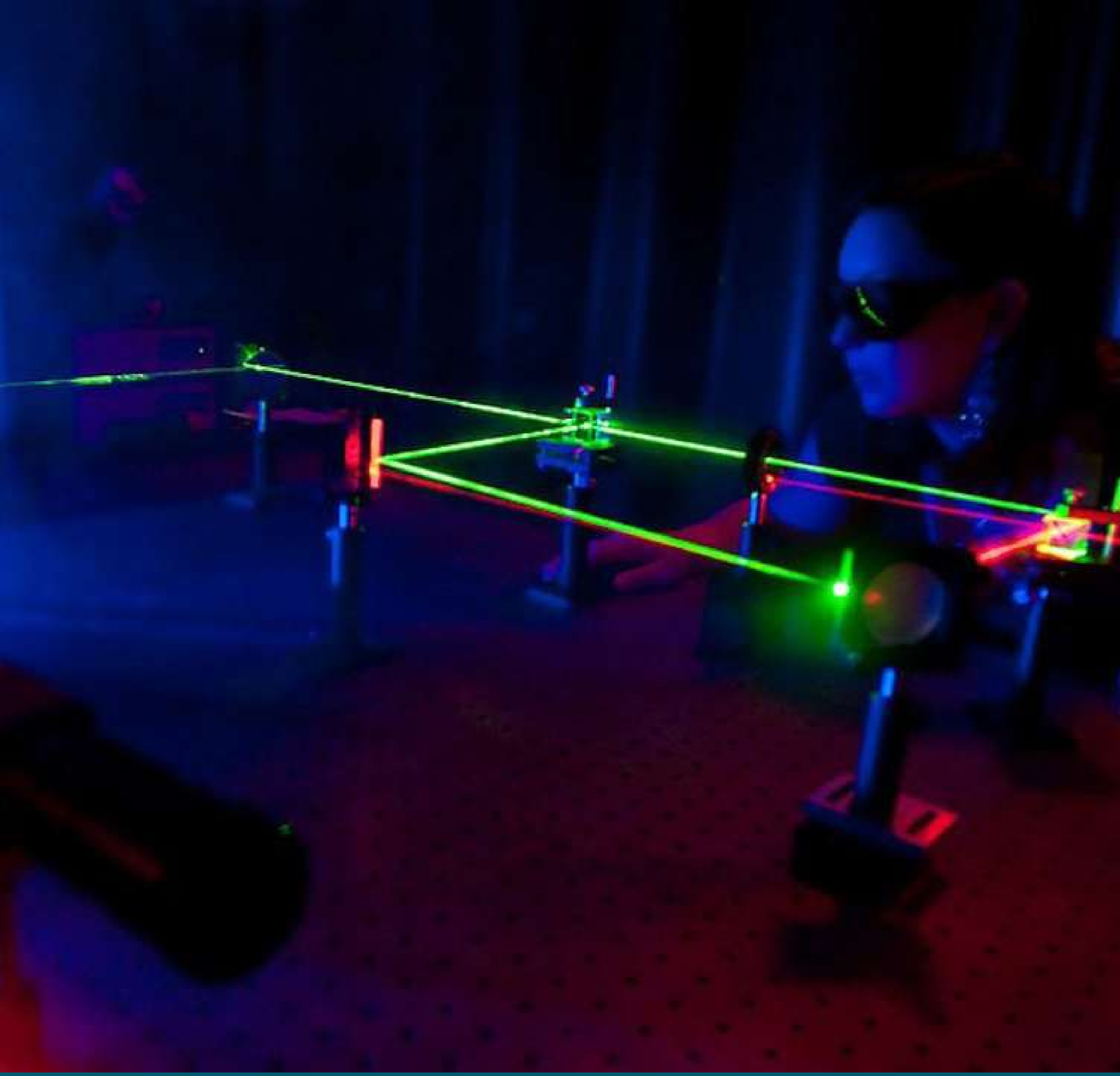

Abstract Book

LOPFORUM2023

International Forum on Lasers, Optics and Photonics

March 13-14, 2023 | Virtual Conference

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Dr. Alex Kazemi

ARK International LLC President & CEO

Fiber optic Sensing Systems for Aerospace and Aviation Applications

This presentation is an outline to fiber optic sensor systems and its understanding of the utilization of these systems for aerospace and aviation applications. It documents the current state of the art and provides references for users of this advanced technology for future of aerospace and track the rapid advances in leading edge technologies under development plus revolutionary progresses in fiber optic technology as applied to flight-test instrumentation that that has been achieved over the last two decades and are expected to continue at a rapid pace for the foreseeable future.

Optical fiber is well-known for its ability to carry information at high speeds over long distances. They have evolved a long way from the first low-loss fiber demonstrated in the late 1960s. Fiber optic technologies offer unique features that can be exploited in a variety of ways, such as carrying high optical powers in flexible light guides for welding stations, transfer ring images in endoscopes, distribute sensing along a large structure such as wing of the aircraft, and for low weight and high-transmission bandwidth in avionics.

Fiber Brag grating (FBG)-based sensing technology originally developed in 1978 represents a 20-fold improvement over existing sensing solutions and could represent a quantum leap forward for industries as diverse as aerospace, automotive, energy, and medical devices. Recently, there has been significant accomplishments in both manufacturing of fibers and the miniaturization of hardware, which has enabled movement of this technology form-controlled laboratory environments to realistic aircraft operations. Using fiber optic Brag grating potentially will eliminate strain gages and their associated wiring while collecting more accurate and densely spaced measurements at a significantly reduced system weight. The technology also enables the determination of many other derived engineering parameters such as structural shape, and applied loads; information that has not been available before with conventional aircraft sensors systems. Fiber optic system not only will revolutionize flight test instrumentation, but able to monitor health of structure of aircraft in real time.

This presentation also covers the current state-of-the art for FBG/LPFG technologies and provides references for users to track the rapid advances expected in fiber optics in the coming years. One application for this technology could be to a wide range of aircraft systems in order to establish a comprehensive set of data for aging aircraft. Other future applications could entail embedding fiber optic systems in composite structures as they are manufactured, allowing extremely light-weight flexible structures to be actively controlled, and giving enhanced capability to aircraft systems.

Biography:

Dr. Alex Kazemi a world recognized Micro Technologist, and materials scientist is the CEO and President of ARK International LLC is focusing on development of fiber optics, miniaturized fiber components, fiber optic sensors, and micro/nano technology of laser components for aviation, aerospace and space applications. He is developer of the lightest fiber optic cable in aviation history, World 1stfiber optic sensor for rocket engine, U.S. 1stfiber optic delivery system for micro welding oflaser chips, and leading-edge technologies. He isThe Boeing CompanyFiber Optic Architect, Associate Technical Fellow,and worked for 25 years for Boeing as well as 10 years fortelecom, lasers, sensors and MEMS indus-

tries. He also taught physics and materials science for several years at University of Southern California.
Currently he is the Principal Consultant for development of new generation of fiber optics and sensors to the Boeing Company. He has authored/edited 8 books and one book chapter in the area of photonics, lasers, sensors, fiber optics, micro and nano technologies, plus published over 48 papers in International Journals and hundreds of presentations throughout of conferences and technical community's world-wide.In recent survey by "Research Gate" organization over 1500 of his peers reviewed his published papers. In 2018, 2019 and 2021 three separate International Awards were awarded to him for the phenomenal presentation for his research on fiber optic sensor and lasers. He has been Chairman of SPIE International Conferences in Photonics Applications for Fiber Optic Sensors and Lasers for 8 years and Chairman, Chief Scientific Committee and Chief Editor of Excel Global International Conference on Lasers, Optics, Photonics, and Sensors since 2021. He has bestowed hundreds of recognitions, awards and patents.

Edgar A. Mendoza, Yan Esterkin, Theodore Andreas, Sebastian Mendoza

Redondo Optics Inc

Advanced Fiber Optic Sensors for Applications Where Weight, Size, and Power are Critical for Operations

Fiber optic sensing (FOS) is a well-established and mature technology used within an array of industrial applications from avionics and aerospace, automotive, energy, infrastructure, transportation, robotics, and biomedical applications among many others uses providing key sensing and monitoring solutions in challenging applications. Fiber optic sensors typically use either a single, or multiple, optical fibers for the distributed multipoint measurements of strain, stress, temperature, pressure, vibration, velocity, acceleration, acoustics, ultrasound, moisture, chemical agents, and corrosion deployed over multiple locations of an analyzing structure. The most prominent advantages of fiber optics sensors are their small size, light weight, and immunity to electromagnetic interference enabling placement of the sensing elements in places where electronic sensors have difficulties performing. A major disadvantage of fiber sensor technology is that conventional state-of-the-art fiber optic sensor interrogation data logger systems are typically bulky, heavy, and high-power consuming bench top instruments not suitable for use in applications where weight, size, power, and cost are critical for operation. Recent advances within the telecommunication industry and their progressive development and use of photonic integrate circuits (PICs) and Silicon photonics optical microchips is enabling the development of miniature, lightweight, and battery power FOS interrogation systems suitable for passive and dynamic sensing with high-speed data acquisition, and wireless data transmission. This presentation will describe new trends in the use of photonic integrated circuit (PIC) microchip technology as an enabling tool for the development of miniature, lightweight, and power efficient fiber optic sensor systems.

Dr. Mahmoud El-Sherif

Acousto-optic Imaging Applications

Fiber Optic Hydrophone Sensors for Medical

Existing major Bio-medical Imaging Systems/techniques are three types. The first is the Magnetic Resonance Imaging (MRI) system which uses strong magnets and radio waves to create detailed pictures of the organs and tissues within the body. It is a very sensitive technique, however using strong magnets and radio waves makes MRI systems not healthy for repeatable use. The second is the Computerized Axial Tomography (CAT) Scan, which is an X-ray procedure combining many X-ray images with the aid of a computer to generate cross-sectional views and 3-D images of internal organs and more, which is also not safe for human repeatable use. The third one is the Ultrasound Imaging Systems, wherein, ultrasound sound waves are beamed into the body causing return echoes that are recorded to "visualize" structures beneath the skin tissue. The technology is especially accurate at seeing the interface between solid and fluid filled spaces, and is safe for human use but with very limited sensitivity and poor resolution. The technical limitations are due to the limited ultrasound frequency, which can't exceed bout 10 MHz. This limits the images resolution and contrast. The limitation is due to the limited minimum size of the piezoelectric hydrophone.

Because of the human health and safety issues when using MRI and CAT Scan, as well as the limited imaging quality when using ultrasound technique, a novel imaging system is underdevelopment. The idea is based on replacing the piezoelectric hydrophone detector, by a fiber optics hydrophone, capable of detecting ultrasound echoes in any medium next to the hydrophone. The fiber optics imaging hydrophone system is consisting of a large number of miniature fiber optic pressure sensors, positioned in a 2-D array structure. There will be no limitations on the frequency of the ultrasound transducer, up to100 MHz and more. Each of the miniature pressure sensors is constructed of a single optical fiber, wherein, the tip of the fiber has been modified by removing the fiber jacket and the cladding to have direct interaction of light signals within the core with the medium out side the fiber tip. Ultrasound echoes/pressure induces changes in the refractive index of the medium in contact with the fiber tip, resulting in modulating the signals within the fiber core. For better sensing sensitivity, the modified fiber tip is coated with a nano-layer of metal/gold, acting as a semitransparent coating. The optical back reflected signals, received from all photodetectors, are multiplexed to form the actual object image. In this paper, successful experimental work, on the development of a sensitive fiber optics hydrophones, will be presented, which is the first step in developing a novel safe and sensitive Acousto-optic Imaging (AOI) system for future medical applications.

Sukhdev Roy

Department of Physics and Computer Science, Dayalbagh Educational Institute, Agra 282005, India

Low-Power Deep Optogenetic Control of the Brain and Heart with Light

Optogenetics has made a strong impact in neuroscience by providing unprecedented spatiotemporal resolution in reading and writing neural codes with relatively lower invasiveness. In optogenetics, a genetically encoded light-sensitive protein is introduced into cells to make them sensitive to light. The expressed protein generates either inward or outwardcurrent in the presence of light, and can reversibly change the cell membrane voltage. Thus, the activity of these cells can be controlled and monitored with light. Optogenetics also enables all-optical control and recording of cellular activity in living tissue and opens up exciting prospects for optical neural prostheses. Recently, the first successful human trial of optogenetic retinal prostheses and promising results in cardiac optogenetics have been demonstrated.

Computational modelling of optogenetic systems has made significant contributions in developing a better understanding of the photocurrent dynamics in opsin molecules and the change in membrane potential in opsin-expressing cells in response to light. Computational models help in quick virtual testing of newly developed light-sensitive proteins in different cell types within realistic tissue and organ-level settings.

The talk would focus on our recent research in computational optogenetics for low-power, high-fidelity and high-frequency excitation, inhibition and bidirectional control of different neurons in the brain and cardiomyocytes in the heart, with newly discovered light-sensitive proteins and opsin pairs. The study not only provides a better understanding of the mechanism to efficiently control different cells but also allows optimization of their response.

Desensitization of photocurrent is a fundamental problem while using faster opsins. Under sustained illumination, the photocurrent in fast opsins desensitizes with time and results in spike failure below a certain threshold. Recently, we have shown that co-expressing step function opsins with fast channelrhodopsins can overcome this challenge. It has also been shown that ultra-low power deep sustained optogenetic excitation or suppression of electrical activity in human cardiomyocytes can be achieved with the newly discovered ChRmine opsin. The future prospects of optogenetics will also be discussed.

Biography:

Sukhdev, Roy, Professor and Head of the Department of Physics and Computer Science, Dayalbagh Educational Institute, Agra 282005 India.

Professor Sukhdev Roy received the B.Sc. (Hons.) Physics from Delhi University in 1986, M.Sc. Physics from DEI, in 1988, and PhD. from IIT Delhi in 1993. He joined the Dayalbagh Educational Institute in 1993, where he is at present the Head of the Department of Physics and Computer Science. He has been a Visiting Professor at many universities that include, Harvard, Waterloo, Würzburg, Regensburg, Osaka, City University and Queen Mary University of London, TIFR, Mumbai and IISc. Bangalore. He has also been an Associate of ICTP, Trieste, Italy. He has won a number of awards and fellowships and published 175 research papers. He chaired the 8th World Conferenceon Nanoscience and Nanotechnology, Philadelphia, USA in 2020. He has delivered more than 100 invited talks that include the prestigious Keynote Address at the 38th Convocation of the CAETS, and at the Annual Meeting of American Physical Society. He was the Guest Editor of the March 2011 Special Issue of IET Circuits, Devices and Systems on Optical Computing.He is an Associate Editor of IEEE Access, Fellow of SPIE, Indian National Academy of Engineering, National Academy of Sciences, India, IETE (India), and Optical Society of India, and a Senior Member of IEEE.

Professor. Syed Murshid

Florida Institute of Technology

Pushing Higher Data Rates Through Optical Fiber Systems by Combining different Multiplexing and Modulation Techniques

This presents high speed fiber optic communications architectures that push the frontiers of the state-of-the-art. The demand for faster and reliable data communications continues to grow unabated. Quantum growth in transmission media can only be addressed through implementation of new modulation and multiplexing techniques. Therefore, this endeavor presents optical communication architectures that revolve around spatial domain multiplexing, aka space-division multiplexing (SDM), and orbital angular momentum (OAM) of photon-based multiplexing. SDM is a multiple-input, multiple-output (MIMO) architecture that launches optical energy from multiple laser sources of the same wavelength into a single carrier fiber with different input orientations. The resultant channels follow helical trajectories while traversing the length of the fiber and exhibit no crosstalk, thereby enabling spatial reuse of optical frequencies, and adding a new degree of photon freedom to optical fibers. It is also shown that SDM channels carry their OAM. Hence, it is possible to multiplex data from multiple laser sources as a function of the spin of their OAM. Finally, it presents results for a hybrid architecture that combines SDM with an all-optical PAM4 modulated scheme.

Biography:

Professor Syed H. Murshid is the director of Optronics Laboratory and a professor of Electrical and Computer Engineering at the Florida Institute of Technology in Melbourne, Florida. His research endeavors revolve around optical communications and sensors, and he is pushing cutting-edge technologies in the field of photonics. He has added two new degrees of photon freedom to optical fibers by inventing spatial domain multiplexing and orbital angular momentum of photon-based multiplexing. His current research is focused on integrating these technologies for multi-Terabits/sec communication architectures. He disseminates the results of his research endeavors regularly in peer-reviewed articles, books, book chapters, conference presentations, and white papers. He has published multiple books, hundreds of invited and contributed papers, and holds numerous US and international patents.

Awards

- Named one of Florida's five most influential scientists, Florida Trend magazine, November 2004
- Teacher of the Year, College of Engineering, Student Government 2000-2001

Patents

- International Patents in the following countries: Australia, Canada, European Union, Germany, and Japan.

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Yang Yue[1], Tianxu Xu[2] and Dongzhao Yang[1]

[1]*School of Information and Communications Engineering, Xi'an Jiaotong University, China*

[2]*School of Electrical and Information Engineering, Zhengzhou University, China*

Fiber optic Sensing Systems for Aerospace and Aviation Applications

Human joint extraction has a wide range ofapplications in human-computer interaction, virtual reality, augmented reality, intelligent video surveillance, intelligent medical care, etc. Unlike the current human joint extraction method based on two-dimensional images, which is easily affected by the environment and light, the infrared Time-of-Flight (ToF) depth camera has significant advantages in dark light conditions and other complex environments, and can quickly and accurately acquire the target's depth information. To realize human joint extraction based on single-frame point cloud, a ToF depth camera is used to capture the human point clouds with different poses, and two human joint extraction algorithms have been proposed. The former determines the positions of the human joints based on the geometric characteristics of 3D human silhouettes in different poses. The algorithm is validated on the public dataset and in-house captured dataset, and the average distance error of the extracted joints is <5.8 cm. The latter uses the PointNet++ deep learning network method to realize the part segmentation of the human body point cloud, and combines different human body parts in the model through mathematical analysis methods to realize the extraction of human body joints. The results show an average normalized error of <4.2 cm. Based on this, we further investigate the multi-size measurement method of the human body. The results show that, with the appropriate parameters, the average measurement error for all the relatedsizes was <4.1 cm.

Biography:

Yang Yue, Professor at Xi'an Jiaotong University, China

Yang Yue received the B.S. and M.S. degrees in electrical engineering and optics from Nankai University, China, in 2004 and 2007, respectively. He received the Ph.D. degree in electrical engineering from the University of Southern California, USA, in 2012. He is a Professor with the School of Information and Communications Engineering, Xi'an Jiaotong University, China. Dr. Yue's current research interest is intelligent photonics, including optical communications, optical perception, and optical chip. He has published over 200 journal papers (including Science) and conference proceedings with >10,000 citations, five edited books, two book chapters, >60 issued or pending patents, >200 invited presentations (including 2 tutorial, >40 plenary and >50 keynote talks). Dr. Yue is a Fellow of SPIE, a Senior Member of IEEE and Optica. He is an Associate Editor for IEEE Access and Frontiers in Physics, Editor Board Member for four other scientific journals, Guest Editor for >10 journal special issues. He also served as Chair or Committee Member for >100 international conferences, Reviewer for >70 prestigious journals.

Ali Masoudi* & Gilberto Brambilla

Optoelectronics Research Centre (ORC), University of Southampton,

Southampton, UK

Fiber optic Sensing Systems for Aerospace and Aviation Applications

Because of their intrinsic geometrical features and extraordinary transparency, optical fibers allow for continuous and dynamic monitoring of strain along all their length. In state-of-the-art systems, 100,000 points can be resolved over a range of the order of 50 km, providing an extremely cost-effective strain sensing solution per sensing node. In its basic implementation, a light pulse is launched into the sensing optical fiber and the Rayleigh backscattered light is monitored, in a process similar to a radar system. While the phase relation between different points along the fiber is used to reconstruct the strain (thus the acoustic information), the time of flight (e.g., the delay between injected pulse and received backscattered light) provides information about the physical location along the fiber. In the last decade, research on novel detection schemes and fibers has allowed extending the detection range to over 170km, to decrease the spatial resolution below 10 cm and significantly increase the signal-to-noise-ratio. As a result, distributed acoustic optical fiber sensing (DAS) has found applications in the oil and gas industry for oil well monitoring and geodesics and more widely for the monitoring of border and perimeter security, resulting in a market of the order of $1 billion. More recent applications include monitoring of railways and road traffic, structural health, earthquakes, and other geophysical events.

Biography:

Ali Masoudi, Senior Research Fellow

Dr Masoudi is a senior research fellow in the Optoelectronics Research Centre (ORC) at the University of Southampton and leads the distributed optical fiber sensing group at the ORC. He received his PhD degree in 2015 for his work on distributed acoustic sensors. After receiving his PhD, Dr Masoudi designed and developed portable DAS units which he subsequently used in several industrial collaborations with entities such as Network Rail, BT, and Carbon trust. He has authored 3 patents and published more than 60 papers in scientific journals and international conferences and has presented his research as an invited and keynote speaker on 7 different occasions.

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Fiber optic Sensing Systems for Aerospace and Aviation Applications

Laser ablation propulsion is space propulsion that utilizes reaction force against object surface ablated by laser irradiation. It was proposed to deorbit space debris, such as abandoned satellite, with this laser ablation propulsion. Recent years, demonstration in space is being plannedconcretely as a preparation for deorbiting service.In this project,a satellite equipped with laser is rendezvoused with a target satellite, and the orbit of the target is gradually changed with repetitive laser pulse irradiation.To know the characteristics of the laser ablation importantfor the demonstration,following three things were investigated using YAG laser with the wave length of 1064 nm and the pulse width of 10 ns. First one is characteristics of the laser ablation of multi-layer insulator (MLI), which is the sheet covering most of satellites.

Biography:

Yusuke Nakamura, Designated Assistant Professor.

Yusuke Nakamura is a designated assistant professor at Department of Aerospace Engineering, Graduate School of Engineering, and Nagoya University. His research interests are electric propulsion and compressible flow. 2019 Doctor Degree (Doctor of Science, The University of Tokyo) 2019- Nagoya University, Department of Aerospace Engineering.

B. I. Gramatikov
Ophthalmic Instrumentation Development Laboratory Wilmer Eye Institute The Johns Hopkins University School of Medicine Baltimore, Maryland, United States

New developments in the detection and treatment of amblyopia using optical technologies

Amblyopia, otherwise known as "lazy eye", is a disorder of the visual system that is characterized by poor or indistinct vision in an eye that is otherwise physically normal.The problem arises from chronic suppression by the brain of the visual image from a blurred or misaligned eye.The term "lazy eye", frequently used to refer to amblyopia, is inaccurate because there is no "laziness" of either the eye or the person with this condition. "Lazy brain" is a more accurate term to describe amblyopia. An estimated prevalence is about 1.6 - 3.6% of the population. Approximately 380,000 children in the US alone are affected by amblyopia. The primary causes of amblyopia are Strabismus ("Misalignment of the eyes", typically "crossed eyes."), and Defocus, where different type or amount of refractive error between the two eyes (anisometropia), are causing a discrepancy in the focus between the two eyes that can lead to amblyopia in the defocused eye. In the case of strabismus in childhood, the brain may suppress the input from one eye in order to avoid double vision or visual confusion. Our primary goal has been to develop a Pediatric Vision Screening (PVS) instrument for early detection of amblyopia. Such an instrument is best based on the birefringence of the Henle fibers, i.e. their property to causepolarization changes in the reflected light during scanning with polarized light. The polarization change depends on the angle between the orientation of the fiber and the plane of polarization of the incoming light. A family of Retinal Birefringence Scanning (RBS) vision screeners is described in the talk. In addition, other methods for detecting amblyopic suppression are presented, based on visual stimulation and simultaneous acquisition of electrophysiologic signals. Finally, our shutter-glass-based stimulation system for unsuppressing a "lazy eye" is introduced. This system is subject to a pilot laboratory trial.

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Development of the Networked Objective Opto-meter for Vision Screening

We are working to develop the networked auto-refractor for mass vision screening. This refractor can be separated into three parts: Shack-Hartmann sensing unit, communication link and computing unit. The working principle will be introduced. The communication link is new to existing refractors, so it is a main focus in this talk.

Dayan Ban

Department of Electrical and Computer Engineering, Waterloo Institute for Nanotechnology, University of Waterloo, 200 University Ave. West, Waterloo, Ontario N2L3G1, Canada

Scanning Probe Microscopy Measurements of Photonic Devices

The operation and performance of active photonic devices are governed by inner workings such as electric potential distribution and dynamic charge carrier distribution, which can conventionally be calculated from theoretical modeling but rarely be measured directly from experiments. The experimental characterization of active photonic devices is mainly focused on input/output behaviors or static structural information. In the former case, the devices are in operation but no nanoscopic information can be obtained. In the latter case, nanoscopic structural information can be obtained by using scanning electron microscopy and transmission electron microscopy but the devices under inspection are not in their working condition. Scanning probe microscopy, including scanning spreading resistance microscopy, scanning capacitance microscopy and scanning voltage microscopy (SVM), is a novel and enabling tool to quantitatively probe internal dopant profile, voltage distribution and carrier distribution at nanometer scales. In this talk, I will present our experimental study by applying scanning probe microscopy to a few representative photonic devices – buried heterostructure (BH) lasers, ridge waveguide lasers, terahertz (THz) quantum cascade lasers (QCL) and interband cascade lasers (ICL). The experimental results demonstrate that the unique SPM technique can reveal the inner workings at nanometer scales , thus connect internal mechanism with external measures. The demonstration of resolving dynamic charge carrier density distribution and electric potential profile in an operating optoelectronic laser device is unprecedented and could open the door to many future applications in probing the underlying mechanisms for many puzzling issues such as sub-par performance and degradation in nanoelectronic devices, quantum devices and optoelectronic devices.

Note: to the organizing committee, this is my abstract submission for the invited talk that I have accepted as a keynote speaker. Thank you for your invitation.

Dror Malka

Faculty of Engineering, Holon Institute of Technology (HIT), Holon 5810201, Israel

Four and Two C-Band Channel Using Multi Silicon Nitride MMI Configuration

Dense wavelength division multiplexing (DWDM) technology is used to increase the data transfer bitrate by decreasing the spacing between peak wavelengths and as a result more channels can be utilized for a single spectral band.Back reflection losses are a key problem that limits the performances of optical communication systems that work on DWDM technology based on Silicon (Si) Multimode Interference MMI waveguides. In order to overcome this problem, we propose a novel design for a 1×4 optical demultiplexer based on the MMI in Silicon-Nitride (SiN) strip waveguide structure that operates at the C-band spectrum. Simulation results show that the proposed device can transmit 4 and 2-channels with a 10 nm spacing between them that work in the C-band with a low power loss range of 1.98-2.35 dB, large bandwidth 7.68-8.08 nm, good crosstalk 20.9-23.6 dB. Thanks to the low refractive index of SiN a very low back reflection of 40.57 dB is obtained without using a special angled MMI design which usually required using Si MMI technology. Also, the results show the promising potential for such a device to be implemented in DWDM technology communications systems to increase the data bitrate.

Biography:

Dror Malka received his BSc and MSc degrees in electrical engineering from the Holon Institute of Technology (HIT) in 2008 and 2010, respectively, Israel. He has also completed a BSc degree in Applied Mathematics at HIT in 2008 and received his Ph.D. degree in electrical engineering from Bar-Ilan University (BIU) in 2015, Israel. Currently, he is a Senior Lecturer in the Faculty of Engineering at HiT. His major fields of research are nanophotonics, super-resolution, silicon photonics and fiber optics. He has published around 50 refereed journal papers, and50 conference proceedings papers.

Heinz W. Siesler

Department of Physical Chemistry, University of Duisburg-Essen, D 45117 Essen, Germany

On-Site Quality Control and Protection against Product Counterfeiting byHandheld Near-Infrared Spectrometers: Anytime, Anywhere by Anyone

Recently, miniaturization of Raman, mid-infrared (MIR) and near infrared (NIR) spectrometers has made substantial progress, and marketing companies predict this segment of instrumentation will have a significant growth rate within the next few years. This increase will launch vibrational spectroscopy into a new era of quality control by in-the-field and on-site analysis.
While the weight of the majority of handheld Raman and MIR spectrometers is still in the>1 kg range, the miniaturization of NIR spectrometers has advanced down to the < 500 g level, and developments are under way to integrate them into mobile phones. Thus, based on high-volume manufacturability and significant reduction of costs, numerous companies target primarily with NIR instruments a non-expert user community for consumer applications. Especially from this last-mentioned development, a tremendous potential for everyday life can be expected ranging from food testing to detection of fraud and adulteration in a broad area of materials (pharmaceuticals, textiles, polymers, etc.).
However, contrary to the exaggerated claims of many direct-to-consumer companies,this presentation will provide an impression regarding the present user potential of these instruments by discussing in detail selected, realistic industrial and every-day-life applications.

JiangGuo

State Key Laboratory of High-Performance Precision Manufacturing, Department of Mechanical Engineering, Dalian University of Technology, Dalian 116024, PR China

Ultra-precision polishing technology for microstructured surfaces

Microstructured surfaces have been widely used in the field of national defense, optics, microfluidics, surface engineering, etc. owing to their unique characteristics and functions compared with the traditional surfaces. Currently, for fabricating microfeatures in size of tens to hundreds of micrometers, precision machining technologies are primarily employed considering machining cost, efficiency and flexibility. However, due to the limitation of the achievable surface quality attributed to defects such as burrs, tool marks and subsurface damages, a post-polishing process is therefore inevitable. To solve the problem that high efficiency, high accuracy and high surface quality cannot be all taken into account by the present polishing technology for microstructured surface, this work conducted research from the aspects of method, mechanism and applications. A new multi-field coupling (mechanics, magnetic, chemical) polishing technology and equipment for typical micro-structured surface such as V-groove and rectangular structure is proposed. The profile accuracy maintaining mechanism of microstructured surface under the multi-field coupling is investigated. At the same time, the removal and suppression mechanism of surface defects is illustrated. Finally, through the practical application of the technology using optimized process parameters, successful applications have been achieved on typical microstructures such as Fresnel lenses and microfluidic molds. The achievement of the research will provide as technical support for the high-performance manufacturing of precision parts.

Keywords: Polishing, Magnetic abrasives, Multi-field Coupling, Microfeature, Surface damage.

Dr. Jose Marques-Hueso

Heriot-Watt University, ISSS, School of Engineering & Physical Sciences (EPS), Edinburgh, EH14 4AS, United Kingdom

Material Science Shortcuts to Enable Low-Power Laser Manufacturing

This talk will present different techniques that have been developed to enable multimaterialintegration by using manufacturing-with-light technologies, in particular laser writing and stereolithography.Particularly, it will be focused on how to achieve low-power laser manufacturing, increasing the efficiency of some processes. Firstly, it will be presented a technique that enables the direct light writing of metal tracks on a variety of 3D printed materials. The light exposure through direct laser writing facilitates the nucleation of silver nanoparticles on the polymer samples. Later, this nanoparticles are used as nucleation layer for metal plating. Two different catalytic techniques have been developed to accelerate the patterning photoreactions, with increases by up to two orders of magnitude. Different polymers have been studied, including biodegradable materials, high temperature plastics and elastomers. The technique provides a high throughput and resolution (25 µm). Next, it will be presented a technique that provides a shortcut to the limiting printing depth of current stereolithography technology. Common stereolithography photoresins exhibit penetration depths of only a few millimetres. This imposes the limitation of only being able to write in a 2D contour at a time, or layer by layer. Here, the penetration depth has been increased over the centimeter scale by using non-linear effects. For this, a new formulation, which includes components with defined optical energy levels, has been developed. This strategy has enabled the 3D printing of rigid-flexible and multicoloured samples by stereolithography. This new technique paves the way to unexpensive multimaterial 3D printing.

Biography:

Dr. Jose Marques-Hueso is associate professor at Heriot-Watt University, Edinburgh, UK. His research focus on the use of optical materials, laser manufacturing, spectral conversion and engineering applications. He received his MSc in physics from the University of Valencia and he completed his PhD at the Institute of Materials Science of the UV, on the development of nanophotonic and plasmonic devices. In 2011, he joined Heriot-Watt University as a research associate, and obtained a position as assistant professor in 2017. He has been an associate professor since 2021. He has led public and industrially funded projects and carried out consultancy for laser manufacturing processes. He has published over 80 publications.

Niloy K.Dutta

Department of Physics, University of Connecticut, Storrs, CT 06268

Quantum Dot Semiconductor Amplifiers and Their Application to High-Speed Optical Logic Systems

Semiconductor optical amplifiers with quantum dot (QD) active region have fast gain and phase recovery times due to the presence of the wetting layer which acts as a reservoir of carriers. A rate equation model for gain and phase response has been developed which includes nonlinear dynamics including carrier heating, spectral hole-burning, carrier relaxation, and wetting layer.

All-optical Boolean logic functions AND, XOR and NOT using Mach-Zehnder interferometers with semiconductor optical amplifiers with quantum-dot (QD) active layers is studied at 80Gb/s. The results show that the QD excited state and wetting layer serve as reservoir of carriers, and, the ultra fast carrier relaxation from these layers, results in high speed Boolean logic operations. Logic operation can be carried out up to speed of 250 Gb/s. The performance of a pseudo-random bit stream generator (PRBS) will be presented. Optical encryption and decryption circuits have been studied.

Biography:

Niloy Dutta is a professor of physics at the University of Connecticut, Storrs, CT. He was Director of Optoelectronic Device Research at AT&T Bell Laboratories, Murray Hill, NJ. He is a Life Fellow of the Institute of Electrical Engineers (IEEE), a Fellow of the Optical Society of America, a Fellow of the International Society of Optical Engineers (SPIE), and, a Fellow of the Connecticut Academy of Science and Engineering. He received the Photonics Society Distinguished Lecturer Award in 1995 and Bell Laboratories President's Award in 1997.

Kazemikhoo N[1,2*], Nilforoushzadeh M A[1], Mokmeli S[3], Zare S[1], Dahmardehei M[4], Vaghar doost R[4], Momeni M[4], Ansari F[5]

1. *Skin and Stem Cell Research Centre, Tehran University of Medical Sciences, Tehran, Iran.*
2. *Department of Dermatology. St. George Hospital. UNSW. Sydney. Australia.*
3. *Canadian Optic and Laser Centre, COL centre, BC, Canada.*
4. *Department of Biology, Faculty of Science, Islamic Azad University, Hamedan branch, Hamedan, Iran*
5. *Burn Research centre, Department of Plastic and Reconstructive Surgery, Iran University of Medical Sciences, Tehran, Iran.*
6. *Research Centre for Evidence-Based Medicine, Health Management and Safety Promotion Research Institute, Tabriz University of Medical Sciences, Tabriz, Iran*
7. *Iranian EBM Centre: A Joanna Briggs Institute Affiliated Group*

An Open Label Study of Photo Bio Modulation Followed by Autologous Fibroblast Transplantation for Healing Grade 3 Burn Wounds in Diabetic Patients

Background:
Photo bio modulation (PBM) has been used as an effective therapeutic modality since the mid-1960s. Although there have been several clinical studies using PBM in wound healing especially diabetic, pressure and venous ulcers, there are few reports of using this technique in burn ulcers. Autologous fibroblast transplantation is a novel treatment for patients with burns or venous ulcers. In this study for the first time we used PBM along with autologous fibroblast skin transplantation to treat grade 3 burn ulcers in diabetic patients.

Materials and Methods:
After Tehran university Ethics comity approval (IR.TUMS.REC.1394.1683) and Iran Registry of Clinical Trials (IRCT2016050226069N3, ten diabetic patients with 10 grade 3 burn ulcers, who were candidate for skin graft surgery entered the study. Donor skin was biopsied using 3 mm punch. Fibroblasts were extracted and cultured in-vitro in GMP Technique lab. Patients were treated using PBM in 3-4 weeks during the time that fibroblast cultures became ready to use. PBM was done using red light, 650 nm, 150 mW, 1 J/ cm2 for the bed of the ulcer and infra-red light 808 nm, 200 mW, 6 J/ cm2 for the margins every other day for 10 sessions.

Results:
The mean wound size before treatment was 16.28 Cm2. All patients healed completely after 10- 12 weeks.

Conclusion:
We conclude that this method can be used as an effective method for treating large wounds especially in complicated patients including diabetics.

Key Words:
Photo bio modulation, Autologous Fibroblast Transplantation, Burn Wound

Stephen W James

Centre for Engineering Photonics, Cranfield University, Cranfield, UK

Interferometric measurement of shape, strain and pressure for aerospace applications

Optical fiber segment interferometry (FSI) is an emerging technologythat exploits the principles of Range Resolved Interferometry (RRI) to allow the multiplexing of a serial array of interferometers formed between in-fibre reflectors, offering high resolution measurements athigh bandwidths, with a noise floor of 1x10-4 rad/√Hz at bandwidths > 100 kHz. In this presentation, the versatility, robust nature and high-fidelity measurement capabilities of this technique are demonstrated, focusing on potential applications in the aerospace sector. In a wind tunnel test, FSI was used to characterize the strain distribution along the flap of a high-lift wing, while RRI was exploited in an extrinsic fibre Fabry Perot interferometer to facilitate measurement of pressure, exhibiting measurement performance comparable to that of a commonly deployed electrical pressure sensor. 44 fibre segment interferometers were deployed on a helicopter rotor blade during a full-speed ground test, in a configuration that allowed the measurement of the strain distribution along the blade, and also the direct measurement of changes in the shape of the blade, providing and data on the dynamics of the blade obtained from a sequence of controlled pilot inputs.

Biography:

Stephen W James, Professor of Applied Optics.

Stephen James leads the optical fibre sensors research theme within the Centre for Engineering Photonics at Cranfield University, UK. He undertook his PhD at the University of Southampton, studying optical phase conjugation in photorefractive materials, and joined Cranfield University in 1993 as a post-doctoral researcher to develop 3D laser velocimetry instrumentation. As his academic career at Cranfield progressed, he worked on a number of optical measurement techniques, including speckle interferometry and optical fibre sensors. His current work encompasses the development, design and application of optical fibre-based sensors and instruments for sensing physical and chemical measurands, with a strong focus on their practical deployment. The instrumentation and sensors designed by the Centre have been field trialed in applications including flight testing on fixed wing aircraft and rotor craft, tramway component health monitoring, composite material production process monitoring, foundation pile characterization, and measurements of transient loading in superconducting magnets.

LOPFORUM2023

International Forum on Lasers, Optics and Photonics
March 13-14, 2023 | Virtual Conference

Andrea Zifarelli*[1], Pietro Patimisco[1], Stefano Dello Russo[2], Giansergio Menduni[1], Marilena Giglio[1], Angelo Sampaolo[1], Hongpeng Wu[3], Lei Dong[3], and Vincenzo Spagnolo[1]

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[2]*Italian Space Agency (ASI), Centro di geodesia Spaziale "Giuseppe Colombo", Matera, Italy*

[3]*State Key Laboratory of Quantum Optics and Quantum Optics Devices, Institute of Laser Spectroscopy, Shanxi University, Taiyuan 030006, China*

Quartz Tuning Fork as Infrared Photodetector in Tunable Diode Laser Absorption Spectroscopy

Environmental monitoring, as well as safety and security, oil&gas and biomedical applications demand for real time and in-situ solutions together with unambiguous identification and quantification of the chemical analytes composing the investigated samples. Gas spectroscopy exploiting laser sources is a reliable tool providing highly selective and sensitive detection with robust and compact sensor architectures. In the past decade, the rapid development of infrared laser technology has led to an increasing demand for photodetectors with high sensitivity and a wide operative spectral range suitable for spectroscopic applications. In this work, we report on the study of light-induced thermo-elastic effects occurring in quartz tuning forks (QTFs) when exploited as light detectors in Tunable Diode Laser Absorption Spectroscopy (TDLAS) sensors. When used as photodetector, the QTF can be either placed far from the target gas and sealed in a gas chamber with an inert gas or under vacuum or accommodate in the same gas cell confining the gas samples. Therefore, LITES approach can be employed as non-contact measurement method for remote standoff gas detection as well as compact gas sensor for the analysis high concentrations analytes. The photodetection process is based on light impacting on the tuning fork and creating a local temperature increase that generates a strain field. This light-induced, thermoelastic conversion produces an electrical signal proportional to the absorbed light intensity due to quartz piezoelectricity. The induced photothermal processes and the temperature distribution following the absorption of laser beam upon the crystal quartz was studied by using finite-element-analysis with COMSOL Multiphysics. The electromagnetic energy release and the induced thermal distribution were related to the absorbance curve of the quartz crystal. In the spectral region with high absorption, the radiation travels few tens of micrometers in the quartz crystal, while in the spectral region with low absorption, the radiation is trapped at the interface between the chromium film and the highly reflective gold layer.In this talk, the characteristics of QTF photodetectors will be presented and the main figures of merit will be described. Then, the results of the investigation upon the spectral response of the QTF-based photodetector will be presented. To demonstrate the flat response of QTF detectors, a custom tuning fork with a fundamental resonance frequency of 9.78 kHz and quality factor of 11500 at atmospheric pressure, was used as detector in a TDLAS setup and tested with five interchangeable laser sources operating at different wavelengths from 1.6 up to 10.35 µm were employed within TDLAS sensors. A spectrally flat responsivity of 2.2 kV/W was demonstrated, corresponding to a noise-equivalent power of 1.5 nW/Hz1/2, without employing any thermoelectrical cooling system.

Biography:

Andrea Zifarelli, Research Associate at University of Bari.

Andrea Zifarelli received the M.S. degree (cum laude) in Physics in 2018 from the University of Bari and his Ph.D. in Physics from the University of Bari in 2022. His research activities were mainly focused on the development of spectroscopic techniques based on laser absorption for the analysis of complex gas mixtures by employing quartz tuning forks as sensitive elements. This investigation was performed by using innovative laser sources as well as developing new algorithms for multivariate analysis approaches. Currently, he is research associate at the University of Bari and his research activities are carried out at the PolySenSe Lab, joint-research laboratory between Technical University of Bari and THORLABS GmbH.

AvazNaghipour

Department of Computer Engineering, University College of NabiAkram, Tabriz, Iran

Construction of Binary Self-Dual Codes from 4-Class Association Schemes

In this paper, we study binary self-dual codes from 4-class association schemes. We give a method to obtain self-dual codes from the adjacency matrices symmetric and non-symmetric of these schemes. In the case of symmetric 4-class association schemes, our focus will be on the rectangular scheme and association schemes derived from symmetric designs.

Biography:

Dr. Naghipour received Ph.D. degree in Applied Mathematics (Quantum Computing) from University of Tabriz, Tabriz, Iran in 2015. Now he is an Assistant Professor, Department of Computer Engineering, University College of NabiAkram, Tabriz, Iran.

Dr. Naghipour has published over 20 technical papers and is the author of the book Algebraic Construction of Binary Quantum Stabilizer Codes (LAMBERT Academic Publishing Co., 2016). His research interests include image processing, pattern recognition, artificial intelligence, medical information processing, fuzzy logic, genetic algorithms, neural networks, optimization, quantum computing, and quantum information.
Dr. Naghipour is a Member of the American Mathematical Society, and anIEEE member.

Dr. Naghipour is also a Member of the Mendeley Advisor Community and a Reviewer of IEEE Communications Letters.

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Badis Kahouadji[1,*], Mebarki Lamine[1]

[1]*Laboratory of physical-chemistry, University of Bejaia, Bejaia06000, Algeria*

Structural and Optical Properties of YPO_4:Pr^{3+}/ Polystyrene Luminescent-Polymer Nanocomposite Films

YPO_4/Polystereneluminescent nanocomposite films were successfully prepared throughthe direct solution mixing method, between luminescent nanoparticles of nanometrics size and polysterene granules.First, the structural and photoluminescence characterization of YPO_4 nanoparticles was given in detail.The XRD analysis of the YPO_4: Pr^{3+} (0.1, 2 % at) /PS nanocomposite films reveal two diffraction regions: one before 2θ=20°, attributed to the amorphous phase of the polystyrene, and other after 2θ=20° which presents several diffraction peaks attributed to the pure crystalline phase of YPO_4. An improvement in the crystallinity of PS was observed during the insertion of the nanoparticles of YPO_4: Pr^{3+} in the PS films, this improvement is more pronounced in the case of the YPO_4: Pr^{3+} (2% at) /PS film.The emission spectrum of the PS film underexcitation at 223nm shows a broad emission band in the UVA region (280-400nm). The emission spectra of the nanocomposite films show the same profile as that of the PS film, however a decrease in the intensity of the luminescence was observed. This decrease is more pronounced in the case of the YPO_4:Pr^{3+} (2% at)/PS film, thus the intensity quenching phenomenon is caused by the YPO_4:Pr^{3+} nanoparticles.

Keywords:
YPO_3:Pr^{3+}nanopowder,YPO_4:Pr^{3+}/PSnanocompositefilm , photoluminescence,direct solution mixing method.

Biography:

Dr. Kahouadji has a PhD in physics, option: physics of materials since April 2017, teacher researcher at A.Mira university of Bejaia –Algeria-, faculty of technology. He is working on nanomaterials based on rare earth orthophosphates in collaboration with two laboratories: Laser Department/ Nuclear Research Centre of Algiers (CRNA), Vinča Institute of Nuclear Sciences, University of Belgrade. Since approximately 7 years his research is entirely devoted to the development of luminescent materials and scintillators for medical and nuclear applications . He has managed 4 master project as director and 1 PhD thesis in progress. He has published more than 18 international papers. He is Editorial Board Member in International Journal of Materials Science and Applications (IJMSA).and Journal of Modern Polymer chemistry and Materials, Reviewer for Advances in Science, Technology and Engineering Systems Journal (ASTES). has about 6 international and 3 national oral communications.

Skills and expertise:
-Nanomaterials
-Luminescent materials
-Photoluminescencespectroscopy
- Sol-Gel Synthesis
- Phosphors.
- InorganicScintillators.
- NanocompositeScintillators.

*Elvis Moyo and Manny Mathuthu

Center for Applied Radiation Science and Technology (CARST),

North-West University (Mafikeng), Cnr Albert Luthuli Road and University Drive, 2735, Mmabatho,

South Africa

Application of LIBS to study the elemental composition between organic and genetically modified plants

Genetic modification includes the change in the genetic make-up of a plant in order to meet the requirements for food security, which is in contrast to organic plants that are grown naturally by the use of organic fertilizers and natural manure. The purpose of this research was to study the difference in elemental composition between organic and genetically modified plants. It is believed that the change in genetic make-up results in change in elemental composition of a plant. Laser induced breakdown spectroscopy (LIBS) was used to differentiate the two categories according to the signature of their essential and trace elements and determine the effects of GMO to people and the environment. LIBS was able to detect ten elements, Mn I, Fe I, Fe II, Cu II, K I, O I, Ca II, C I, N II and Ca I from both organic and genetically modified plants, but the difference was in elemental intensities. The absence of other elements on LIBS was due to its working limitation, which is the ability to analys elements on the surface of the sample. Hence, analyzing and comparing the elemental composition between organic and genetically modified plants can be the key solution to solve the plants related diseases

Keys words

Laser induced breakdown Spectroscopy (LIBS), elemental analysis, organic and genetically modified plants.

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Revalde G.[1,2,] Zajakina A.[3], Spunde K.[3], Abola A.[1], A. Martinovs4and Skudra A.[1]

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Study of Polychromatic UV Light Sources for Disinfection

The last pandemic caused by the SARS-CoV-2 virus evoked new interest in different means of disinfection and inactivation of human pathogens. One of the well-known tools that can be used for disinfection is ultraviolet light [1]. However, the potential of ultraviolet disinfection is not fully exploited due to the limited possibilities in the choice of UV light sources. Commonly, the mercury 253.7 nm resonance emission line is used due to theeasy production and availability of mercury low pressure discharge lamps. There are some experiments with ultraviolet light emitting diodes. However, the inactivation action of light below 240 nm and its interaction with different materials are not well studied.

In our work, we produced discharge lampsof a special type, containing different filling elements, to create a polychromatic light spectrum in the UV region for inactivation studies of viruses and bacteria, using different UV wavelengths in the region from 195 – 300 nm. One of the goals would be the disinfection of medical fiber-based equipment. The low pressure gas discharge lamps were filled by some metal element and inert gas as a buffer gas, and excited with outer electrodes at about 100 MHz frequency [2]. For these experiments, such elements as thallium, arsenic, selenium, lead, and others were used. The intensities of the lines in the ultraviolet region in absolute units were measured using Ocean Optics HR4000 monochromator and a NIST traceable calibration lamp, allowing the estimation of real doses, as well as inactivation tests withvirus sampleswere performed.

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2. Zorina, N., Skudra, A., Revalde, G. &Abola, A. 2020. Study of As and Tl high-frequency electrodeless lamps for Zeeman absorption spectroscopy. In: Proc. SPIE 11585, Biophotonics–Riga 2020.

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ecosystem" Nr. VPP-EM-FOTONIKA-2022/1-0001 and A.Ābola acknowledges European social fund Project No. 8.2.2.0/20/I/006.

Biography:

Gita Revalde, leading researcher, professor.

Main directions of scientific research: atomic physics, quantum physics,low-temperature plasma, light sources, laser spectroscopy, disinfection using UV, heavy metal detection using AAS, VOCs detection using CRDS. Lecture courses: General Physics, Photonics, Spectroscopy,Particle cooling and trapping, etc. Currently, studies are being conducted for the determination of VOCs in air and exhalation, in the development of UV light sources for disinfection and other applications. The experience of a project manager, supervisor and chief executor in about 20 projects: National Research Programmes (NextICT), COVID-19 mitigation, ECOSOC, ESF, ERDF, ERASMUS projects, managed and monitored large-scale infrastructure projects.). Administrative experience as director of the Higher Education Department of the Ministry of Education and Science (2007-2012), rector of Ventspils University of Applied Sciences (2013-2016), deputy rector of Riga Technical University (2013), director of the Latvian Council of Science (2020), and president of the Almaty University of Telecommunication and Energy. Expert of the Agency "Independent Agency for Accreditation and Rating", expert of the Latvian Council of Science "Physics and Astronomy", expert of the Serbian Council of Science, member of the Latvian Physics Society, member of the Latvian Union of Scientists.

Hernandez-Martin Estefania[1,2]

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Optical and Deep-brain Interface to measure Neural activity: ODIN

Both the deep brain stimulation (DBS) as well as the near infrared spectroscopy (NIRS) are technologies used by to measure the brain activity at deep brain and cortex levels. The technological developments have been miniaturized to levels unthinkable. The know-how acquired by us about NIRS field, and its application in measuring the brain function in humans, lead us to think that is the right time to develop an implantable neural interface. For that, a modified NIRS system (3 sources-4 detectors) with a size of 3x3 cm, along with a titanium cover, make an impermeable and biocompatible NIRS system. Prior studies described the successful use of NIRS system at subdural level (highly invasive), demonstrating the local metabolic activity at high spatial and temporal resolutions. Such multimodal assessment enhances the resolution, accuracy, and reliability of recordings, and thus the invasive procedure is beneficial especially in pre- and intra-surgical diagnoses. In contrast with prior studies, we purpose that the implantable NIRS system must be in the skull of an adult experimentation pig (less invasive) to evaluate the potential use of NIRS technology in medical and BCI applications. But also, if we add DBS technology that provides a great opportunity to record the neural activity from deep brain regions, we can get an interface combining multiple neurophysiological signals from deep brain regions until cortex. Both DBS as well as NIRS technologies have been used on the motor pathway, to treat the motor disease and testing the reliability and precision of NIRS tech, respectively. Here, we implant on this pathway in an awake pig while the animal is moving. We present ODIN, the first brain interface prototype which combine deep brain electrodes and implantable NIRS in movement animal model, to provide the command at a brain-computer interface (BCI) in an early future.

Katerina Lazarova[1,*], Darinka Christova[2] and Tsvetanka Babeva[1]

[1]Institute of Optical Materials and Technologies "Acad. J. Malinowski", Bulgarian Academy of Sciences, Sofia, Bulgaria,

[2]Institute of Polymers, Bulgarian Academy of Sciences, Sofia, Bulgaria

State-Of-The-Art in Development of Thin Film Based Optical Sensors for Environmental Monitoring of Humidity

Monitoring the level of humidity is a priority in many fields such as health care, preservation of cultural heritage, storage of food and medicinal products, etc. Advances in materials science create limitless possibilities in sensor technologies for optical response detection which stand out among the multitude sensors available. One of the simplest and easiest methods for estimating the level of humidity is through color detection. When interacting with the analyte/water molecules, the colorimetric sensor changes its color, indicating the level of humidity in this case, without the need for special equipment, usually bulky, expensive and electrically powered. Thin film sensors are precise, stable, reliable and cheap, offering numerous advantages over conventional sensors. Many materials and methods have been studied for the fabrication of such sensors in form of thin films, of particular interest being the reversibility of the sensor without the need for regeneration and the possibility of making it small and/or flexible. Among all studied materials, polymers allow the tuning of their properties and the synthesis of tailored copolymer structures suitable for the fabrication of humidity sensors. Eco-friendly technologies and materials are considered when developing new devices, and in recent years this trend has been particularly relevant.

Recent examples of the progress of materials implementation in such sensors based on single-film are hydrophilic and amphiphilic copolymers of different chemical composition and structure, including poly(vinyl alcohol) derivatives (i.e. polyvinylacetals), poly(N,N-dimethyl acrylamide)/poly(ethylene oxide) di- and triblock copolymers and star-shaped and branched chain architectures. Spin-coating is

chosen as an easy and suitable method for deposition of polymer thin films with excellent optical quality. Furthermore, these sensors exhibit fast response to humidity variations from 5 % to 95 % RH. The color/reflectance change, dependence of the sensitivity and hysteresis of the sensors on the copolymer composition and macromolecular architecture are investigated. The progress and challenges of developing a fully colorimetric thin film based humidity sensor are discussed.

Biography:

Assoc. Prof. Dr. Katerina Lazarova has been a scientist at the Bulgarian Academy of Sciences for the last 9 years. In 2013 she began her doctorate in the field of photonic crystals and optical sensors based on zeolites and porous materials. In 2016 she became a chief assistant at the IOMT-BAS and from 2019 to 2021 was a postdoctoral fellow with a scholarship in the same field. Curretly Dr. Lazarova is Associate professor. Author of more than 40 articles, with awards for presentations in scientific forums and participation in numerous scientific projects in collaboration with other scientific organizations.

Marilena Giglio, Andrea Zifarelli, Pietro Patimisco, Angelo Sampaolo and Vincenzo Spagnolo

PolySense Lab, Dipartimento Interateneo di Fisica, University and Politecnico of Bari, Via Amendola 173, Bari,70126 Italy

QEPAS-Based Sensors for Direct and Indirect Greenhouse Gases Detection

In this work we report on three multi-gas sensors based on QEPAS technique and developed for environmental monitoring purposes. In QEPAS the gas molecules to be detected are excited by a modulated laser source, whose emission wavelength matches a gas absorption line. The generated pressure wave is detected by a quartz tuning fork (QTF), whose damped prongs deflection causes a charge displacement. The QEPAS signal is proportional to the target molecules concentration, as well as the laser optical power, and the QTF quality factor.All the presented sensors employ a QTF with T-shape prongs, coupled with optimal tubes and resonating at 12456 Hz. The first detector is a laboratory workbench sensor, employing a Vernier-effect quantum cascade laser (QCL), acting as an electrically tunable, switchable light source with emission clusters in the range 2100 cm-1 to 2220 cm-1. Within this spectral range, carbon monoxide, nitrous oxide, carbon dioxide, and water vapor exhibit absorption features. The second and third detectors are compact, portable box-size sensors, employing a distributed-feedback (DFB) quantum cascade laser as the light source. One employs a DFB-QCL targeting carbon monoxide absorption lines and a hygrometer to measure the water vapor concentration. The other one employs a DFB-QCL targeting methane and water absorption lines, while a second QTF is used to detect gas molecules excited by a laser source placed externally to the box, in front of an aperture on the side panel. The operation of this box has been demonstrated by using an external DFB-QCL targeting nitric oxide and water vapor absorption features. Each of the three QEPAS-based sensors has been calibrated using certified concentrations of gas sample, in controlled pressure, flow and humidity conditions. The sensitivities and detection limits achieved with the three sensors allowed carbon monoxide, nitrous oxide, carbon dioxide, methane, nitric oxide, and water vapor detection in air. The three sensors were then employed to monitor the indoor (the first and third sensor) and outdoor (the second sensor) air quality. The concentration of the analyzed gas molecules in laboratory air matched the typical values of the amount of these gas species in an indoor environment. The concentration of the analyzed gas molecules in outdoor air, close to a traffic light, matched the daily averages reported by the local air inspection agency. Spikes of carbon monoxide concentration above the average value were correlated to heavy-duty vehicles in transit.

Biography:

M. Giglio, Assistant Professor.

Dr. Marilena Giglio studied Physics at the University of Bari, Italy, and graduated with an MS in 2014 (cum laude) and a Ph.D. in 2019. In 2012 she visited the group of Prof. van Leeuwen at the Academic Medical Center of Amsterdam, The Netherlands as a trainee. In 2016 she joined Prof. Tittel's group of visiting Researchers at Rice University, Texas. After a 2-year Post-Doc at the Polytechnic of Bari, Italy she's currently an Assistant Professor in the same institution. She has published 39 research articles (Scopus), 2 reviews, 1 book chapter, and more than 30 proceedings. She co-invented 2 patents.

Mircea Mujat, Ankit Patel, and Nicusor Iftimia

Physical Sciences Inc, USA

Phase Imaging of Retinal Microstructures

Recently, it was shown that by using a larger, offset pinhole in the adaptive optics scanning laser ophthalmoscope (AO-SLO) detection unit, images that capture multiply scattered light can reveal retinal structures with unprecedented clarity. Split-detector imaging uses two offset apertures on the opposite sides of the illumination spot and the image is obtained as the difference divided by the sum of the two offset images. This technique works well when imaging mostly round structures, like photoreceptors or red blood cells. It is also very sensitive to structures that have edges perpendicular to the split direction; however, it is less sensitive to structures along the split direction. We developed a new detection scheme with an arrangement of light collecting fibers that removes this disadvantage and provides isotropic imaging while retaining all the advantages of offset aperture and split-detector imaging. The method is simple and any SLO system can be easily retrofitted to use this imaging configuration. Four optical fibers are arranged as a compact bundle. Split-detection analysis is performed using multiple combinations of the four offset images. Multiple split images highlight structural edges such as blood vessel walls along different directions and reveal extraordinary maps of capillaries.The phase and the phase gradient images are obtained from any pair of orthogonal split images and enable additional contrast mechanisms for identifying retinal structures. The imaging modality described here enables fundamental research essential for early detection, diagnosis, and quantification of retinal disease. AO-SLO imaging based on simultaneous acquisition of multiple offset aperture images provides an improved, isotropic image free of single offset-axis directionality artifacts.Cellular resolution in retinal imaging provides clinicians with the possibility to see the building blocks of retinal microstructures such as cone photoreceptors, rods, retinal pigment epithelium (RPE) cells, pericytes – associated to the vessel wall structure, ganglion cells, blood cells, the microvasculature, microaneurisms, or the retinal layers.

Biography:

Mircea Mujat, Principal Research Scientist.

Mircea Mujat received his PhD at the University of Central Florida, College of Optics and Photonics in 2004. He continued his activity as a Research Fellow with Harvard Medical School and Wellman Center for Photomedicine, Massachusetts General Hospital, and is currently a Principal Research Scientist with Physical Sciences, Inc. His current research interests include high resolution optical imaging (i.e., optical coherence tomography, optical frequency domain imaging, adaptive optics, phase contrast imaging, confocal and polarization microscopy), polarized light scattering, and biomedical applications of lasers. Mircea is SPIE and Optica Senior Member, and Optica Fellow.

Angela Capocefalo A, Silvia Gentilini A, Loredana Massaro B, Claudio Conti B and Neda Ghofraniha A

Consiglio Nazionale delle Ricerche, Istituto dei sistemi complessi. Piazzale Aldo Moro 5, 00185-Rome (Italy)

Università La Sapienza, Dipartimento di Fisica. Piazzale Aldo Moro 5, 00185-Rome (Italy)

Disordered and Ordered Micorlasers

Light confinement at micron scales can lead to the realisation of microlasers used in the last decades in sensing, imaging and spectroscopy.

In this talk I will expose our achievements in Random Lasers (RLs) and Whispering Gallery Lasers (WGLs). In the last two decades we deeply investigated RLs and we used their "disordered emission" for lithographed and biomimetic lasers, paper based devices, spectral fingerprinting of complex micro structures and the first experimental demonstration of Replica Symmetry Breaking theory. I will show how this theory ca be used to obtain the emission mapping of a heterogeneous random laser with switching activity.
Recently we are using the "ordered emission" of WGLs for biosensing and mode coupling studies. We show protein detection with a sensitivity of less than 1ng.
I will also show a hybrid realisation of RL and liquid WG lasers with controllable emission used as photonic barcodes. By inserting proteins and powders inside liquid droplets we tune the emission lines of the microlasers within a spectral range of about 100 nm.

Biography:
Neda Ghofraniha is researcher at Istituto dei Sistemi Complessi (Consiglio Nazionale delle Ricerche) in Italy and currently working in the fields of random photonics and microlasers.
She has consolidated experience in nonlinear optics and nonlinear waves propagation and past experience in phase transitions in soft matter.

Her main achievements are the first observation of nonlocal dispersive optical shock waves in liquids and the first experimental demonstration of the Replica Symmetry Breaking Theory, that is mentioned in the motivations of the Nobel Prize in Physics 2022 to Giorgio Parisi.

In addition, she realised several micron sized lasers made of biomimetic and lithographed organic materials, liquid droplets and electrospun polymer fibres.

Personal Webpage: https://sites.google.com/view/neda-ghofraniha/home.

Dr. Nicusor Iftimia, SPIE/Optica Fellow

Physical Sciences Inc, MA

New advancements in using high-resolution optical imaging for guiding skin cancer therapy

High resolution Optical Coherence Tomography (OCT) and Reflectance Confocal Microscopy (RCM) can be used individually or combined to noninvasively diagnose nonmelanoma skin cancers (NMSCs). RCM provides submicron scale resolution and thus enables enabling identification of skin morphological changes, with the downside of limited penetration depth, while OCT imaging of the same lesion brings the benefit of better resolving its depth of invasion. In this paper we report the use of a novel hand-held probe that combines RCM and OCT within the same optical path for guiding laser or radiotherapy on basal cell carcinoma (BCC) patients. Probe capability to provide spatially co-registered enface RCM mages with subcellular-level resolution and cross-sectional images of skin with micron-scale resolution
has proven to enable accurate evaluation of BCC margins and effectively guide therapy.

QiuRong Yan, Wei Gao, Wencheng Li, YanQiu Guan, Bing Li

School of Information Engineering, Nanchang University, Nanchang, Jiangxi, 330031

Sampling and Reconstruction of Integrated Neural Networks for Photon Countingsingle-Pixel Imaging

Photon counting single pixel imaging is a combination of single pixel imaging and single photon counting techniques, it has the advantages of low cost and ultra-high sensitivity. However, long sampling and reconstruction time limit its application in high resolution and real-time scenarios. The compressed sensing reconstruction algorithm based on deep learning can map the measured value directly to the reconstructed image, avoiding the huge computational load of the traditional reconstruction iterative algorithm, and achieving fast and high quality reconstruction. On the basis of the deep compression reconstruction network, the sampling and reconstruction integrated neural network design (SRIED-Net) is proposed for photon counting single pixel imaging system, taking the binarized fully connected layer as the first layer of the network, by modifying the forward and backward propagation of the network, and training it into a binary measurement matrix, which can be directly loaded onto the digital micromirror array to achieve efficient compressed sampling, through the joint optimization of sampling and reconstruction subnetworks, high performance reconstruction is realized. In order to effectively remove block artifacts, a subpixel convolutional layer sampling subnet and an improved deep reconstruction network design (HRSC-Net) based on traditional Inception network are proposed to further improve the reconstruction performance. In order to avoid slow convergence caused by alternate training, a sampled-co-optimized compressed reconstruction network (OGTM) based on generation model is proposed to transfer the initial weights of sampling and generating subnetworks from an automatic encoder. The photon counting single-pixel imaging system is built. The results show that the above networks we proposedcan quickly generate images from few measurements, and its reconstruction effect is better than that of existing compressed sensing restoration algorithms.

Keywords: Single pixel imaging;Photon counting;Compressed sensing;Deep learning.

Biography:

Qiurong Yan received the B.S. degree from University of Electronic Science and Technology of China in 2005, the M.S. and Ph. D. degree from University of Chinese Academy of Sciences in 2008 and 2012, respectively. He is a professor with school of information engineer, Nanchang University and a winner of Outstanding Young Talents Project in Jiangxi Province. His research interests include single photon imaging, computational imaging, photon counting wireless communication. He has published more than 60 SCI and EI papers in important journals and academic conferences. As the first inventor, he authorized more than 20 invention patents.

Yiwei Dong, Xiang Guo, Bo Xu

Xiamen University

Lasers, Optics and Photonics

Ultrafast laser has the characteristics of high peak power density and significant nonlinear absorption, and the high-accuracy laser processing methods for the metallic materials have become a research hotspot recently. Since the change of the laser optical path and the complex physical phenomenon occurred during the process have a certain influence on the ablation morphology, it is difficult to determine an accurate numerical model to describe the entire process of the interaction between ultrafast laser and metallic material. We have conducted the orthogonal experiments on laser parameters to explore the effects of the laser parameters such as the repetition frequency, rotation rate, average power and overlap ratio on the surface morphology and depth of laser ablated metal. Based on the experimental and theoretical research and analysis, a dual temperature model to accurately describe the interaction relationship between femtosecond laser and metallic materials has been determined, and the influence of laser focus moving down and spot trajectory on laser processing has been analyzed, moreover, the change pattern of the metal ablation topography by the spiral drilling method has been discussed.

Considering the limitations of the two-temperature model in describing the phase transition process of materials, such as the coupling of multi-physics fields of solid-liquid, gas-liquid phase transition processes, the molecular dynamics and the two-temperature equation have been combined. With the help of ultrafast laser processing experiments, the influence of the different laser pulse widths and energy densities on the ablation morphology was obtained. However, the generated plasma during the processing cannot be ignored, since its shielding effect will affect the laser processing process, and the radiation power of the laser will be weakened as the pulse energy deposition on the metal surface, then the depth of ultrafast laser drilling will be affected directly. Therefore, by analyzing the formation mechanism of the plasma, the plasma shielding effect has been coupled in the improved two-temperature equation to realize the plasma shielding effect. Finally, through the numerical calculation of the three-dimensional space-time evolution of ultrafast laser ablation of metallic material, the constructed numerical model can accurately describe the interaction between ultrafast laser processing, which can be used to predict the topographic features of laser ablation accurately..

Biography:

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Currently Dr. Dongis an Associate Professor of Mechanical & Materials Engineering at the Xiamen University, Xiamen, China, where he directs the Advanced Manufacturing Lab (AML), He has more than 10 years of research experience focus on the Advanced Manufacturing Technology, Multi-scale modeling of heat and mass transfer for materials processing, Intelligent and adaptive control of manufacturing processes, etc., He has (co)authored over 10 conference papers, 10 patents, and approximately 50 articles, chapters, proceedings, and reports.

UPCOMING CONFERENCE

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