper. QRNG is another crucial component in the QKD applications. In QRNG, as well, the laws of physics guarantee the true randomness (i.e., unpredictability and uniform distribution) of the sequence generated.

It is possible to use both free space and fiber optic links as medium of transmission. In general, quantum states of photons (polarization, orbital angular momentum modes etc.) may be used to encode classical information. Two approaches are Discrete Variable QKD (DVQKD) and Continuous Variable QKD (CVQKD). A QKD system consists of single photon sources, sin-

gle photon detectors, linear optical elements, modulators, laser sources, nonlinear crystals for entangled photon generation and coincidence detectors.

This article is an overview of such secure communications protocols, standardization studies pursued by IEEE, ETSI and ITU, and their physical implementations.

Keywords: Physical Layer Security, Qkd, Quantum Communications.

Biography:

Atilla Hasekioglu, PhD (RPI, USA) in Electrical Engineering. During his PhD, he worked on semiconductor device modeling and simulating image sensors. After working at the Canadian Space Agency, Montreal, Canada as a researcher, he joined the National Research Institute of Electronics & Cryptology (UEKAE), the Scientific and Technological Research Council of Turkey (TUBITAK), in Turkey as a lead researcher. He has worked cryptology, cyber security, quantum cryptography, quantum computing, quantum information and imaging related projects. In 2014, he became the Director of Cyber Security Institute. Currently, he is working as a project manager and coordinating quantum technologies related projects. He also participates in ETSI Quantum Key Distribution Standardization group activities as a vice-chair. He represents Turkey as a deputy member for Quantum Community Network (QCN) in Europe. He is a representative of TUBITAK Informatics and Information Security Research Center (BILGEM) for Quantum Industry Consortium (QuIC) in Europe.

Optical Techniques for Biomedical Analysis

Paddy French
TU Delft

Abstract:

Optical techniques offer a powerful tool for a wide range of biomedical applications. There are a number of ways optics can be used, both for in-vivo and in-vitro applications. These include absorption, interference patterns, evanescence and fluorescence. In some cases, the cells/molecules of interest are trapped on the surface of the sensor, which causes, for example, additional absorption of light. The selectivity of this method is determined by the functionalisation of the surface and the materials are commercially available. When trapping cells/molecules the devices need to be cleaned before re-use, although in some cases this is not possible and the devices are for single use. The evanescence wave, is the part of the wave outside a waveguide. If the surface of the waveguide is functionalised, the presence of the target bacteria will result in higher absorption and the reduction of the intensity is a direct measure of the concentration of the bacteria in the sample. Fluorescence can be achieved simply by the presence of a molecule and can be fully reversable. An example of this is an optical oxygen sensor.

This presentation will describe the basic optical techniques and give examples which can be used for biomedical applications.

Biography:

Paddy French received his B.Sc. in mathematics and M.Sc. in electronics from Southampton University, UK, in 1981 and 1982, respectively. In 1986 he obtained his Ph.D., also from Southampton University, which was a study of the piezoresistive effect in polysilicon. After 18 months as a post doc at Delft University, The Netherlands, he moved to Japan in 1988. For 3 years he worked on sensors for automotives at the Central Engineering Laboratories of Nissan Motor Company. He returned to Delft University in May 1991 and became a scientific staff member. In 1999 he was awarded the Antoni van Leeuwenhoek chair and was from 2002 to 2012 head of the Electronic Instrumentation Laboratory.

RES Hybrid Prism-A New Kind of Lens for Light in the Visible Spectrum as well as for X-Rays

Friedrich Grimm
MD-RES Institute, Germany

Abstract:

The invention relates to a hybrid prism (1) for an optical system (2), which, as an optical component, combines the properties of a lens with the properties of a reflection prism and consists of a rotational rhomboid (P), which is optically denser than the surrounding matter and has at least one glass body

(10) for light (L) with a wavelength λ of 780 nm to 380 nm and has a vacuum (V) in an enveloping body

(11) that is surrounded on all sides for X-rays (R) with a wavelength λ of 1 nm to 30 pm. The rotational rhomboid (P) defines the beam path through four interfaces (a-d) to optically thinner matter over a length (e) in such a way that the rays (S) emanating from an object (Θ) allow the reproduction of an image of the object (Θ) on an image surface (Φ) with example rays (A,B) in a chained beam path and in such a way that the example rays (A,B) enter into the rotational rhomboid (P) at a front interface (a) and pass through an even amount of total reflections at two inner totally reflecting boundary surfaces (b,c), each arranged with an angle of inclination (α) to that of the optical axis (x), in order to exit from the rotational rhomboid (P) at a rear interface (d), while at least one of the interfaces (a-d) has a generating curve (y) with a continuously changing tangent angle (β) for the rotational rhomboid (P) in a longitudinal section (f) of its length (x).

Biography:

Prof. Friedrich Grimm was born in Stuttgart in 1954. He studied architecture at the University of Stuttgart and at the Illinois Institute of Technology in Chicago in 1980. After having finished his studies in 1981, he worked as an employed architect and later on temporarily joined the scientific staff of the Institute for Building Construction at the University of Stuttgart. During his practice as a freelanced architect, since 1989 he took part in competitions and completed several multifamily houses in southern Germany.

Optical Wavefront Shaping for Mode-Division Multiplexed Transmission

Tomohiro Maeda*, Hideyuki Sotobayashi
College of Science and Engineering, Aoyama Gakuin University, Japan

Abstract:

To address the theoretical limitations of transmission capacity in current optical transmission systems with single-mode optical fibers (SMFs), there is a growing interest in exploring new dimensions for signal multiplexing. Mode-division multiplexing (MDM), which leverages the orthogonality of spatial modes in multimode optical fibers (MMFs), is one of the promising approaches for spatial multiplexing. Standard MMFs with 50-μm cores can support over a hundred spatial modes, making MDM a highly anticipated method for substantially enhancing transmission capacity. Spatial mode conversion is a critical technique used for conducting MDM transmission. Planer lightwave circuits (PLCs) help provide an exceptional and efficient approach to convert and multiplex spatial modes while maintaining a compact form factor. Although PLCs can handle a limited number of spatial modes, they are currently effective, as real-time processing is constrained to three spatial modes only owing to limited signal-processing capacity. In case the multiplexing number increase owing to the advancement of signal-processing technology and dispersion management, optical processing in free space, which offers an immense degree of freedom, may eventually surpass PLCs. This presentation introduces our ongoing research activities related to spatial mode conversion in free space.
To convert the fundamental mode of an SMF into any arbitrary spatial mode of an MMF, optical complex amplitude distributions need to be modulated. Computer-generated holograms (CGHs) based on lightwave diffraction are typically used for modulating complex amplitude distributions. While CGHs can accurately generate spatial modes with a narrow spatial frequency bandwidth, their low diffraction efficiency can lead to considerable insertion loss. Enhancing diffraction efficiency can often compromise the accuracy of generated complex amplitude distributions, creating a trade-off between crosstalk and insertion loss in spatial mode conversion. We have proposed two different approaches to address this trade-off.

One approach uses lightwave interference, referred to as dual-phase modulation (DPM). Complex amplitude modulation via DPM is achieved by replacing the mirrors with phase-type spatial light modulators (PSLMs) in both the optical paths of the Michelson interferometer. The desired complex amplitude is decomposed into two phase vectors and assigned to each PSLM, and complex amplitude modulation is achieved by recombining phase-modulated lightwaves. DPM exhibits high light utilization efficiency, as it avoids lightwave diffraction, and experimental results have demonstrated that the accuracy of spatial mode conversion is equivalent to CGHs.

Another approach leverages lightwave diffusion, referred to as spatial cross modulation (SCM). In SCM, the phase-conjugate distribution of the diffused phase, obtained by simulating lightwave diffusion using a diffuser, is applied to a PSLM. Complex amplitude modulation is achieved based on the phenomenon where phase-conjugated light reconstructs its original wavefront while passing through the diffuser again. Although SCM offers a higher light utilization efficiency than DPM, as it can modulate the intensity distribution without attenuation, it can introduce crosstalk owing to the presence of speckle noise in the generated field. Furthermore, we have considered optimization algorithms to enhance conversion accuracy.

Keywords: Optical Wavefront Shaping, Mode-Division Multiplexing, Optical Communication.

Biography:

Tomohiro Maeda was born in Saga, Japan, in 1990. He received BS and MS degrees from Hokkaido University in 2013 and 2015, respectively. From 2015 to 2017, he briefly stepped away from academic research to work in a general private company. In 2017, he returned to Graduate School of Information Science and Technology, Hokkaido University and resumed his research activities. He received a Ph.D. in Information Science from Hokkaido University in 2020. His research interests lie in the control and measurement techniques of optical wavefronts and their applications in the field of optical communications. The paper titled 'Mode conversion based on dual-phase modulation utilizing interference of two-phase-modulated beams,' authored by him in 2018 for Optical Review, received the 2019 Optical Encouragement Award from the Optical Society Japan.

Optical Wavefront Shaping for Mode-Division Multiplexed Transmission

Wenxing Xu[1*], Tsung-Han Tsai and Aaron Palke[2]
[1] Independent Researcher, Cheerstrasse 13, Luzern, Switzerland
[2] Gemological Institute of America, USA

Abstract:

Photoluminescence spectroscopy, particularly when applied to chromium-doped gem materials, has emerged as a promising tool for the rapid identification of gemstones in Gemological laboratories. In this comprehensive study, we harnessed the power of a 405 nm photoluminescence spectroscopy technique to delve into the intricate luminescence decay profiles of a diverse array of spinel and alexandrite gemstones. Our investigation encompassed natural specimens, laboratory-grown counterparts, and even heated spinel, each unveiling unique photoluminescence characteristics.

Both spinel and alexandrite, renowned for their captivating color-changing properties, exhibited photoluminescence lifetimes that spanned a remarkable range. Spinel showcased lifetimes between 9 and 23 microseconds, while alexandrite demonstrated even more extended lifetimes, ranging from 25 to 53 microseconds. These findings underscore the potential of photoluminescence spectroscopy as a precise and discriminating tool for gemstone analysis.

Significantly, our research revealed profound disparities in photoluminescence lifetimes and exponential parameters among the various gemstone categories, namely natural, heated, and lab-grown specimens. These distinctions offer critical insights into gemstone origin, treatment history, and growth conditions. By harnessing the capabilities of a 405 nm photoluminescence device, we have unlocked a novel avenue for color gemstone identification, elucidation of treatment processes, and origin determination.

This study represents a significant advancement in the field of gemology, presenting an approach to gemstone analysis that goes beyond traditional methods. The insights gained from our research offering a deeper understanding of the rich diversity within gem materials and their distinctive photoluminescence signatures.

Recent Publication: Xu W., Tsai T.H., Palke A., Study of 405nm Laser-Induced Time-Resolved Photoluminescence Spectroscopy on Spinel and Alexandrite, Minerals 2023, 13, 419. https://doi.org/10.3390/ min13030419

Keywords: Spinel, Alexandrite, Photoluminescence Lifetime, 405nm Laser.

Biography:

Wenxing Xu is a mineralogist and materials scientist, known for her expertise in gemstones. She earned her Master's and PhD degrees from the University of Mainz in Germany. With roles as a Senior Gemmologist at Gübelin Gem Lab and a Research Scientist at GIA, she has focused her studies on gemstone materials and origin determination. Wenxing specializes in identifying and unraveling the origins of colored gemstones, drawing from over two decades of experience across three continents. Her pioneering work involves developing non-destructive spectroscopic methods for gemological laboratories. She remains at the forefront of gemological research, contributing significantly to the field's advancement. Wenxing Xu's unwavering dedication and passion make her a leading figure in mineralogy and materials science, shaping the future of gemstone analysis.

Effects of Laser and Led Irradiation on the Growth and Control of Normal and Malignant Cells in Cell Cultures

Efrain Solarte*[1], Danielle Viviana Ochoa[2], Carlos Galindez[1], Oscar Gutierrez[2].
1. Department of Physics, Universidad del Valle, Santiago de Cali, Colombia
2. Basic Medical Sciences School, Universidad del Valle, Santiago de Cali, Colombia

Abstract:

The interaction between radiation and matter in its general aspects has been clarified with the formulation of quantum electrodynamics, and led to its scientific and technological practical applications since the end of the 20th century. The rebirth of Optics, due mainly to the commercial emergence of the lasers and especially to the consolidation of photonics, as the technology and engineering of light, allowed scientific advances and technological developments over a broad spectrum of areas of sciences of sciences and engineering. New laser and LEDs sources and new and better methods and systems for light detection, led to a set of classical and quantum applications of electrodynamics in Optical Science and in other fundamental natural sciences (Physics, Biology and Chemistry), but also in those directly related to the environment, human health, agriculture and engineering, which nowadays use and need light and their technologies for their development and application. High power laser radiation applications in various fields of medicine and in particular in surgery, is a technological reality that ranges from its application as scalpel and cautery, to complex photochemical applications. New laser´s technologies, the high energy density available by pulsed lasers, and the use of fiber optics for transport and to apply of laser radiation, have opened a research area with notable developments in several medical fields, where this energy, and the ability of cells to absorb it, is exploited to remove tumors, malformations or stones and to "weld" biological tissues or wounds and possibly repair tendons and nerves. More recently, due advances in photochemistry and the ease of inducing chemical reactions with different lasers, new applications have been developed related to therapy activated or facilitated by light.

Low Intensity Laser Irradiation on cells has been studied and exploited in two different ways, on one side; there are laser applications mainly related to physical therapy. This field encloses wide possibilities: from internal injuries of muscles and tendons, to external injuries, whether surgical or not. Including pain relief, wound healing and cell reproduction, which opens a new therapeutic field known as Low Level Laser Therapy. The uses of laser in pain relief applications leaded to applications in plastic and reconstructive surgery due the effect on some photon's energy on adipose cells. On the other side, the laser applications for wound healing and cell reproduction leaded to applications in cell biology, cell control, and cell and tissue replacement therapy. After briefly discuss the fundamentals of the interaction between light and cells and with the biological tissue; a schematic presentation of laser action on human tissues, and on cells, will be made. The findings of the laser light effects on white adipose tissue will be presented. The importance of fluorescence spectroscopy in cancer diagnosis and malignant cell studies, and finally the use of laser sources and low coherence light to improve cell proliferation and cell differentiation in cell cultures will be given and discussed. Some examples and most of the results are taken from our research.

Keywords: Laser-Tissue Interactions, Spectroscopy, Cell Cultures, Cancer.

Biography:

Prof. Efrain Solarte –Rodriguez, Dr.rer.nat

Physicist, National University of Colombia (NUC), graduated in 1975 as the best graduating from the College of Science NUC. He completed his graduate studies at the same university and graduated as Master Science in 1978. During his research work, he built the first plasma ion source in the country and he won the DAAD - NUC scholarship for doctoral studies in Germany. He graduated as a Doctor of Natural Sciences of the Technical University of Kaiserslautern with a thesis on Laser-Molecule interactions. Full Professor for Optics, Atomic and Molecular Physics and Laser Physics. PhD, MSc. and BSc. Thesis Advisor at Universidad del Valle. Leader of the Quantum Optics Research Group (1994-2020). Cofounder and President (2005-2010) of the Colombia Network for Optics. Cofounder, Secretary (2013-2016) and President (2016-2019) of the Iberian American Network for Optics. SPIE Senior member, OPTICA, EOS, SEDO, RCO and RIAO member. Main research interests in Biophotonics and its applications in Biomedical Sciences and H. Tech Agriculture, and Laser applications to Air and Water Quality.

Slr Plan for Next Five Year at Shanghai Observatory

Zhongping zhang*, Zhibo Wu, Mingliang Long, Huarong Deng, Haifeng Zhang
Shanghai Astronomical Observatory of Chinese Academy of Sciences, Shanghai, China; *Corresponding Author E-mail: wzb@shao.ac.cn

Abstract:

Satellite Laser Ranging (SLR) techniques are employed for determining distances precisely between ground stations and satellites. SLR and Lunar Laser Ranging (LLR) technology has wide applications and contributions in geodesy, geodynamics, lunar physics and testing fundamental physical theories. In the next five years, SHAO plans to carry out a series of station construction projects, by building 3 new high-performance (1mm rms for Lageos Normal Point, 5mm and 2mm for short-term stability and long-term stability respectively) SLR stations in the northwest, southwest, and northeast regions of China. Compared to existed ones that had long belonged to International Laser Ranging Service (ILRS), these newly-built stations have been designed to compliant with next generation SLR standards with higher measurement precision, stability, and repetition rate, and one of them set its sights on Lunar Laser Ranging Technology. The new stations will significantly improve the quality of future observational data and to some extent optimize the layout of SLR stations in China and East Asia.

Keywords: SLR, High Performance, LLR, Millimetre Precision.

Biography:

Zhongping Zhang is an academic researcher from Shanghai Astronomical Observatory. The author has contributed to research in topics: Time transfer & Space segment. The author has an hindex of 1, co-authored 1 publications receiving 7 citations.

Hopf-Boundary-Limited External-Cavity Modes and their Transition to Chaosin Semiconductor Lasers with Time-Delayed Opto Electronic Feedback

Qin Zou*
SAMOVAR,Telecom Sud Paris, Institut Poly technique de Paris, 91120 Palaiseau, France

Abstract:

We theoretically investigate the bifurcation itineraryto chaos of a semiconductor laser subject to an optoelectronic feedback under the Hopf-bifurcation condition.We show that the first external- cavitymode (ECM) emerges when the compound laser undergoes a saddle-node bifurcation, and that a characteristic state (forbidden, emergence, bifurcation, or transition) of an ECM depends strongly on the gain factor (denoted as β) of the optoelectronic loop (example: Figures 1 and 2).

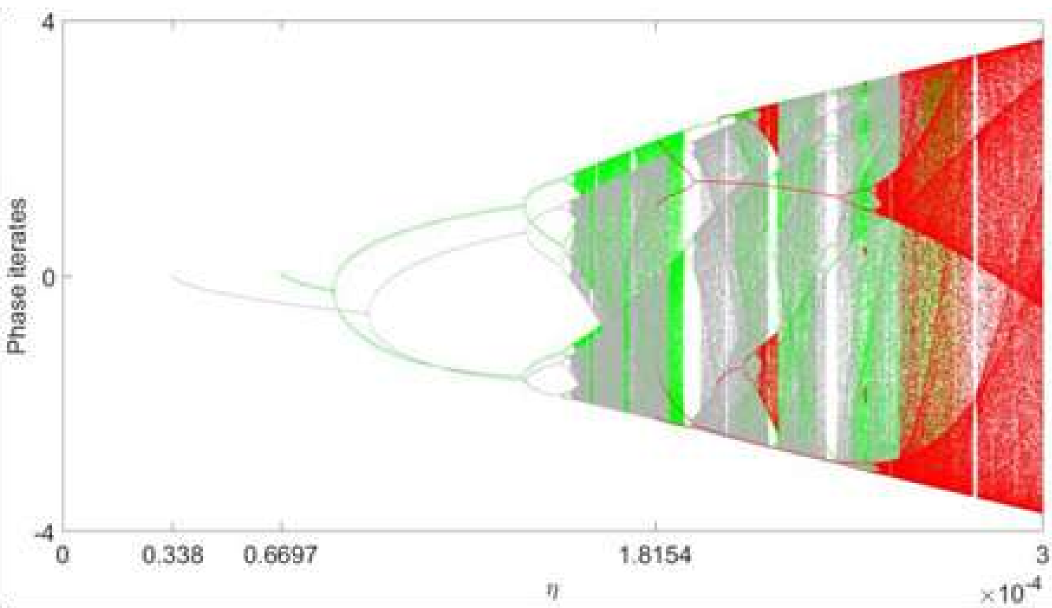

Figure1.Bifurcation diagrams, in terms of the normalized field phase, as a function of the normalized feedback rate η.Red dots:situation of usual external optical feedback (β= 0). The saddle-node point η_SN=1.8154×10−4 does not give rise to an ECM solution; Green dots:optoelectronic feedback with "weak" amplification (β=2). The compound system "repairs" the distorted phase map with this value of βand restores thus solutions for ECMs: the first one emerging at η_SN =0.6697×10−4; Grey dots: optoelectronic feedback with "strong"amplification (β = 5). With this greater value of β, the first solution for an ECM appears at a smaller value of η_SN(η_SN= 0.338×10−4).

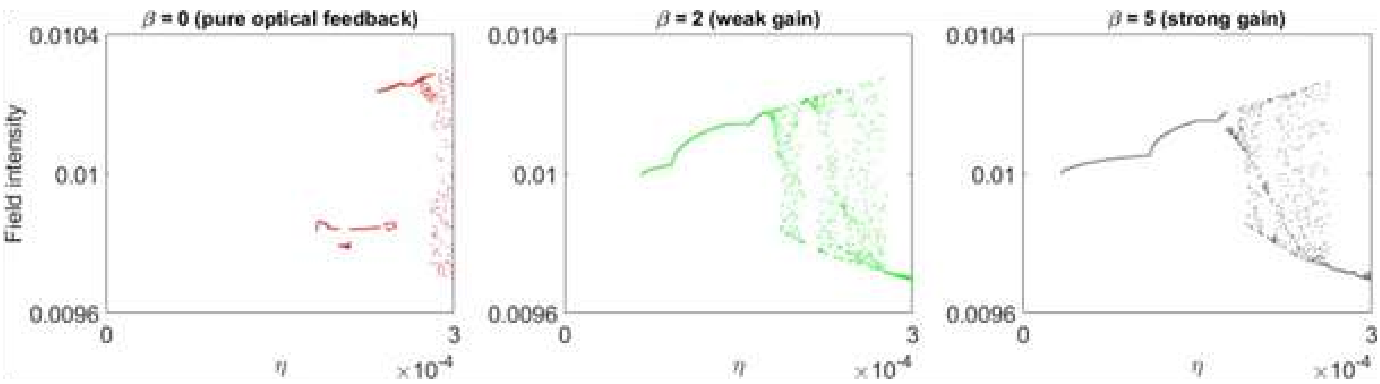

Figure2. Corresponding route to chaos of the optical-field intensity. Note that in the case of pure optical feedback, the dominantphenomena include irregular oscillations and mode jumping, and that the so-called anti-mode solutions are not presented in this figure.

Keywords: Semiconductor Lasers,Time-Delayed Optoelectronic Feedback,
External-Cavity Modes, Phase Iterates, Hopf / Saddle-node Bifurcations, Optical Chaos.

References :

[1] T.Erneux andP.Glorieux, LaserDynamics,Cambridge UniversityPress,2010.
[2] H.G.Schuster,DeterministicChaos:AnIntroduction,Weinheim:Physik-Verlag,1984.

Effects of Optical Irradiation with Laser and Led Light Sources on Cell Cultures of Leu-kemia

Danielle Ochoa[1,2], Efrain Solarte[2], Oscar Gutirrrez[1]
[1] 2Pharmacology Research Group, Universidad del Valle, Santiago de Cali, Colombia.
[2] 1Quantum Optics Research Group, Universidad del Valle, Santiago de Cali, Colombia.

Abstract:

The study of cancer in Colombia has become a priority for the health system, since: There is detec-tion in advanced stages, late attention, secondary and adverse effects after conventional treatment.

This causes a great socioeconomic impact and a high mortality rate, since cancer is one of the lead-ing causes of mortality and this phenomenon is recognized worldwide.

One of the main reasons is that its treatment is not selective and patients who have suffered from it experience recurrence of the disease after conventional treatment by chemotherapy, radiotherapy or surgery, in addition to secondary and adverse effects, given that these treatments not only eliminate cancer cells but normal ones; that is, there is no selectivity for leukemic cells.

This technology is the subject of research around the world (it has not only allowed biomedical ad-vances, but also at an industrial, technological and engineering level).

Low Intensity Laser Irradiation on cells has been studied and exploited in two different ways, on one side; there are laser applications mainly related to physical therapy. This field encloses wide possibilities: from internal injuries of muscles and tendons, to external injuries, whether surgical or not. Including pain relief, wound healing and cell reproduction, which opens a new therapeutic field known as Low Level Laser Therapy. The uses of laser in pain relief applications leaded to applica-tions in plastic and reconstructive surgery due the effect on some photon's energy on adipose cells. On the other side, the laser applications for wound healing and cell reproduction leaded to applica-tions in cell biology, cell control, and cell and tissue replacement therapy.

Methods:
With this research project is to will design, build and launch an experimental setup that allows the implementation of a new technology that targets and treats leukemia cells without harming the sur-rounding environment (normal cells), called optical therapy.

The application of light energy in biological tissues can give rise to different applications in both biological sciences and health sciences. Therefore, experiments will be carried out that allow study-ing the light-matter interaction, through optical therapy with laser and led sources that promise a new revolution in the research field, since they have good space-time resolution, which it makes it selective according to its wavelength and specific according to its direction-ality.

Keywords: Laser, LED, Cell Cultures, Leukemia, Cancer Therapy.

Main subject: Biophotonics and biomedicalapplications
Secondary subject:Optical design and manufacturing and Spectroscopy

References :

[1] Banavath, H. N., et.al. Journal of Photochemistry and Photobiology. 35-40, 1357 (2018).
[2] Hopkins, S. L., et.al. Photochem. Photobiol. Sci. 15, 644 (2016).

Preferred Presentation Type: ORAL AND POSTER

Biography:

Danielle Viviana Ochoa, a graduate of the Chemistry Academic Program of the Faculty of Natural and Exact Sciences of the Universidad del Valle, won the Ecopetrol-Colciencias schol-arship to pursue postgraduate studies, within the framework of a research project with the Research Group in Bioprocesses and Reactive Flows - BIOFRUN from the National Uni-versity of Colombia. Currently, Danielle is part of the Macro-innovation project "Charac-terization using laser techniques of the chemical reactions of heavy crude oil, during in situ combustion", a topic that is on the rise given the large number of unconventional oil wells that represent important resources. For the oil industry and the country's energy resources.

Raman Spectroscopy in Biomedical Research and Diagnostics

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Abstract:

Raman spectroscopy, a vibrational analytical technique harnessing inelastic light scattering, has emerged as a powerful tool for obtaining a detailed molecular fingerprint of tissues and cells. Based at King's College London, our laboratory is committed to propelling the field forward through Raman-based molecular characterization and diagnostic applications across various diseases and biomedical contexts. Our research addresses fundamental challenges in biomedicine, seeking to enhance our comprehension of biological systems through the application of optical spectroscopy. Within this framework, we present different biomedical applications for Raman spectroscopy, underscoring its efficacy across different domains.

We present the application of confocal Raman microscopy in the domains of regenerative medicine and tissue engineering. Here, we explore the technique's potential for temporally unraveling intricate molecular details within tissue constructs and native tissues. Additionally, we show the development of a new Raman Spectral Projection Tomography (RSPT) technique. This innovative tool specifically crafted for temporally monitoring living tissue-engineered constructs provides a non-invasive label-free 3D molecular construction of tissue samples.

In our pursuit of advancing clinical cancer diagnostics, we introduce a multimodal fiber-optic fluorescence/Raman endoscopic instrument based on coherent fiber bundles. This instrument promises improved capabilities for diagnosing cancer by enhancing our ability to simultaneously probe both molecular signatures and cellular morphology within tissues. To optimize the efficiency of Raman spectroscopy, we present SpectrAI (www.spectrai.org), a state-of-the-art deep learning framework tailored for spectral data that contributes to expediting data acquisition and analysis.

In our latest developments, we present work on multimodal correlative imaging, integrating Raman spectroscopy with mass spectrometry in a unified instrument. This integration not only

amplifies analytical depth but also creates novel opportunities for molecular-specific optical imaging. By elucidating the synergies between Raman and mass spectrometry, we showcase a comprehensive and versatile approach for lipidomic imaging of tissue specimens using light.

Keywords: Raman Spectroscopy, Artificial Intelligence, Biomedical Engineering.

Biography:

Dr Mads S Bergholt is a Senior Lecturer at King's College London leading the Label-free Bio-imaging Laboratory (www.bergholtlab.com). He received his MSc. Degree in Engineering, Physics and Technology (Optics) from the University of Southern Denmark and his Ph.D. in Biomedical Engineering from National University of Singapore in 2014. He was then awarded a Marie Curie Fellowship at Imperial College London and a King's Prize Fellowship at King's College London. In 2018 he started his own group at King's College London working on biomedical optics, linear/non-linear optical spectroscopy/imaging, endoscopy and artificial intelligence. He is a Fellow of the Institute of Physics and was given the United Kingdom Regenerative Medicine Platform (UKRMP) Special Merit Prize and the FACSS Innovation Award in 2022.

Structural Characterization of Carbon Materials and Semiconductor Devices Using Tip Enhanced Raman and Scanning Near-field Raman Spectroscopy

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Toray Research Center, Inc., Sonoyama3-2-11, Otsu, Japan

Abstract:

We have studied cutting-edge materials using advanced Raman, infrared, photoluminescence, and cathodoluminescence (CL) spectroscopy. Among various spectroscopic techniques, vibrational spectroscopy is particularly versatile, offering applications such as characterizing the orientation, crystallinity, and chemical bonding structure of molecules. It addresses a wide range of significant and complex analytical challenges. I Specifically, Raman spectroscopy, as a complementary technique, is often essential for a comprehensive measurement of the vibrational modes in molecules, solids, or solutions. We present advanced characterization of crystallinity in materials ranging from power semiconductors like Silicon and 4H-SiC, to graphene oxide and carbon nanotubes, employing both far- and near-field Raman spectroscopy.

Keywords: Raman, Spectroscopy, Near-field, Stress.

Biography:

Dr. Masanobu Yoshikawa completed his doctorate in applied spectroscopy with the Fourier transform infrared (FT-IR) and Raman spectroscopy at the Osaka University in 1986. After his analytical study of the one-dimensionally conducting metal-tetracyanoquinodimethanide (M-TCNQ) with FT-IR and Raman spectroscopy at the Osaka University, he joined Toray Research Center, Inc. in 1986, which is a leading analytical service company in Japan. He has mainly studied wide-gap semiconductors, using FT-IR, Raman and cathodoluminescence. He worked for Fraunhofer-Institute in Freiburg in Germany for 6 months in 1998. Furthermore, he has served as the Japanese national project leader for development of the world-first scanning near field Raman spectroscopy (SNORM) from 2003-2007, entrusted by New Energy and Industrial Technology Development Organization (NEDO) in Japan and succeeded in stress characterization of Si devices with a spatial resolution of less than 100 nm. As a result, he was awarded the Advance Analytical Instrument Development prize from the Japan Society for Analytical Chemistry (JAIMA) in 2010. He is working for Toray Research Center, Inc. as a president and a senior fellow.

Photonic Layers for Solar Cells

Hugo Aguas, Jenny Boane, Ivan Santos, Pedro Centeno, Manuel J. Mendes, Rodrigo Martins
i3N/CENIMAT, Department of Materials Science, NOVASCHOOL OF SCIENCE AND TECHNOLOGY | FCT NOVA, Universidade NOVA de Lisboa and CEMOP/UNINOVA, Campus de Caparica, 2829-516 Caparica, Portugal

Abstract:

Optimized IZO micro-meshes results in improved transparent electrodes with strong light-interaction effects, including pronounced light scattering and reduced sheet resistance. These new transparent electrodes offer great potential as advanced front contacts for all sorts of solar cells, particularly for thin-film solar cells[1].
Structuring parylene-C transparent encapsulants for thin-film solar cells using colloidal lithography, results in superhydrophobic surfaces with broadband light-trapping properties allowing for effective self-cleaning. The controlled nano/micro-structuring of the surface features generates strong anti-reflection and light scattering effects, resulting in significant photocurrent enhancement along the UV-Visible-Infrared range. The optimized parylene coatings demonstrate short-circuit current density gains of up to 23.6% and an enhancement of up to 35.2% of the average daily power generation on microcrystalline silicon solar cells[2].
TiO2 honeycomb arrays were patterned on flat crystalline silicon (c-Si) wafers and on standard planar c-Si interdigitated back-contact solar cells (pIBCSCs) through colloidal lithography. The -coated c-Si wafers achieved 36.6 mA/cm2 of photocurrent density, mainly due to an intense and broad anti-reflection and light-scattering effects arising from the front nanostructured coatings, whereas the improved test devices reached 14% efficiency with 679 nm of electrically harmless thick TiO2 nanostructures, corresponding to ~30% of efficiency gain relative to uncoated pIBCSCs. Moreover, several of the designed structures showed unmatched angular acceptance enhancements in efficiency and photocurrent density for high light incidence angles, up to 63% and 68% gain, respectively[3].

References:

[1] Jenny L.N. Boane et al., Micro. 1 (2021) 215–227. https://doi.org/10.3390/micro1020016
[2] Pedro Centeno et al., Advanced Materials Interfaces, 7(15), (2020), 2000264. https://doi.org/10.1002/admi.202000264
[3] Ivan Santos et al., Advanced Optical Materials, (2023), https://doi.org/10.1002/adom.202300276

Biography:

Hugo Aguas, is Associate Professor at the Materials Science Department of NOVA School of Science and Technology of NOVA University of Lisbon, Portugal, and Photovoltaics research group leader at CEMOP-UNINOVA. He received his PhD in 2005 in Optoelectronics Engineering. He holds a patent for Solar Tiles comprising the development of silicon thin film technology for direct application in ceramic tiles building elements, which was given the Innovation Award in Energy Live Expo in 2014. He has a publication record of more than 188 publications recorded by WoK. The number of citation times registered in the WoK is above 3800 and has an H-index of 37.

Mid-Infrared Laser-Based Absorption Spectroscopy for Trace Gas Detection

Simona Cristescu
Life Science Trace Detection Laboratory, Institute for Molecules and Materials, Faculty of Science, Radboud University, Heyendaalseweg 135, Nijmegen, the Netherland

Abstract:

Detection and real-time monitoring of various trace gases plays an important role in many areas including environmental monitoring, leak detection, process control, agrotechnology, biology and medicine. Many gaseous molecules have the strongest ro-vibrational absorption bands with unique spectral features in the "fingerprint" mid-IR region (2 – 24 µm). This makes mid-IR gas spectroscopy a great tool for their chemical identification and quantification.

The common approach for gas phase absorption spectroscopy is the on-line, real-time analysis of single known molecule, sometimes two to three species at the same time. For this, high power (cw and pulsed) Quantum Cascade Lasers (QCL) operating at room temperature with power levels up to 1 Watt, and the related Interband Cascade Lasers (ICLs) are most commonly used.

Recently, the availability of broadband mid-IR light sources such as the supercontinuum based on fibers or intrapulse difference frequency generation from mode-locked lasers, open new avenues, allowing the simultaneous detection of a large number of species in the gas phase with high selectivity and sensitivity. Their output beam is spatially coherent, in contrary to the thermal sources, thus enabling long interaction lengths between light and the gas sample. Our team has developed different types of spectrometers incorporated with these sources for different applications, such as detecting volatiles compounds in fruit storage facilities [1], human breath research, environmental monitoring, wastewater treatment and study of plasma-based gas conversion [2].

A selection of several optical methods for gas detection and real-time monitoring applications over the last two decade of research will be presented. The choice is based on their maturity and high potential for applications outside the laboratory (e.g. in storage facilities, clinical settings, on a boat and aircraft).

Keywords: Mid-IR Lasers, Gas Sensing, Absorption Spectroscopy.

References:

[1] K.L Jahromi et. al., Sensitive multi-species trace gas sensor based on a high repetition rate mid-infrared supercontinuum source, Opt. Express 28(18), 26091-26101, 2020.
[2] R. Krebbers et. al., Mid-infrared supercontinuum-based Fourier transform spectroscopy for plasma analysis, Sci. Reports 12: 9642, 2022.

Biography:

Simona Cristescu is associate professor at Faculty of Science, Radboud University, Nijmegen, the Netherlands. She received her Ph.D. in physics (Magna cum laude) in 1999 in Laser Spectroscopy and currently she is the head of the Life Science Trace Detection Laboratory (www.ru.nl/TDLab).Her research is focused on detection and real-time monitoring of volatile compounds in complex gas mixtures. For this, her group develops and applies state-of-the-art techniques and analytical methodologies using mid-IR laser-based absorption spectroscopy and mass spectrometry for a wide range of gas concentrations (from sub-ppb to percentages). Applications include: biomarkers detection for precision medicine, fruit storage, dairy farming, air pollution and waste water monitoring, plasma diagnostics, etc.

Computing, Medicine, Mobility: How Optics Drive Mega Trends

Patrick Heissler,*
Focuslight Technologies, Xi'An, China

Abstract:

New light sources, such as micro-LEDs, super luminescent LEDs, or mid-IR quantum cascade lasers, are reaching mass-market readiness. They have the potential to transform various industries, improve the quality of life for people around the world and drive the mega trends of the next decades. To leverage their full potential, new ways of designing optical components and packaging are required. This poses new challenges and opportunities for optical design and manufacturing. In this presentation, we will explore how new optical concepts and technologies can enable the effective use of these light sources in applications ranging from non-invasive continuous glucose monitoring to AI to autonomous driving. We will also discuss how advanced optical design helps to overcome the difficulties of producing these optics at large scale and low cost, using methods such as wafer-level optical manufacturing.

Keywords: Micro-Optics, Light Sources, AI, Optical Design.

Biography:

Patrick Heissler studied physics at the University of Augsburg and the Ludwig-Maximilians University Munich. He did his PhD work at the Max-Planck Institute of Quantum Optics in the group of Ferenc Krausz, with various research visits to internationally renowned institutions, like the University of Utah, the Rutherford Appleton Laboratory, and the Los Alamos National Lab. Additionally, he holds an MBA with a focus on innovation and business creation from TU Munich.

For more than a decade, Patrick has held various management positions in the industry, where his focus is on scaling businesses with new and innovative solutions for the optics community. Since 2024, he is the Chief Commercial Officer at Focuslight Technologies.

JAYNSTEIN Æ 369 Rule

Jay Robles Pecharroman
Founder & CEO of JAYNSTEIN LLC, USA

Abstract:

JAYNSTEIN Æ 369 Rule
This rule could be described as: A vision outside the quantum of light

Æ яevolution is my third publication in which I will explain how The Fifth Force generates the quantum of light and how this causes a reaction in spacetime known as Electromagnetism. In this second rule that I call JAYNSTEIN Æ 369 Rule, I would like to show you how The Fifth Force causes effects around the quantum of light in the generation of Electromagnetism.

If I look back at when I started investigating the Æ or æther back in 2017 at Lake Tahoe with the spin of an orange, I realize the great breakthrough. First, knowing that The Fifth Force is the new force that comes from the union of two opposite polarities, and that gives rise to electromagnetism itself. My simplification is of such magnitude that with only two rules I can explain this. The first, JAYNSTEIN Æ 123 Rule describes how from a vacuum something can acquire a three-dimensional dimension, and the second, JAYNSTEIN Æ 369 Rule as its surroundings cause the generation of Electromagnetism.

Recent Publications

1. Æ º Ion Quantum Theory Quicksort.
October 28th, 2019.
ISBN: 9781087815503

2. Æ º Ion Quantum Theory Extended.
February 3rd, 2020.
ISBN: 9781087946030

Biography:

I am the Founder & CEO of a couple of Startups in the USA in which I am enjoying my true passion as a Principal Research Scientist. My biggest challenge as a scientist has been to create a new theory that allows us to interpret the concept of energy from a more radical point of view, and as an engineer, to transform this into technology. With a new scientific model called JAYNSTEIN Æ Model, I concluded the first thing, and the new technology that I am developing from it I call JAYNSTEIN Æ Tech. The JAYNSTEIN Æ Vortex Antenna is the key component in this way. That most scientists are not creative is not because they do not know how to think, rather it means the opposite. that is, they do not know how to stop thinking. The JAYNSTEIN Æ Vortex Antenna is included in the new wearables to help to achieve this goal, like a practitioner of meditation.

Nanocarbon Added Ceramics: Current Status and Future Trends

Csaba Balazsi
HUN-REN Centre for Energy Research, Hungary

Abstract:

The plenary lecture will give a comprehensive view on innovative developments made in the field of nanocarbons e.g. carbon black, carbon nanotubes, graphene added ceramics highlighting the key issues related to integration technology and improvements in the mechanical, tribological or functional properties as a result. Among non-oxide ceramics the silicon nitride based ceramics are well-known as low density materials with high strength and toughness. Silicon nitride, known as a typical dielectric material, is an ideal candidate for several structural applications, even at high temperatures. The addition of graphene or carbon nanotubes to silicon nitride to create ceramic nanocomposites gives rise to promising applications in a wide range of fields such as electronics, biomedical aids, membranes, flexible wearable sensors and actuators, energy systems. The presentation shows how the use of different reinforcing phases and sintering methods affects microstructure and as a result, mechanical properties, electrical conductivity and tribological properties of the final silicon nitride nanocomposites. The prospective future applications will be also discussed.

Keywords: Nitride, Carbon Nanotube, Graphene.

Biography:

Dr. Csaba Balázsi (MSc-1993, PhD-2000, DSc-2014) is a Scientific Advisor in HUN-REN Centre for Energy Research, Centre of Excellence of Hungarian Academy of Sciences. He is President of Fine Ceramics section of the Hungarian Scientific Society of Silicate Industry (SZTE) and Representative of SZTE in International Ceramic Federation (ICF), Member of Council Board and Industrial Working Group Leader (ECerS), Member of the American

Ceramic Society (ACerS), European Materials Research Society (EMRS), Bolyai Engineering Science Committee Evaluation Member (HAS), Member American Nano Society. He served as Board Member of the Hungarian Society of Materials Science (MAE), Executive Committee Member of Federation of European Materials Societies (FEMS), Member of PEC (ECerS) and Steering Committee Member of Energy Materials Industry Research Innitiative (EMIRI), Brussels. He organized several international conferences, was acting as chair of ECERS2017 (Budapest), FEMS Junior EUROMAT2018 (Budapest), EMRS Fall Meeting Symposia (Warsaw) with topics on ceramics based nanocomposites in 2009, 2012 and co-chair of WoCERam2019 (Budapest). Awards: Bolyai Plaqett (Hungarian Academy of Sciences), Fellow of the European Ceramic Society (ECerS), Gabor Dennis award (Novofer Foundation), ACerS Global Amassador (ACerS), Fellow of the American Ceramic Society (ACerS) and Academician of the World Academy of Ceramics.

A Theoretical Construction of Graphene by Applying Twin Physics

Anna C.M. Backerra
Institute for Theoretical & Applied Micro Magnetics,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 and occur in nature joined, one of both dominatingthe observation. The resulting descriptions are 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, two of them being surrounded by a finite magnetic field.

After an introduction to twin physics without going deep into the basics, a graphene molecule will be constructed according to this theory. We start with two Hydrogen molecules; next a Helium atom is constructed from them and two Helium atoms are combined to a Beryllium atom. Adding one more Helium atom, a Carbon atom is obtained. Using the characteristic of the involved types of electrons, it turns out that this Carbon atom has the features of Graphene, including three sigma bonds, one pi-bond and a high conductivity.

Keywords: Twin Physics, Graphene, Four Types of Electrons.

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 in Nano Progress. They may be downloaded at www.itammagnetics.com. Discussed subjects are nanotechnology, graphene, optics and human magnetism. Four types of electrons are described. The most recent article is titled 'Electron creation by photon annihilation'. The results about magnetism, seen in a broad perspective, gave rise to the establishment of an institute, fully dedicated to the theoretical as well as applied investigation of related subjects.

High Speed Roll to Roll CVD Graphene And Applications

Yongki Kim
Charmgraphene Co.,Ltd. South Korea

Abstract:

A CVD graphene can be applied to various high-tech industrial fields due to graphene's excellent quality characteristics, and many researches are being conducted around the world. However, difficulties in mass production and high prices of CVD graphene are hindering the development of application products, which is also a significant obstacle to the industrialization of CVD graphene.

The Charmgraphene has been developing roll-to-roll CVD technology that enables high-speed, mass production of CVD graphene to solve this problem for over 10 years. As a result of these efforts, high-speed production of up to maximum 2 m/min has been possible. In addition, Charmgraphene is attempting to develop various application products by solving the graphene supply issues and is developing a variety of products from low-end to high-end products.

Accordingly, I would like to introduce a Charmgraphene's roll to roll CVD technology and the development of technologies for commercialization of CVD graphene, such as EUV pellicle and vacuum window using graphene membrane technology.

Keywords: CVD Graphene, Roll to Roll, Membrane, Industrial Scale.

Biography:

CEO of Charmgraphene Co,.Ltd., PhD in Physics which analysis electronic structure of surface and interfaces in Sungkyunkwan university. Developed deposition equipment for semiconductors and displays, such as sputter, CVD, and evaporator. Have developed Roll to Roll CVD equipment for mass production of graphene for over 10 years. Being Struggle for the CVD graphene industry success as developing of killer-application products.

Graphene-like Materials in Tribological Applications

Andreas Kailer
Fraunhofer-Institute for Mechanics of Materials IWM, Germany

Abstract:

Different graphene-types have been investigated as possible additives in lubricants, polymers and ceramic materials to improve their tribological behaviour (friction, wear, lubricity). In this presentation, the recent results of these projects are summarised in order to appraise the usefulness of different approaches for technical applications:

- Graphene as additives in lubricants
- Graphene fillers in polymers and polymer coatings
- Graphene-fillers in ceramic materials

For each approach, the synthesis, and results of the tribological tests are discussed. As far as already investigated, synergies with other tribological materials like PTFE and ionic liquids are evaluated and hypotheses for tribological mechanisms are made. Finally, some perspectives for technical use and applications are given and results for application-related evaluations are shown.

Keywords: Graphene, Friction, Wear, Polymer Coatings, Ceramics, Lubrication.

Biography:

Andreas Kailer received his doctoral degree in Applied Mineral Sciences at University Tübingen, Germany in 1999 and then joined the Tribology Department of Fraunhofer Institute for Mechanics of Materials IWM, where his current position is Group Manager. His main research fields are tribology of ceramic materials, high temperature tribology, and tribo-corrosion.

Towards Simultaneous Photovoltaics and Optical Wireless Communication with Fluorescent Optical Antennas

Jacopo Catani[1,2*]
Marco Meucci1[,2], Mauro Aresti[1], Ali Muhammad Umair[1], Massimo Calamante[3], Sergio Brovelli[4], Franco Meinardi[4]
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2 LENS European Laboratory for NonLinear Spectroscopy, Via Nello Carrara 1, 50019 Sesto Fiorentino, Italy
3 ICCOM-CNR Istituto per la Chimica dei composti Organometallici del CNR, Via Madonna del Piano 10, 50019 Sesto Fiorentino, Italy
4 Dipartimento di Scienza dei Materiali, Universita Milano-Bicocca, Via R. Cozzi 55, 20125 Milano, Italy

Abstract:

Optical Wireless Communication (OWC) will represent one of the key assets for 6-th generation communication systems (6G), unleashing revolutionary applications in several sectors, ranging from indoor to vehicular, terrestrial, intra-, and inter-satellite applications. Recently, a new class of optical receiver (RX) based on organic and/or inorganic fluorescent materials dispersed in Luminescent Solar Concentrator (LSC) waveguides have been studied and developed, proven remarkable advantages in terms of Optical Gain (OG) and Field of View over conventional photodiode-based receivers. Besides inherent advantages, such approach naturally paves the way towards the realization of multi-purpose, hybrid devices, capable of joint optical communication and energy harvesting. Such devices could have tremendous impact in deploying sustainable and pervasive communication architectures.
We will present recent results on development and tests of efficient optical antennas for white-light Visible Light Communication (VLC), employing fluorescent planar waveguides based on both organic and inorganic fluorophores. We will show a thorough characterization of their intrinsic properties of two novel organic antennas as RX stages for VLC applications, as well

as the results of communication tests with off-the-shelf white LED sources. In the last part, we will also report on the characterization of the first demonstration of a smart window with combined VLC and solar energy conversion capabilities based on photovoltaic semitransparent glazing units for integrated building photovoltaics (IBPV) exploiting Quantum Dots as wavelength conversion elements.

Keywords: Visible Light Communication, Solar Energy, Optical Wireless Communication, Optical Antennas.

Biography:

J.C. is Senior Researcher with National Institute of Optics - CNR (Sesto Fiorentino, Italy), and is responsible of the OWC/VLC research Lab at CNR-INO. His research interests span from novel systems for optical wireless communications from visible to THz range, to research in quantum science and technologies based on atomic quantum gases.

Quantum Mechanical Device for Permanent Plasma Enclosure in a New Type of Fusion Reactor

Friedrich Grimm
MD-RES Institute, Germany

Abstract:

The talk by Prof. Friedrich Grimm concerns a fusion reactor for which quantum effective geometry conditions are described to achieve permanent electromagnetic plasma confinement. Symmetry conditions within a double helix are identified for charged particles with spin quantum number 1/2 to return to their original spin state within one orbit through the double helix, allowing the electromagnetically induced fluid dynamics of the plasma to be understood as a harmonic ring oscillation. This harmonic oscillation achieves dynamic equilibrium within the high-energy state of a fusion plasma. The proposal for a novel fusion reactor also includes the technical principles for assembling the fusion reactor with the quantum-mechanically effective double helix, designed as an integrated system composed of modular components and functional elements. This integrated system enables continuous plasma confinement in the plasma vessel of the fusion reactor for an unlimited period of time. The fusion reactor in question is centred at the intersection of a space defined by longitudinal, transverse and vertical axes. It's designed to achieve stable electromagnetic confinement of a plasma volume within a plasma vessel surrounded by multiple Helmholtz coils. The plasma volume is organized in a multitude of layers around a central magnetic field line consisting of four identical arcs with four vertices and four connecting points arranged on a radius around a centre point.

This central magnetic field line is surrounded by concentric helix surfaces, which provide space for the inclusion of off- centre magnetic field lines in multiple layers. Helmholtz coils, positioned at regular intervals across the central magnetic field line, induce an electromagnetic current in the plasma and, in conjunction with a chiasmus of the looped magnetic field lines, force a fourfold inversion of the spin of charged particles with a quantum number of 1/2 along a zero line of the ring oscillations, spanning two periods of harmonic ring oscillations. Within the concentric layers of the plasma volume and between the tube surfaces, deuterium and tritium nuclei and electrons are guided along spiral eccentric magnetic field lines, with equal path

lengths for electrons and ions. The operational capability of the fusion reactor is made possible by a coil cooling system, a plasma heating system, a plasma vessel heat transfer system, a plasma vessel support structure and a fuel injection system. The reactor enables continuous operation by allowing the nuclei of deuterium and tritium to collide at temperatures between 100 and 400 million degrees Celsius and speeds exceeding 1000 km/s. This collision triggers a chain reaction that causes the nuclei to fuse to form helium, releasing a million times more thermal energy than would be possible in any exothermic chemical reaction. This is why fusion is so fascinating, and why it holds the promise of elegantly solving humanity's pressing energy problems.

Advances in High Performance Computing

Houssain Kettani
Department of Computer Science, Al Akhawayn University, Ifrane, Morocco

Abstract:

Over the last three decades, the landscape of high-performance computing has undergone a remarkable transformation, witnessing a phenomenal increase in processing capabilities coupled with a dramatic reduction in physical footprint. This transformative journey has propelled the fastest supercomputers from the modest performance of one Teraflop/s in 1997 to one Exaflop/s in 2022, marking an astounding million-fold performance gain in a quarter of a century. Notably, this exponential progress is not confined to specialized computing behemoths alone; even today's ubiquitous handheld devices, such as smartphones, boast computational prowess that rivals the formidable machines at the start of this century. This evolutionary shift towards enhanced computing capabilities has not only revolutionized hardware but also reshaped our daily interactions with technology. Inevitably, hardware limitations necessitated the integration of parallel computing into the very fabric of our digital existence. It has become inconceivable to envision a device, including smartphones, that does not harness the power of multiprocessors. What originated as a hardware-driven response to physical constraints has catalyzed a paradigm shift in software engineering. This, in turn, has kindled a fervor for parallelism, spurring theoretical advancements in algorithm design and analysis. The result is a computational landscape increasingly oriented towards parallel processing rather than a reliance on serial execution.

This newfound focus on parallelism has ushered in a host of possibilities. It empowers us to harness more extensive datasets and conduct a multitude of simulation trials, profoundly enhancing the precision and smoothness of Monte Carlo simulations. However, this surge in computing prowess carries a double-edged sword. The exponential growth in computational capability also augments the efficiency of brute force attack algorithms on encryption standards. This ominous trend suggests that the widely adopted Advanced Encryption Standard

may become obsolete by the end of the century. Yet, as we venture into the era of exascale computing and beyond, it is imperative to retain a vital perspective. The true power of humanity does not solely reside in the formidable machines we create but, fundamentally, in our intelligence and our capacity to craft innovative solutions to fundamental challenges. Amidst the relentless march of technology, let us never forget that the heart of progress is our ability to adapt, evolve, and apply our collective intelligence to shape a future where high-performance computing is a tool for the betterment of humanity.

Keywords: Algorithms, Computing, Exascale, Technology.

Biography:

Dr. Houssain Kettani received the bachelor's degree in Electrical and Electronic Engineering from Eastern Mediterranean University, Cyprus, and Master's and Doctorate degrees both in Electrical Engineering from the University of Wisconsin, Madison. Dr. Kettani has over twenty years of academic experience, he served as faculty member at the University of South Alabama, Jackson State University, Polytechnic University, Fort Hays State University, Florida Polytechnic University, Dakota State University, University of South Carolina Aiken and Al-Akhawayn University. Dr. Kettani also has served as Staff Research Assistant at Los Alamos National Laboratory, Visiting Research Professor at Oak Ridge National Laboratory, Visiting Research Professor at the Arctic Region Supercomputing Center at the University of Alaska and Visiting Professor at the Joint Institute for Computational Sciences at the University of Tennessee.Dr. Kettani's current research interests include cybersecurity and data analytics. He presented his research in over hundred refereed conference and journal publications and according to Google Scholar, his work received close to one thousand citations by researchers all over the world. He chaired over hundred international conferences throughout the world and successfully secured external funding in millions of dollars for research and education from US federal agencies such as NSF, DOE, DOD, and NRC.

Graphene / Boron Carbide Ceramic Composites Prepared by SPS And Flash Sintering

Pavol Hvizdos
Slovak Academy of Sciences, Slovakia

Abstract:

Ceramic materials containing various amounts of graphene platelets within boron carbide matrix were prepared by the field assisted sintering methods, namely by spark plasma sintering (SPS) and by flash sintering methods (FSPS). Carefully prepared powder mixtures were sintered by SPS at 2200 °C, at heating and cooling rate of 100°C/min, with simultaneous application of 15 MPa pressure and with no holding time. For FSPS, the samples were discharged just for 24 seconds under a peak power of about 25 kW which is the 65% of machine power.

In B4C/GPLs system prepared by SPS technology almost full compaction was reached for all specimens up to 5 wt.% of GPLs addition. The highest density 99.9% of ρTD was measured for the reference material. These well compacted experimental materials are the result of precise preparation of starting powders and using of the technological benefits which bring SPS processing. In FSPS technique the effect of carbon-based sintering activators was observed, when specimen with the addition of 5 wt.% of GPLs achieved 95.7% of ρTD in comparison with the carbon-free reference material which reached only 90.6% of ρTD and a higher portion of pores caused by the process.

Microstructural analysis of polished B4C samples, cross-sections and fracture surfaces were carried using scanning electron microscopes (FIB – SEM Auriga Compact and EVO 40HV, Carl Zeiss). Fracture surfaces of reference materials show the difference of the used processing method on material densification. On the fracture surfaces of composites at relatively low magnification, the distribution of the GPLs in the B4C matrix and the preferential perpendicular orientation of GPLs to the pressing direction during sintering process is visible. The GPLs were relatively well dispersed and arranged in boron carbide matrix. The addition of GPLs has no significant influence on the grain size of the boron carbide, but the addition of GPLs has an important role in densification of experimental materials prepared by FSPS technique.

The hardness of the composites prepared by SPS was in the range of 26.6–17.7 GPa. In the case of FSPS samples the strong effect of residual porosity on hardness values in the range of 16.9–14.0 GPa is evident.

The addition of GPLs and new processing ways had a positive effect on fracture toughness. The KIC values of SPS specimens were in the range of 2.52–4.17 MPa.m1/2 which is the improvement of 61%. In the case of FSPS specimens, fracture toughness values were in the range of 4.63–5.14 MPa.m1/2 and the small drop could be caused by porosity.
The elastic modulus of the SPS specimens was in the range of 542–433 GPa and for the FSPS ones in the range of 519–441 GPa. All elastic moduli were influenced by the presence of pores in the material because the pores represent a secondary phase with a zero modulus of elasticity.

This work was suported by Slovak Research and Development Agency under the contract no. APVV-19-0497, APVV-21-0402, and APVV-22-0493. The support of M-ERA.NET3/2021/82/DuplexCER/2022 is also greatly appreciated.

Keywords: Boron Carbide, Field Assisted Sintering, Graphene Platelets, Ceramic Composites.

Biography:

Associated Professor Dr. Pavol Hvizdos, DrSc. is a leading scientist and researcher in the Slovak Academy of Sciences. He has been working in the IMR SAS since 1988.
In 2000-2002 he worked at Queen Mary University of London, UK, in 2003-2008 he held a post-doc position at Universitat Politécnica de Catalunya in Barcelona, Spain. In both places he served as a teacher, supervisor of diploma and project theses, and PhD co-supervisor. After his return to the IMR SAS he has been working as a senior scientist and student supervisor (4 PhD, 10 MSc theses). His scientific expertise includes microstructure and fracture properties of composite structural ceramics, recently his interest have been focused on nanoindentation, tribology, and advanced fabrication methods of composite materials. He is a principal investi-

gator and reviewer of number of domestic and international research projects. He serves also as a reviewer in a number of world renowned material science journals. He is a member of several journal editorial boards. He authored over 300 scientific papers with more than 1500 citations (h-index 23), 3 monograph chapters and 3 university textbooks. Since 2014 he has been serving as the Director of IMR SAS, Kosice, Slovakia.

Progress of Laser Time Transfer at Chinese Space Station

Zhibo Wu*, Kai Tang, Wendong Meng, Mingliang Long, Zhongping Zhang
Shanghai Astronomical Observatory of Chinese Academy of Sciences, Shanghai, China

Abstract:

Satellite Laser Ranging (SLR) enables range measurements with sub-centimetre precision and accuracy, featuring long-range capability and robust resistance to disturbances. It holds broad prospects for applications in the determination of precise orbits and station coordinates, the calculation of Earth's gravity field and Earth Orientation Parameters (EOP), laser time transfer, etc. And the time transfer technique further provides insights into the time and frequency metrology and space geodesy. The Chinese Space Station (CSS) is equipped with a laser time-frequency transfer payload (CLT) developed by Shanghai Astronomical Observatory (SHAO), integrating single-photon detector, event timer, laser reflector and other modules. The size of the CLT unit is 230×190×169 mm, the mass amounts to 6 kg, and its power consumption is approximately 24W with fluctuations up and down due to different working modes This payload is used to establish a high-precision and highly stable space-to-ground time-frequency transfer link, assess the stability of CSS's atomic clock frequency signal, and was launched in October 2022.To overcome lots of difficulties such as low orbit, fast range variation, and short overpass time, the payload is designed with specifications such as high repetition rate of 10 kHz, large field of view up to 128 degrees, compact design, low noise, and high stability. A low-temperature drift detection circuit and input optical system with stable transmittance in various incident angles are applied, combined with ground laser emission energy control, to achieve low time walk in photoelectric detection. Since 2023, several satellite-based experimental measurements have been conducted using ground SLR stations. The results demonstrate that the precision of range measurements is better than 3mm, the precision of satellite-ground clock difference measurements is 20ps, and the satellite-ground clock rate difference reaches 1e-12. These findings validate the success of CLT payload, and further evaluations of higher precision clocks are planned for the future.

Keywords: Satellite Laser Ranging, Laser Time Transfer, China Space Station.

Biography:

Zhibo Wu, Professor of the Shanghai Astronomical Observatory of the Chinese Academy of Sciences, engaged in research on satellite laser ranging and its applications for many years, focusing on subjects such as satellite laser ranging, space debris monitoring, and laser time transfer payloads.

Application of an Industrial-Grade 100-Watt, 300-Kilohertz Picosecond Green Laser for Space Target Laser Ranging

Haifeng Zhang[1], Mingliang Long[1]*, Zhibo Wu[1,2], Huarong Deng, Yang Yu[4], Qin Si[1], Zhongping Zhang[1,2,3,]

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[3] East China Normal University State Key Laboratory of Precision Spectroscopy, Shanghai 200062, China

[4] Center For Advanced Laser Technology, Hebei University of Technology, Tianjin 300401, China

Abstract:

With the rapid development of aerospace, the outer space of the earth has set off a boom in commercial applications. Therefore, there is a growing demand for high-precision monitoring of space target orbits, as thousands of space targets are expected to be launched to the Earth's surface in the future.One of the most accurate technologies for measuring satellite orbits is satellite laser ranging, which uses laser pulses to accurately determine the round-trip time interval from a ground observation point to satellite. This technology has a ranging accuracy of sub-centimeter and millimeter, and it is widely used in high-precision monitoring of space target orbits. To meet the technological demands of high-precision laser measurement of space targets, an industrial-grade 100-watt 300-kilohertz picosecond green laser has been introduced. This laser has a single pulse energy of 380 uJ, a pulse repetition frequency of 1Hz~1MHz, a pulse width of 14 ps, a divergence higher than 0.3 mrad, and a beam quality of M2=1.1. Based on the 60 cm-telescope satellite laser ranging system of the Shanghai Observatory, the laser works at a repetition frequency of 5 kHz to achieve all-day high-precision ranging of the

low, high and synchronous orbits of the cooperative target satellite, and the optimal ranging accuracy reaches 2 mm; Additionally, to address the interference of laser backscatter light in the atmosphere, an ultra-high repetition frequency SLR in the alternating mode of distance gated transceiver has been proposed. This innovative approach has been tested and verified through technical research and experiments on distance gated circuits, lasers, low-noise and high-efficiency single-photon detection, data processing, and real-time display. As a result, an ultra-high repetition frequency satellite laser ranging system has been established. At a laser repetition frequency of 200 kHz, the system can achieve high-precision ranging of cooperative target satellites in low, high, and synchronous orbits throughout the day, significantly improving the amount of measurement data and reaching an optimal accuracy of ~40um. Furthermore, the system can also be used for ranging large-sized space debris, with a maximum distance of 1294 km and a minimum fragment size of 4.5 m2. This research is the first in the world to demonstrate that a single laser can be used for both high-precision cooperative target ranging and space debris measurement. It has greatly advanced the development of satellite laser ranging technology and promoted the high-precision detection and monitoring of space targets through laser ranging.

Keywords: Satellite Laser Ranging, Space Debrism, Pulse Repetition Frequency, Back-Scattering, Single Photon Detection.

Biography:

Zhang Haifeng is a senior engineer at the Shanghai Observatory and a master tutor. His main area of expertise is satellite and space debris laser ranging. He has published over 30 papers and holds several invention patents.

Long Mingliang is an associate researcher at the Shanghai Observatory, he is also mainly engaged in satellite/space debris laser ranging. He publishes more than 20 SCI/EI paper, and authorized 6 invention patents.

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Advances in the Thermoelectric Measurements of 2D Superconductor Utilizing Contact Printed Circuit Boards

Sanaz Shokri
Institute for Metallic Materials, IFW Dresden, Germany

Abstract:

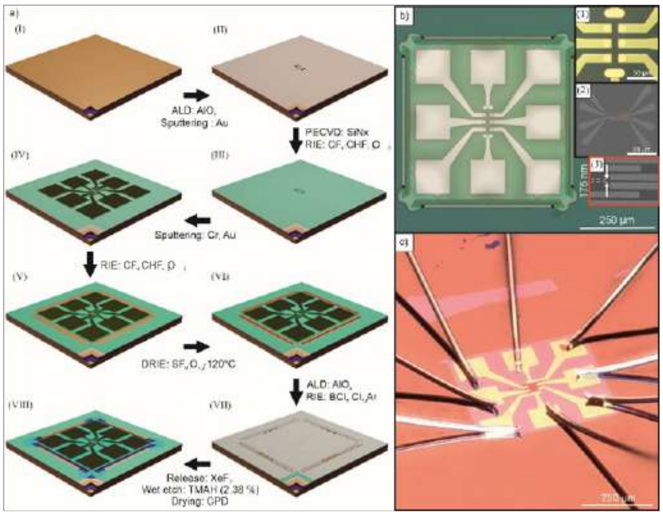
This study introduces an innovative approach to overcome challenges in contact pad fabrication for air-sensitive materials by incorporating a freestanding SiNx nanomembrane with variable thickness (ranging from 200 nm to 800 nm). The nanomembrane serves a crucial role in constructing a circuit tailored for thermoelectric transport measurements, housing thermoelements, a heater, and vertical contacts within its structure. This setup is designed for the investigation of a 2D Cuprate superconductor.

Functioning as a versatile interconnection medium, the nanomembrane seamlessly links bottom contacts with the underlying 2D materials and larger-scale pads through via contacts created by dry etching via reactive ion etching. Following the PDMS cryogenic transfer technique onto our material, this integration facilitates wire bonding on top of the nanomembrane. This, in turn, enables the electrical connection of our sample to the chip carrier on the PPMS puck, which is then loaded into the Cryostat. Notably, this approach eliminates the need for chemical solvents, photolithography, and traditional metal deposition on top of the nanomaterial, resulting in an exceptionally pristine surface morphology.

The utilization of thermoelectric measurements becomes particularly relevant due to the presence of van Hove singularities in the density of states, which can lead to an amplified Seebeck coefficient in 2D materials. This serves as an additional experimental tool to explore quantum transport phenomena in 2D materials. Furthermore, thinning down the Van der Waals heterostructure superconductor, such as Bi2Sr2Cu2O(8+δ) (Bi-2212), in hall measurements indicates an increase in the additional part arising from superconductivity vortices. Therefore,

Nernst measurements, which also indicate the formation and movement of superconductivity vortices, can be a valuable tool to study superconductivity by thinning down the heterostructure superconductor.

Keywords: Van der Waals Heterostructure Superconductor, 2D Material; Nanomembrane, Thermoelectric.



Biography:

I am Sanaz Shokri, currently a PhD student at TU Dresden, focusing on 2D superconductivity at the IFW Leibniz Institute. My research revolves around fabricating devices using 2D materials that are sensitive to air and moisture. To achieve this, I employ cryogenic techniques to fabricate the devices in order to measure various transport properties. Originally from Iran, I pursued my master's studies at TU Dresden, where I delved into the realm of bulk Cuprate superconductors. In my master's thesis, I conducted Nernst and Seebeck measurements to explore the superconductivity properties, particularly in the region above the superconductivity transition temperature, known as the Pseudogap.Saggau, Christian N, Shokri, Sanaz et al. "2D high-temperature superconductor integration in contact printed circuit boards." ACS Applied Materials & Interfaces 15.44 (2023): 51558-51564.

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