Book of Abstracts

INTERPHOTONICS 2019

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(INTERPHOTONICS 2019)

Kemer/Antalya - Turkey

November 4-9, 2019

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INVITED SPEAKERS

Id-275

Simple Strategies to Enhance Efficiency and Stability of Nano-Film Electrodes in Solar Energy Conversion Processes

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Abstract: Metal chalcogenide (MX; M = Cd, Cu, and others; X = S, Se or Te) polycrystalline film electrodes of are widely assessed in photoelectrochemical (PEC) solar energy conversions, for many reasons. These films are commonly prepared by chemical bath deposition, electro-deposition or other simple methods, but normally suffer low stability and low PEC conversion efficiency (<1%). Enhancement is being actively investigated. According to US-DOE, maximum conversion efficiency for these electrodes in 2020 is expected to be ~15%. To further enhance the electrode characteristics, we have use two simple strategies. Controlled film annealing and cooling rate is used to enhance particle characteristics (conductivity, interconnection, adherence, band gap value). Each metal chalcogenide film needs specific annealing temperature and cooling rate. To enhance charge transfer across the solid/redox couple interface, electrodes were coated with electro-active materials inside polymeric films, where the electro-active materials behave as charge transfer catalysts. Faster hole transfer to redox couple occurs, which increases photocurrent density. Hole accumulation in the space-charge-layer (responsible for electrode photo-corrosion) is also prevented. By combining both strategies together, metal chalcogenide film electrode stability and efficiency have been remarkably enhanced here. High efficiency values (~12 -18%) have been observed here for metal chalcogenide films. Details of results and their discussions will be described. Theoretical models will also be presented to explain how the modification methods affect both conversion efficiency and film stability. Future prospects of metal chalcogenide film electrodes will be critically discussed.

Keywords: Metal Chalcogenide, Solar Energy Conversion, Charge Transfer, Conversion Efficiency.

INVITED SPEAKERS

Id-279

Optoelectronic Tools in Non-Contact Detection of Threats for Security Implementation

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Abstract: Today's organizational structures, and regulatory frameworks involve more and more the security aspect in design and operation of counter measurements in terms of protection from any harm or danger threat. It applies to any vulnerable and valuable asset, such as single persons, buildings, communities, nations or international organizations, in general referred as critical infrastructures. The concept of Security is usually associated with risk, i.e. the possibility that some hazardous events concretize, and with threat, i.e. the action that triggers the risk actualization. Terroristic threats are usually asymmetric since the "defender" must cover all points of possible attack, while the attacker only needs to identify a single weak point upon which to concentrate the disruptive efforts. The ENEA Diagnostic and Metrology (DIM) Laboratory has contributed to the development of different optoelectronic monitoring tools, for real time analysis of suspicious substances including forensic applications. Among the detection technologies investigated and implemented, Raman-based spectroscopy, Laser Induced Fluoresence and Laser Induced Breakdown Spectroscopy have recently gained consents as potential tools to be implemented stand-off at a certain distance from the target also due to the high selectivity for a uniquely identification of the substance in a interfering background.

Keywords: Real-Time Sensing, Pinpointing Targets, Multi Sensor, Emerging Technology.

INVITED SPEAKERS

Id-282

Current State of the Development of the Opto-Electronic Oscillator

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Abstract: The opto-electronic oscillator (OEO) is a very well-known device used to generate high-frequency signals in the micro-wave and millimetre-wave ranges. One of the main advantages of the OEO is that the phase noise is not subject to the operating frequency, thanks to the resonator's properties. It is composed of both optical and electrical components and provides optical and electrical outputs simultaneously. There are some issues to be resolved with the OEO, such as multi-mode operation, long-term stability, and the power penalty. From the middle of the 1990s there have been many solutions developed to minimize these challenges. In this invited talk we will introduce the main points of all the solutions in order to provide the efficient use of the OEO and we describe the application of an OEO in a radio access network (RAN). In addition, techniques such as the feedback control loop, the quality multiplier, the dual loop and the multi-loop as well as an OEO in a two-mode fibre will be reviewed. We have also introduced a useful technique to measure the free spectral range and the side-mode suppression efficiently. The compact and novel, fully integrated OEO will also be discussed. Possible implementation of the fully integrated OEO in next generation RAN will be discussed and some solutions will be offered to fix the challenges of the fully integrated OEO. M. Alp Ilgaz received funding (ITC CG) from the EUIMWP (CA 16220) COST Action to attend this conference. The work presented in this article was created within the FiWiN5G Innovative Training Network, which has received funding from the European Union's Horizon 2020 Research and Innovation Programme 2014–2018 under the Marie Skłodowska-Curie Action, grant agreement No.642355.

Keywords: Opto-Electronic Oscillator, Integrated Microwave Photonics, Millimeter Wave, Radio Access Network, Integrated Optics.

INVITED SPEAKERS

Id-284

Progress of Silicon-Based Design for Optical Phased Array

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Abstract: Optical phased array (OPA) has attracted significant attention owing to its promising capabilities of non-inertial optical beam forming and steering. By manipulating the specific distribution of the amplitudes and phases of the array, OPA can form the desired radiation patterns, which enables numerous applications, such as laser radar, 3D imaging, display, and optical communications. Compact, high-speed, high-efficient phase modulator array is indispensable for the OPA. In our research, we propose to utilize high-contrast grating (HCG) as phase modulator. It is proved that HCG possesses high-Q resonances that origins from the cancellation of leaky waves. As a result, sharp resonance peaks appear on the reflection spectrum thus HCGs can be utilized as efficient phase shifters. As an example, a thermo-optic phase shifter is proposed and demonstrated by utilizing the high-Q resonance in HCG. The Q-factor up to ~12000 is measured in a footprint of 110 μm×300 μm. A phase shift of ~1.2π under heating power of ~32 mW is directly observed and demodulated. On the other hand, we theoretically and experimentally investigated the 8 × 8 system design for silicon-based OPA, including the star coupler, phased array, emission elements and far-field patterns. The non-uniform optical phased array which is controlled by wavelength for simplified beam steering was presented. Furthermore, we propose a modularized architecture of an OPA, using electro-optical pixels. Each pixel contains a directional coupler, a micro-ring phase shifter, and a grating optical antenna, on a compact configuration of area 50 μm × 50 μm, with optical and electrical interconnections.

Keywords: Optical Phased Array, High-Contrast Grating, Silicon-Based.

INVITED SPEAKERS

Id-287

Ultrashort Solitons and Their Interaction with Dispersive Waves in the Regime of Event Horizons in Nonlinear Optical Media

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Abstract: Several concepts for the description of nonlinear pulse propagation in dispersive optical media will be introduced and compared. Among those are envelope models, based on nonlinear Schrödinger-type equations (NLSE's), short-pulse equations (SPE's), as well as our generalized approach. Interestingly, SPE's, which describe the electric field directly, rather than it's envelope, intrinsically provide limitations for ultrashort solitons. As the width of the solitons decreases, they are shown to evolve into formation of cusps in the limit. This seems to be a quite universal feature, which has also been observed in generalized NLSE type equations. Furthermore it will be shown, that solitons can mimic event horizons for smaller (dispersive) optical waves (DW's), under special conditions. In such cases the mutual nonlinear interaction between solitons and DW's can become very efficient, such that the solitons are dramatically affected by DW's. Moreover, it will be demonstrated, both numerically, and more efficiently by a new analytic theory, that DW's can be used to control such solitons. This opens a new concept of all-optical switching, with interesting new applications. In particular, the parasitic Raman effect can be completely compensated by properly chosen DW's, such that the soliton properties remain unchanged by this support.

Keywords: Solitons, Event Horizons, Ultrashort Pulses, Nonlinear Waves, Short Pulse Equations

INVITED SPEAKERS

Id-289

Constrained Locality with Extended Horizons in the Abstract Geometry of Signal Transmission

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Abstract: A geometry of electromagnetic radiation is examined, which has the following properties: The rest frame is represented by one spatial dimension, which carries forward momentum by reference to which the perpendicular temporal and spatial axes are non-local; these carry time components and the field. The local frame is linear-Galilean whereas relativistic length contractions and time dilatations are ascribed to the non-local frame. This geometry is compatible with special relativity theory (SR) applied to electromagnetic radiation but leads to interesting rearrangements of terms and reinterpretations of the described physics. In contrast to SR the information contained in the assignment of dimension and in the physical constants is meticulously preserved and extended. Physical units can be assigned to the local and non-local frames and are subject to simple counting rules. For example, when applied to thermal radiation, the intensity of the radiation acts on the radiation's oscillation period and transfers the energy of the non-local field into the local momentum frame. Examining the dimensionality reveals that the intensity thus acts analogously to acceleration. This description is also, historically, applicable to stimulated emission at some transition frequency and accommodates multi-photon absorption. The geometry described herein equates a line increment in the local frame with a tangential velocity in the non-local frame, which provides a key to interpreting many physics processes, generally. On this basis the possibility is discussed that the Lorentz transformation, which can be decomposed into a boost and a rotation, has some fundamental physical meaning more profound than just adapting the Cartesian coordinate system to the constancy of the velocity of light.

Keywords: Electromagnetic Radiation, Lorentz Transformation, Multi-Photon Absorption.

INVITED SPEAKERS

Id-290

Photochemical and Photophysical Properties of Novel Dipyrromethene Complexes with Boron and Zinc

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Abstract: Study of dipyrromethene complexes with different structure is one of developing areas of modern chemistry. Systematic observation of photochemical and photophysical properties and establishment of their connection with structural features of the complexes are required for successful usage of dipyrromethene complexes and creation of various hi-tech optical devices which are based on them. Therefore, the purpose of the work is to study photonics of different complexes of dipyrromethenes with boron and zinc, the optimal combination of which will indicate the direction of effective use of these dyes. The photonics of boron fluoride dipyrromethene complexes (BODIPY) was studied in comparison with zinc complexes $Zn(dpm)_2$ of similar ligand in different solvents depending on the wavelength and intensity of the exciting radiation. It had been shown that BODIPY complexes exhibit highly efficient radiation (fluorescence quantum yield up to 90%). Replacement of the boron complexing agent with zinc entails an increase in share of nonradiative processes in the deactivation of excitation energy, which leads to decrease in fluorescence and emergence of long-lived emission. For solid samples based on zinc complexes was found dependency of the long-lived emission intensity of the oxygen concentration in gas flow. The presence of line segment indicates the possibility of the use of these complexes as optical sensors for oxygen determination. The work was supported by Russian Foundation for Basic Research (Project No. 18-33-00284), as well as within the framework of the implementation of state task of the Ministry of Education and Science of the Russian Federation, Project No. 4.6027.2017 / 8.9.
Keywords: Dipyrromethenes, BODIPY, Photonics, Sensory Properties, Stability of Complexes.

INVITED SPEAKERS

Id-291

Solution-Derived Transition Metal Oxides as Carrier Selective Contacts for High Efficiency Perovskite Solar Cells

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Abstract: Organic–inorganic halide perovskite solar cells (PSCs) have achieved a great success in recent years with a demonstrated PCE increasing rapidly from 3.8% to 23.7% for single junction devices. Most high performance PSCs consist of a perovskite absorber sandwiched between an electron transport layer (ETL) and a hole transport layer (HTL), which extracts electrons (holes) and blocks holes (electrons) from the absorber efficiently. Inorganic carrier transport materials have extracted extensive attentions due to their higher mobility and better stability. Particularly, the excellent carrier selective transport property of several different transition metal oxides has been highlighted by their recent application in organometallic halide PSCs, due to the favorable band alignment formed between halide perovskite absorber and oxides HTL and ETL. In this talk, I will introduce our recent researches on the fabrication of solution-derived transition metal oxides thin films including NiO_x, ZnO, In_2O_3 and SnO_2, and their applications as the selective contacts for perovskite solar cells will also be discussed.

Keywords : Solution-Derived, Transition Metal Oxides, Selective Contacts, Perovskite Solar Cells.

INVITED SPEAKERS

Id-292

Ordered Nanoprism Arrays for Nonlinear Optics

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Abstract: Nanostructured materials present the possibility of tailoring their properties, specifically their linear and nonlinear optical properties, by manipulation of their structure, composition and geometry. For optical purposes in particular, ordered nanoparticles arrays present the possibility of coherent addition of the optical effects produced by each nanoelement, and thus an enhanced nonlinear response. For the case of metallic nanoparticles, this can be further enhanced by the field concentration produced at interfaces by the surface plasmon resonances. This also makes them good candidates among other thing, for enhanced sensing applications, such as enhanced Raman scattering. In this work we present a comprehensive study of the third order nonlinear properties of a metasurface consisting of a hexagonal array of triangular gold nanoprisms, produced by nanosphere lithography. Both nonlinear absorption and refraction were studied using fs pulses, including the electronic and thermal contributions to the nonlinear response. A study of the dynamics of the response is also presented, showing the ultrafast nature of the response.

Keywords: Nanoprism, Plasmon Resonance, Metasurface.

INVITED SPEAKERS

Id-293

Analysis of the Effect of the Amount of Lead Content in Perovskite Material as an Active Layer of Solar Cell

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Abstract: Perovskite solar cells has reached 23.3% from 3.8% efficiency only in a few years range. The main material that used in perovskite solar cells are materials with perovskite structure as an active layer of those cells, such as methylammonium lead halide ($CH_3NH_3PbI_3$). $CH_3NH_3PbI_3$ perovskite contains inorganic compound lead chloride ($PbCl_2$), which has high toxicity that can cause health hazards, such as damage to nervous systems, brain, cancer, etc. Many researches has shown further how the influence of lead chloride on health. However, there are currently no research that directly discusses about the effect of the amount of $PbCl_2$ content on the electrical characteristics of $CH_3NH_3PbI_3$ perovskite solar cell. This research discusses the effect of the amount of lead chloride on the electrical characteristics of perovskite solar cell. Three perovskite solar cells were fabricated in this research which the active perovskite layer has varying amounts of $PbCl_2$ content, namely 120 mg, 130 mg, and 140 mg. The results of the fabricated cells shows that the increase in the amount of $PbCl_2$ content makes the $CH_3NH_3PbI_3$ solar cells have better electrical characteristics. Cell with the best performance in this research is the cell with 140 mg amounts of $PbCl_2$ content, with the value V_{oc}=0.879 V, I_{sc} = 3.3 mA, FF = 0.47.

Keywords: Perovskite, Solar Cell, Lead Chloride.

INVITED SPEAKERS

Id-299

High-Precision PSD with a New Principle of Spatial Separation of Photocurrents

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Abstract: Development of position-sensitive detectors (PSD) which allow determining an optical signal position with high accuracy, has remained the essential problem of optoelectronics. Despite significant progress in this area leading to the creation of segmented, lateral and matrix PSDs, as well as PSD Multiscan, each of these position sensors, besides perfect parameters, demonstrates disadvantages caused by its coordinate read-out forming principle. As a result, the problem of achieving the whole set of parameters, such as high linearity of the coordinate characteristic, resolution, accuracy and operation speed, on a single PSD has not been solved yet. Our work presents an analysis of the fundamental reasons limiting the parameters of existing PSDs and describes a new principle of coordinate read-out forming which opens up the possibility of accomplishing our objective, i.e. creating a new PSD without the drawbacks inherent to the above mentioned sensors. The photocurrent spatial separation principle developed by us results in a new topology of the presented PSD which provides mutual linear proportionality of the divided photocurrents. This approach allows us to keep all the known advantages of the previous PSDs and to provide high accuracy, sensitivity and operation speed simultaneously over wide range of the sensor lengths. The results obtained demonstrate resolution of about 0.05 microns, linearity not worse than 0.001%, accuracy of about 0.5 microns and rise time of 3-5 ns with sensor length up to several tens of centimeters for the new PSD.

Keywords: Position Sensitive Detector (PSD), Spatial Separation of Photocurrents, Novel Read-out Concept.

INVITED SPEAKERS

Id-303

IoT Data Exchange Platform on Broadband Networks

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Abstract: Broadband networks have been evolved by optical technologies including the latest device technologies. In particular, optical access networks, referred to as “Last one mile”, have been developed rapidly by PON (Passive Optical Network) technologies. These technical trends have promoted deployment of various services to users. On the other hand, these various services should be multiplexed on optical broadband networks. One of new attractive services is IoT (Internet of Things). IoT should be deployed with other legacy services, e.g., telephony, video distribution, data transfer, etc., on these networks efficiently. For this purpose, The IoT DEP (Data Exchange Platform) on broadband networks is proposed. Traffic characteristics and required network functionalities for IoT are much different from other legacy services. Therefore, in this platform, communication paths for IoT are virtualized and isolated from other services. Then, it provides effective transfer of traffic for IoT harmonizing with other services. Currently, this platform has been discussed in an international standardization committee, i.e., ISO/IEC JTC1/SC41 (IoT and related technologies). In this talk, firstly, traffic features for IoT and requirements to deploy various services including IoT are overviewed. Secondly, to comply with these requirements, architecture of IoT DEP is proposed. Thirdly, operations of IoT DEP on eval use cases is mentioned on broadband networks. Finally, current status of standardization on IoT DEP and future view are introduced.

Keywords: Broadband Network, Traffic Control, IoT, Data Exchange Platform, International Standardization.

INVITED SPEAKERS

Id-304

Laser in Ophthalmology

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Abstract: Lasers are incorporated in a widely number of ophthalmic instruments. Their main applications are for diagnosis and for therapy. Optical coherence tomography and confocal scanning laser ophthalmoscopy, for example, can be used to study the anatomic and cellular structures of the anterior and posterior segments of the eye. For therapy, lasers can be used to treat many eye diseases. Excimer laser is used in refractive surgery. Femtosecond laser is applied to corneal and lens surgeries. In glaucoma and retinal diseases some of the procedures done with argon and Nd:YAG lasers equipments are iridotomy, trabeculoplasty, trabecular ablation, gonioplasty, pupilloplasty, sphincterotomy, synechiolysis, goniophotocoagulation, goniotomy and photocoagulation. Lasers are essential to ophthalmic practice nowadays and their use is boundless.

Keywords: Laser, Ophthalmology, Excimer Laser, Refractive Surgery, Cataract Surgery, Laser Karatoplasty.

INVITED SPEAKERS

Id-305

Optical Splitters: Design and Applications

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Abstract: Optical splitters are passive optical components, which have found applications in a wide range of telecom, sensing, medical and many other scientific areas. Low-index contrast optical splitters (Silica-on-Silicon (SoS) based waveguide devices) feature many advantages such as low fiber coupling losses and low propagation losses. They are considered an attractive DWDM solution in the telecommunication for all optical signal processing in optical communication systems. Nowadays the steadily increasing data volume in communication networks is driven by a rapid proliferation of home-based and business computers, storage capacities, processing capabilities and the extensive availability of Internet. The challenge is to transfer high data volumes in short periods of time over high distances as lossless as possible. The task of the optical splitters in Fiber-to-the-x (FTTx) network is to split one optical signal in many identical signals bringing for example the same TV signal in different households. Of course, the more buildings can be served by one optical splitter the lower are the installation costs. High-index contrast optical splitters (such as silicon, silicon nitride or polymer based waveguide devices) feature much smaller waveguide size compared to low index contrast splitters. Such compact devices can easily be implemented on-chip and have already been used in the development of optical sensors, devices for DNA diagnostics and for infrared spectroscopy. We will present the latest achievements in the design of two mostly used optical splitters (MMI and Y-branch) and discuss their advantages and disadvantages. Finally, some applications of the splitters developed in the frame of various projects will be presented. This work was carried out in the framework of the project PHOCOP (no. SK-AT-2017-0013) and NAMOPRISIN (no. SK-AT-2017-0005) from the Slovak research and development agency of the Ministry of Education, Science, Research and Sport of the Slovak Republic and SK 16/2018 and 15/2018 from OeAD-GmbH.

Keywords: Optical Splitter, MMI Splitter, Y-Branch Splitter, Telecommunications.

INVITED SPEAKERS

Id-306

Pulsed Laser Ablation in Liquids Nanoparticle Production Increase by Simultaneous Spatial and Temporal Focusing

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Abstract: The increasing necessity of high purity ligand free nanoparticles for different applications demands for the continuous improvement of synthesis routes with low environmental impact. Here, a simultaneous spatial and temporal focusing (SSTF) setup is proposed for improving nanoparticle productivity of the eco-friendly femtosecond pulsed laser ablation in liquids (PLAL) technique. The main drawback of employing femtosecond lasers in PLAL is that pulses experience energy losses in the liquid environment where the target is submerged. This is due to the extreme energies that cause nonlinear effects such as filamentation or optical breakdown that dramatically reduce the ablation efficiency. However, the SSTF is a breakthrough technology that allows the overcoming of these limitations by strongly confining the intensity distribution only to the focal volume, where the shortest femtosecond pulse is formed, increasing pulse duration out of focus. The proposed SSTF system is compared against an analogous image system without temporal focusing effect and the conventional laser ablation in liquids setup. A complete spatial, temporal and spectral characterization of each system is performed. Energy losses are evaluated through different water layers obtaining a maximum energy loss of 5% for the SSTF setup, 40% for the analogous image system and 70% for the conventional system. This variation influences gold nanoparticle productivity leading to a maximum productivity increase of a factor 9.4 compared to the analogous image system and 2.4 compared to the conventional one even when the experimental parameter are favourable for the compared systems. Hereby it is demonstrated the enhanced nanoparticle productivity.

Keywords: Pulsed Laser Ablation in Liquids, Femtosecond Laser, Gold Nanoparticles Synthesis.

INVITED SPEAKERS

Id-307

Intracellular Thermometry with Fluorescent Polymeric Thermometers

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Abstract: Intracellular temperature has received widespread attention because it is assumed to be related to many cellular activities and the health status of cells. Fluorescent polymeric thermometers are promising analytical tools for intracellular thermometry because of their high temperature resolution (less than 1°C) and high spatial resolution (molecular scale in principle) (Chem. Commun. 2017, 53, 10976). In a previous study, we developed a fluorescent polymeric thermometer by combining a thermosensitive polymer with an environment-sensitive fluorophore, and we performed intracellular temperature mapping of mammalian cells using fluorescence lifetime imaging microscopy (Nat. Commun. 2012, 3, 705). Cationic fluorescent polymeric thermometers with the ability to enter living cells were also developed for intracellular temperature measurements in yeast and mammalian cells (Nat. Protoc. 2019, 14, 1293). Recently, our group developed a novel cationic fluorescent polymeric thermometer containing both an environment-sensitive fluorophore and a reference fluorophore. This thermometer is capable of practical ratiometric intracellular thermometry and is now commercially available. Its applications can be found in investigating thermogenesis of brown adipocytes and brain tissues. Another research direction is to improve the function of fluorescent polymeric thermometers. A cationic fluorescent nanogel thermometer created with a novel imidazolium-containing cationic radical initiator is our newest case (Angew. Chem. Int. Ed. 2018, 57, 5413). This cationic fluorescent nanogel thermometer showed a remarkable non-cytotoxicity which permitted ordinary cell proliferation and even differentiation of primary cultured cells as well as excellent ability to enter live mammalian cells and high sensitivity to a temperature variation in live cells.
Keywords: Fluorescence, Sensor, Biological Cell, Temperature.

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INVITED SPEAKERS

Id-308

Optical and Photocatalytic Properties of Inorganic-Organic Hybrid Materials

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Abstract: The visible-light-responsive inorganic-organic hybrids are prepared by the attachment of small colorless organic molecules (benzene derivatives) to the surface of wide-band-gap oxides (TiO_2, CeO_2, Al_2O_3, etc.). The appearance of absorption in the visible spectral region is a consequence of the formation of interfacial charge transfer (ICT) complexes between oxides' surface and organic moiety. The synthesized inorganic-organic hybrids are thoroughly characterized by various spectroscopy techniques including photoelectron spectroscopy, transmission electron microscopy, X-ray diffraction analysis, nitrogen adsorption-desorption isotherms, etc. The experimental data are supported by the quantum chemical calculations based on the density functional theory (DFT). The DFT calculations were performed with the use of periodic boundary conditions (PBC), as well as with properly designed finite size clusters. Special attention was paid to the photocatalytic ability of synthetized inorganic-organic hybrids. The photodegradation of different organic dyes and hydrogen production was used to test the photocatalytic performance of surface-modified wide-band-gap oxides with benzene derivatives.
Keywords: Inorganic-Organic Hybrids, Interfacial Charge Transfer Complexes, DFT, Photocatalysis.

INVITED SPEAKERS

Id-311

Visualization the Control of Ultrafast Plasmon by Nonlinear Multi-Photon Photoemission Electron Microscopy

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Abstract: In recent years, ultrafast plasmon including femtosecond localized surface plasmon(LSP) and propagation surface plasmon(SPP), which can be realized by concentrating femtosecond laser pulses in a subwavelength structure, have been intensively explored, and it has potential in fabrication of the plasmonic chip with speed in the Peta–Hertz domain. The ability to engineer a plasmonic system providing a desired ultrafast response in a predetermined nanostructure is crucial, thus it is necessary to full disclose the distribution of ultrafast plasmon field and to manipulate the optical near field in a given nanoscale volume. Obviously, towards this direction a technique that is capable of imaging plasmons with nanometer resolution is imperative. Photoemission electron microscope (PEEM) assisted with nonlinear multiphoton emission process is an ideal tool to visualize ultrafast plasmons with ultrahigh spatial resolution. In this talk, we demonstrate subwavelength imaging of the control ultrafast plasmon in gold bow-tie as well as in Ag trench through ultrafast nonlinear photoemission electron microscopy. A series of images of local surface plasmon modes on different tips of the bowtie are obtained by the two-color photoemission electron microscopy, and accordingly a comprehensive disclose of the localized near-field distribution within a bow-tie nanostructure are realized. The enhanced photoemission assisted by the opening of two-color quantum channel is found to be responsible for the underlying physics. On the other side, visualization of the propagation surface plasmon control on a flat surface with the trench structure at different femtosecond laser excitation wavelengths and polarization angles are given.

Keywords: Plasmonics, Visualization, Control, PEEM.

INVITED SPEAKERS

Id-313

Needle-Shaped Resonant Metallic Quenching of Electromagnetic Field in Photonic Crystals: Physics and Applications

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Abstract: The work is devoted to polarized electromagnetic waves (EMW) interacting with a metal film through a 1D photonic crystal resonator. Several frequency regions are considered: terahertz, infrared and visual. We have investigated theoretically a correlation between spectra of a free photonic structure and that deposited on a metal for several known models of metal. It was found that for quasi-normal incidence of EMW the presence of metal digs narrow spectral wells in the middle of reflection windows existing for the same free photonic crystal. Quite another manifestation of metal-resonator inter-influence takes place at whispering incident angles when reflection spikes coincide with modes of photonic crystal resonator and they are absent throughout the stopband areas. The effects are strongly depended on polarization, number of periods and angle of incidence. We have compared several models of metal to analyze how a polarized electromagnetic wave interacts with a metal medium through the 1D photonic crystal resonator in all considered regions of frequencies. The results show that the spike position is practically independent on the adopted model of metal. In the all metal models, spike #4 is weakly asymmetric. The obtained results may be of interest in an extremely wide spectrum of applications in this area beginning with nebular astronomy and night-vision applications, to defense, sensing, communication applications, bandpass filters, communication line couplers and resistive sheets.

Keywords: Photonic Crystal Resonator, Optical Sensors, Fano Effect, SPR Phenomena, Metallic Quenching of Irradiation.

INVITED SPEAKERS

Id-316

Digital-domain Symbol Masking for Secure Coherent Optical Communication

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Abstract: Highly confidential data encryption technology requires for building a secure external-data-center (EDC) network that includes a lot of intra-data-center networks connected by optical fibers. Eavesdroppers can conduct physical-level security attacks for the EDC network by tapping light leakage from optical components such as optical switches and optical fibers to detect weak-light leakage so that the end-to-end data encryption is required. Symmetric-key-based data encryption generally uses, and a pairing of the encryption key shared between transmitter and receiver. Commercialized cryptographic equipment in optical communication systems commonly selectively employs a 128-bit, 192-bit or 256-bit block-ciphering advanced encryption standard (AES) algorithm that requires a large number of calculations to break the confidentiality. However, pre-symbol mapper encryption such as the AES algorithm performs processing at a bit rate, so the circuit processing speed of the encryption/decryption increases as baud rate and the multi-level number of quadrature amplitude modulation (M-QAM) increase. On the other hand, post-symbol mapper encryption depends only on the baud rate without relying on the multi-level number. Therefore, the post-symbol mapper encryption for the M-QAM signal is possible to realize $\sqrt{M}$ times slow encryption compared to the pre-symbol mapper encryption with bit rate processing. In this paper, I show a hardware-effective symbol-masking of M-QAM system that performs post-symbol mapper encryption using phase shift from binary data of encryption key. To confirm the validity of the system characteristics, I numerically and experimentally show the performance of the 4-QAM signal using symbol masking with a calculated cryptographic strength equivalent to the 256-bit AES algorithm.

Keywords: Optical Communication, Security, M-QAM.

INVITED SPEAKERS

Id-317

Iron Based Nanoparticles for Highly Efficient and Magnetically Controlled Photo-Therapies

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Abstract: Advanced nanobiomedical applications have been traditionally based on chemically synthesized inorganic nanoparticles. Here we present a novel type of structure especially suited for diverse biomedical uses: magnetoplasmonic nanodomes. The nanodomes are composed of a combined, magnetic and plasmonic, hemispherical shell deposited onto 100 nm polymer nanobeads. The variation of the materials and their thicknesses in the shell enables tuning both the optical and magnetic properties of the nanostructures. The very high plasmonic absorption of the nanodomes in the near-infrared is used for very efficient local optical heating, i.e., photo-hyperthermia for cancer treatment. The nanodomes ferromagnetic character allows to remotely manipulate them with magnetophoretic forces to easily regulate the level of photo-hyperthermia. Moreover, given their asymmetric shape they exhibit strong optic and magnetic anisotropies. Thus, the rotation of the nanodomes using alternating magnetic fields can easily tracked optically using their different absorption depending on the orientation. Since the rotation of the nanoparticles depends strongly on the viscosity of the medium, which in turn depends on the temperature, the optical tracking of the rotation can be used to accurately determine the local temperature around the nanodomes, i.e., nanothermometry. Combining the nanodomes efficient photo-hyperthermia with their nanothermometry capabilities, allows in-situ monitoring the local temperature induced in photo-hyperthermia treatments to control the therapeutic response. Financial support from Chinese Scholarship Council and projects MAT2016-77391-R, PCIN-2016-093 are gratefully acknowledged.
Keywords: Magneto-Plasmonic Nanostructures, Photo Therapies, Magnetic Control.

INVITED SPEAKERS

Id-319

Development and Thermal Assessment of a Blue Light Emitting Diode Phototherapy Device for Neonatal Jaundice Treatment in Kangaroo Mother Care

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Abstract: A flexible blue LED mattress has been designed and built, it is capable of providing therapeutic blue light irradiance for treating neonatal jaundice. Its 25 × 10 cm size and 60 g weight allows the mother to use it during kangaroo mother care and illuminate the back and posterior part of the neonate head. A method to estimate the thermal energy transfer from the LED mattress to a neonate has been carried out using thermal mannequins in order to assess thermal safety. One mannequin represents a late pre-term neonate of 2.35 kg, cast on silicone rubber containing 650 ml of water, the other mannequin represents the anterior part of a mother torso with silicone rubber skin; both mannequins are heated by nicrom wire inside them; the power is controlled in a closed loop by means of a microcontroller based system. The mannequins have been arranged in kangaroo mother care position, held to one another by an elastic rubber band making "skin to skin" contact. Mean blue light irradiance in the contact surface is 350 uW/cm^2, the LED matress draws 0.98 Watt from a 12 Volt battery. Heat transfer from the mattress to the neonatal mannequin has been indirectly measured as 0.395 W. Maximum temperature in the contact surface is 2.75^{o}C above neonatal mannequin skin temperature.

Keywords: Pediatrics, Light Emitting Diodes, Skin, Rubber, Heating, Heat Transfer.

INVITED SPEAKERS

Id-324

Progress on the Preparation of Novel Phosphate Based Glasses and Glass-Ceramics for Photonics

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Abstract: Silica glass has been intensively studied as a host material because of its wide wavelength range with good optical transparency, high mechanical strength against pulling and even bending as well as chemical stability. However, silica glass when doped with rare-earth (RE) ions have some limitations due to RE clustering or inappropriate RE local environment. Phosphate glasses have been of great interest as they are easy to process. They also possess excellent thermo-mechanical and chemical properties. They exhibit good thermal stability and excellent optical properties, such as high transparency in the UV-Visible-Near Infrared region. As they can incorporate a large amount of rare-earth, they have become appealing for optical communications and laser sources as well as optical amplifiers. Also of great interest are the rare-earth doped glass–ceramics (GCs) due to their enhanced optical properties compared to their glassy counterparts when the rare-earth ions are located in the crystalline phase. The GCs are usually prepared by heat treating the glass. In this presentation, we present first our latest work on the development of phosphate glasses with different compositions. Then we discuss the challenges related to the preparation of glass-ceramics by heat treating the glass. We will show that the heat treatment does not necessarily lead to the bulk precipitation of rare-earth doped crystals. We will explain that glasses can be prepared with rare-earth doped nanocrystals dispersed in their volume by adding the rare-earth doped nanocrystals in the glass batch or melt. The authors would like to acknowledge the financial support of the Academy of Finland (Flagship Programme, Photonics Research and Innovation ((PREIN-320165) and Academy Projects-308558 and 316483).
Keywords: Glass-Ceramics, Rare-Earth Ions, Silica Glass.

INVITED SPEAKERS

Id-326

Type II InAs/GaSb Superlattice Infrared Photodetectors

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Abstract: Type II InAs/GaSb superlattice (SL) structure is a very promising materials system for advanced infrared photodetector applications and has been investigated intensively in recent years. Type II InAs/GaSb SL detector can cover a very long detection range and has some advantages especially in the long and the very long wavelength ranges compared to HgCdTe counterpart. For infrared photodetctor applications, there may have two main problems which need to be solved. One is the growth of high quality SL materials and the other is the device surface passivation. In this talk, I will present our progress in developing type II InAs/GaSb SL photodetectors. We have grown very high quality InAs/GaSb SL materials and have demonstrated detector devices working in the mid, long, and very long wavelength ranges. We also demonstrate dual-band detector. We have extended the detection wavelength to 1 μm, which makes the type II SL materials cover the whole range of the short, mid, long, and very long wavelength ranges.

Keywords: Type II Superlattice, Infrared Photodetector, Molecular Beam Epitaxy.

INVITED SPEAKERS

Id-327

Integrated Optical Comparator for 2 Successive QPSK-Modulated Symbols Based on Silicon Photonics Waveguide

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Abstract: Optical comparators have the potential to improve the operational speed and reduce the power consumption of optical communication systems, as they directly perform the required operation in the optical domain which avoids any optic-electro conversions. Various comparators are optically implemented including a packet switching and label recognition, however, most studies have been confined to an on-off keying (OOK) modulation as opposed to phase-shift keying (PSK) modulation. Although there is a comparator available for the PSK modulation, the device has a limitation that requires integration into an actual system. In this paper, the author presents an integrated optical comparator based on a silicon photonics for 2 successive quadrature PSK (QPSK) modulated signal. The proposed device is a simple 2.0 * 0.1 mm^2 rectangle, which is approximately 1/7500 the size from previous studies, and it comprises a delay line interferometer and variable splitting ratio optical coupler. The comparator generates the coupled symbol with the comparison result between the target code and the input signal. The author experimentally evaluated the constellation generated from two designed comparators, which are denoted the 00 00 and 11 00 comparators. The paper demonstrates the feasibility of the ultracompact optical comparator for a 4-bit QPSK-modulated signal at 10 Gbaud.

Keywords: Optical Communication, Optical Signal Processing, Optical Comparator.

INVITED SPEAKERS

Id-329

Mechanical Bottom up Nano-Assembling of Photovoltaics Nano-Device Based on Individual Nano-Objects Nanomanipulation and Characterization Using Extreme Small Nanotweezers

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Abstract: Currently two main trends in modern science and technology: nanotechnology and photonics meet each other and produce new trends, namely nanophotonics, nanoplasmonic and “bottom-up” 3D nanoassembling. Nanophotonics and nanoplasmonics deals with generation and manipulation of light waves by functional nanoobjects, such as nanoantennas, nanolasers, semiconductor and spintronic nanoheterostructures etc, whose entire sizes are much smaller then light wavelength. 3D nanoassembling is much younger but very ambition emerging field comprising means and processes of manipulating and integrating the individual nanoobjects under control of optical, electron and ion microscopes using newly discovered extreme small mechanical nanotools well compared in size with real nanoobjects such as CNTs, nanowires, nanoparticles, viruses etc. Among the nanotools the smallest and fastest ones are those based on shape memory effect in intermetallic alloys. The manifest of the newly developed field of mechanical 3D “bottom up” nanotechnological paradigm sounds as follows: “We can manipulate anything we can see”. In this report, the principles and applications of mechanical bottom up 3D nano-manipulation and nano-assembling using extreme small shape memory alloy nanotools for nano-optics, nano-photonics, nano-plasmonics, photovoltaics, energy storage, nano-biosensing reviewed. The applications of near field subwavelength optical microscopy for nondestructive visibility of living biological nano objects, automatic control of 3D nanomanipulation of multiple nanoobjects and manufacturing of nanophotonic sensors are discussed. The work is supported by RFBR, grants No 17-57-45129, 17-57-560002.

Keywords: Nanotechnology and Photonics, 3D Nano-Manipulation, Nano-Assembling.

INVITED SPEAKERS

Id-330

Optical Fiber Fabrication and Testing to Certify Production Control

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Abstract: The paper is aimed to detail the fabrication technology of silica optical fiber cables, together with their in-line and ex-post performed testing. The single or multi mode optical fiber is colored through UV polymerization in N_2 atmosphere. Then the fiber is integrated in MLT buffering loose tube with external diameter ranging between 1.8 to 3 mm. The cable diameter is measured in-line, the elongation is intermediately determined. The loose tube are twisted and then reinforced with textile and metallic reinforcements. The final testing included the attenuation measurement (considering the single or multi mode optical fiber), the attenuation stability to temperature variation and to different complex mechanical testing. Both fiber and cable stability to water penetration and flammability / fire propagation are presented, too. Based on the customer specifications, product certification is needed to demonstrate compliance to specific standard requirements and to assure customer satisfaction. Certain fabrication problematic steps have been analyzed. Non-conformities are registered and the implemented solutions are presented, following the DMAIC (Define, Measure, Analyze, Implement and Control) continuous improvement tool.

Keywords: Buffering Loose Tube, Cable Fabrication, Testing, Non-Conformity, Attenuation.

INVITED SPEAKERS

Id-331

Novel Optical Time/Frequency Domain Reflectometry Capable of Continuous Time-Domain Measurement of Rayleigh Backscattered Light

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Abstract: Vibration sensing using an optical fiber is attracting a lot of attention for monitoring the condition of the structure. For the distributed sensing, phase-sensitive optical time domain reflectometry (OTDR) has been proposed and demonstrated. Phase-sensitive OTDR monitors vibration in a fiber transmission line by the phase shift of the Rayleigh backscattered light due to the refractive index change induced by the vibration. The maximum detectable bandwidth of the vibration in phase-sensitive OTDR is limited by the pulse repetition rate that is determined by the total fiber length. In this paper, we propose novel optical time/frequency domain reflectometry which enables us to monitor the change of the amplitude and phase of the Rayleigh backscattered light continuously in time domain. In the method, two light sources are used as a signal source and a local oscillator which are frequency swept synchronously with a time delay. Experiments have confirmed that the method can achieve continuous time-domain measurement of Rayleigh backscattered light. Digital signal processing of the IF signal made it possible to analyze the location and frequency of the vibration.

Keywords: Optical Time Domain Reflectometry, Phase Measurement, Vibration Analysis.

INVITED SPEAKERS

Id-332

Difference-Frequency Generation in Mid-IR Range of Broadband Fiber Lasers Radiation in Pp-Crystals

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Abstract: Hydrogen bonds C-H, O-H, N-H are widely represented in biological tissues. Absorption lines of their vibrational transitions are located at mid-IR shortwave edge (~3000 nm). Spectral measurements require broadband or tunable light sources for these set of wavelengths. Our proposition for medical and biological researches is the source based on difference frequency generation (DFG) of two near-IR lasers. We are using radiation of 1060 nm Yb and 1560 nm Er pulsed fiber lasers. DFG with narrow spectrum of pump and seed radiation allowed obtaining more than 10 W mid-IR power with efficiency up to 25% in periodically poled lithium niobate (PPLN). Furthermore, the application of fiber sources makes tuning of spectral properties in the mid-IR possible. A wide phase-matching bandwidth could be achieved due to equality of group velocities of the pump and idler waves in the PPLN crystals. In our experiments, phase-matching width was 22 nm for 1060 nm pump in 20 mm crystal. We managed to reach 4 W of output power and 11% efficiency around 3340 nm with FWHM 70 nm broadening. This operation mode might be useful for producing ultrashort pulse generation at 3000 nm. On the other hand, we can carry out the wavelength tuning in 2900 – 3100 nm range by broadening of seed spectrum from 1550 to 1600 nm and adjusting crystal temperature for the choice of the phase-matching conditions. In this case, effectiveness was about 10 - 15 % and FWHM 20 - 30 nm.

Keywords: PPLN, DFG, Mid-IR, Tunable, Broadband.

INVITED SPEAKERS

Id-334

Phase Interferometry Using Synchronously Intracavity Pumped Opo

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Abstract: The laser system suitable for the intracavity phase interferometry, allowing to detect a phase shifts in the order of 0.1 μrad using beat-note measurement, is presented. Applications that motivate this work are sensors, where the measured physical quantity can be converted into a phase difference between two independent frequency combs sharing one cavity. This system is useful for precise measurement of nonlinear index of refraction, electro-optic coefficients, nanodisplacements, acceleration, etc. The system is based on the synchronously intracavity pumped optical parametrical oscillator (OPO). For pumping of OPO a SESAM-mode-locked, picosecond, diode-pumped Nd:YVO_4 linear oscillator, operating at 1.06 μm was used. As a parametric gain medium, PPLN nonlinear crystal was used. The OPO cavity was set to be twice longer than the pumping Nd:YVO_4 laser cavity. The pumping laser was set in such a manner that the parametric gain inside the PPLN overcame the OPO threshold only for one direction of pumping pulse propagation. This leads to the long-term stable generation of two independent trains of pulses at the 1.5 μm spectral range. In order to verify the system performance, a $LiNbO_3$ electro-optic phase modulator was placed inside the OPO. The RF-signal derived from the pumping pulse train, detected by a fast photodiode and divided by two, was applied on the modulator. A stable beat-note signal between the two OPO trains was successfully measured for the first time from such a compact, all-diode-pumped laser system. The bandwidth of beat-note was less than 1 Hz (FWHM) resulting in phase-shift measurement error 1.5×10^{-7} rad. The research was supported by the Czech Science Foundation – Project No. 18-11954S.

Keywords: Optical Parametrical Oscillator, Diode Pumped Solid State Laser, Beat Note Detection, Intracavity Phase Interferometry, Synchronous Pumping.

INVITED SPEAKERS

Id-341

Indoor Localization of Drones Using Visible Light Communications for Industrial Applications

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Abstract: There is a great deal of research in visible light communications (VLC) for a wide range of applications. However, there is a clear gap in VLC uses for industrial applications. Visible Light Communication (VLC) technology using light emitting diodes (LEDs) has been gaining increasing attention in many applications from the last decade. Using VLC for indoor positioning for industrial applications is just one of the applications envisioned for this technology. In this paper, a trilateration indoor positioning system utilizing Cayley-Menger Determinant (CMD) is proposed using VLC to track a drone for industrial applications. CMD is presented to tolerate the errors and to find the optimal estimated position of the drone. The positioning system is based on the optical received signal strength (RSS) and is used to estimates the drone's position. The positioning error for a proposed path of the drone is also simulated and compared with the real path. The system achieved low positioning errors ranging from 0.03 to 4.075 cm. The results show that due to the lack of interfering ambient lights in industrial applications and the use of the high power of industrial luminaires with a strong received signal, CMD can offer an accurate and simple tracking of the drones.

Keywords: Visible Light Communication, Visible Light Positiong, Indoor Positioning, VLC Channel Modeling, Unmanned Aerial Vehicles, Industrial Environment.

INVITED SPEAKERS

Id-343

Development of Highly Sensitive Silicon Nanowires Based Photodetectors

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Abstract: Silicon (Si) based integrated photonics presents a growing interest nowadays, and, in this context, the low-dimensional Si nanostructures have been intensively investigated as promising candidates for optoelectronic applications. Thus, responding to the actual demand of developing high efficiency and, furthermore, the interest towards the self-driven photodetectors, different heterostructures based on Si nanowires (SiNWs) and various semiconductor thin films or semiconductor quantum dots have been explored considering the band gap engineering approaches. We will present the fabrication and functionality of two classes of devices obtained using silicon nanowire arrays prepared by silver assisted chemical etching of p-type Si wafer. First a core-shell heterojunction photodetector based on multilayers of graphene quantum dots (GQD) and SiNWs was investigated and we demonstrated remarkable photo-electrical properties in terms of responsivity, detectivity and external quantum efficiency, arising from the interplay of various mechanisms mediated by GQDs, such as: improvement of the carrier collection/injection on nanowires, charge photomultiplication determined by the presence of the induced electron trap levels and extension of light absorption. Second, we deposited metallic nanowires (Ag, Au) on the top of the SiNWs as Schottky contact to collect holes and we achieved a self-driven photodetector structure where the high interfacial electric field at heterojunction allows transportation of the photogenerated charge carriers without any external voltage.
Keywords: Silicon Nanowires, Photodetector, Hybrid Nanocomposites.

INVITED SPEAKERS

Id-344

Combined Method of Energy and Power Meters Calibration in Optical Range

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Abstract: The method of calibration using calculation of measured optical power radiation in units of radiation energy and backward is presented. The method permits calibration of energy and power meters in range of 8 – 10 orders of magnitude. Comparison detector allows to calibrate energy and power meters and radiation sources via self-calibrated photodiode.
Keywords: Measurement, Radiation Power, Energy of Radiation, Calibration, Photo Detector.

INVITED SPEAKERS

Id-345

Generation and Manipulation of Optical Vortices for Free-Space Optical

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Abstract: Light beams with helical wavefronts, also called optical vortices, possess an azimuthal phase factor $\exp(il\phi)$; l is an integer called topological charge, or orbital angular momentum (OAM), and represents a new degree of freedom with an infinite number of values. Consequently, OAM is a valuable resource for communication and information processing, at both classical and quantum level. In optical communications for instance, by multiplexing various OAM states one can dramatically increase the capacity of the communication channel. At quantum level, photons carrying OAM are used for alignment-free quantum key distribution, for generating higher-dimensional entanglement and for implementing arbitrary qudit gates. Here we present several methods to generate photonic OAM states using optical components, such as spiral phase plates and photonic circuit. We describe the standard microfabrication techniques used in the fabrication of optical components generating beams with helical wavefronts, with an emphasis on the generation of high-order OAM states. We also describe several ways to characterize OAM light, which we use to evaluate the quality of the fabricated optical components. We discuss several applications of our results in free-space optical communication and in quantum key distribution. This work was supported from a grant of the Romanian Ministry of Research and Innovation, PCCDI-UEFISCDI, project number PN-III-P1-1.2-PCCDI-2017-0338/79PCCDI/2018.
Keywords: Optical Communications, Optical Vortex, Quantum Information.

INVITED SPEAKERS

Id-354

New Molecules for All-Solution Processed White Organic Light Emittiing Diodes

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Abstract: Organic light emitting diodes with white emission are devices with several potential applications. In general, white emission can be obtained by the combination of blue-green-red emitters, in such conditions that resonant energy transfer processes are controlled. If not, the energy from the donor (higher energy emitter) is transferred towards the acceptor and only this last molecule is emitting. We showed that the white emission can be obtained by assembling in an all-solution process a conjugated polymer emitting blue with coordination compounds of Zn(II) where the ligands are salicylidene-based molecules. The diode configuration was: glass|ITO|PEDOT:PSS|PVK:Zn(salicylidene)|Ca|Al or glass|ITO|PEDOT:PSS|PVK|PFO:Zn(salicylidene)|Ca|Al, where PVK and PFO are conjugated polymers. The emission of the Zn(II) coordination compounds are preferentially of the salicylidene ligands and hence, single excitions are formed. To generate triplet exitons, we coordinate the same ligands to Pt(II) as a metal center, and the performances of the diodes were significantly improved. We also observed that the purity of the white emission with the PFO:Pt(salicylidene) is greater because of the presence of the red component of the metal center. Also the external yield of the diode is also greater. The electral signals are analyzed by the trapped-charge limite current (TCLC) which was useful to explain the greater performance of the diodes with polyfluorene compared to those with PVK.

Keywords: Zn(II) coordination compounds, Pt(II) coordination compounds, salicylidene derivatives, white emission, OLEDs.

INVITED SPEAKERS

Id-358

Modelling of Deteriorated Electrical Steel Properties Due to Laser Cutting Procedure

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Abstract: Electric machines are used in a variety of the industrial applications. One of the requirements to achieve the quality and the efficiency of the electric machines is to reduce the iron losses to minimum. It is well established that the technological process used for cutting of the electrical steel has an effect on the material process and the resulting machine characteristic. There are different cutting techniques such as mechanical cutting, laser cutting, electrical discharge machining etc. Within this study we performed a detailed review of the state-of-art of the existing cutting techniques and their effects on the electrical steel. Each cutting technique causes deformation on the edges of the electrical steel that deteriorates the magnetic properties of the material. Due to this deformation, the BH curve of the edge area is changed. Each cutting technique has own advantages and disadvantages comparing to the others. Moreover, each of the techniques has different effects on the electrical steel. In this study we focused on the laser cutting technique. The main goal of this study is to present our approach how to model the properties of the deformed area on the ferromagnetic sheets processed using laser cutting technique. We develop the method to determine the deteriorated area of the magnetic properties using measurements and numerical methods. The finite element method numerical model was developed using COMSOL and FEMM software environment. We will present our model based on the samples with a ring shape core. The authors acknowledge the project ID L2-8187 was financially supported by the Slovenian Research Agency.
Keywords: Electrical Steel, Laser Cutting, BH Curve, Electrical Machines, Magnetic Properties.

INVITED SPEAKERS

Id-365

Bidirectional Wavelength Conversion between Infrared and Terahertz Wave in Nonlinear Crystal

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Abstract: Terahertz waves (frequency: 0.1–10 THz, wavelength: 0.03–3 mm) are important not only in the basic sciences, such as molecular spectroscopy, electron acceleration, plasma measurement, and radio astronomy, but also in numerous industrial applications, as in broadband wireless communication, high-precision radar, global environmental measurement, and nondestructive inspection, since they have higher directivity than microwaves and higher transmittances in the atmosphere and in soft materials than mid infrared. Therefore, high-brightness and tunable terahertz wave sources and high-sensitivity and wideband detectors that could be widely used in these applications are required. In this presentation, we demonstrate the generation of high-brightness terahertz waves using parametric wavelength down-conversion from infrared to terahertz waves in a nonlinear MgO:$LiNbO_3$ crystal. We also demonstrate the coherent detection of terahertz waves using nonlinear up-conversion in the same process. We speculate that the high-brightness terahertz wave and its coherent detection could be powerful tools not only for solving real world problems but also fundamental physics, such as real-time spectroscopic imaging, remote sensing, 3D-fabrication, and manipulation or alteration of atoms, molecules, chemical materials, proteins, cells, chemical reactions, and biological processes. We expect that these methods will open up new fields. The authors would like to thank Prof. Kawase of Nagoya University, Dr. Nawata and Dr. Minamide, Prof. Ito of RIKEN, Prof. Taira of IMS, Dr. Sakai of Hamamatsu Photonics, and Prof. Shikata of Nihon University for useful discussions. This work was partially supported by JSPS KAKENHI Grant Number 18H01908.

Keywords: Nonlinear Optics, Terahertz Wave, Wavelength Conversion, Lasers, Detectors.

INVITED SPEAKERS

Id-366

Polyurethane Polycation as a Bio-Based Ion-Selective Membrane for Nitrate Optical Fibre Sensors

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Abstract: In optical fibre sensors, modification of geometrical structure of the optical fibre is essential for sensor performance enhancement. Moreover, optical fibre sensors also needs to be highly selective towards the target analyte. Polymer is a type of material that has been widely used as the sensing material. It is a macromolecule, composed of many repeated subunits called monomer. In sensor application, structure of the polymer can be designed and modified to compliment and selective towards the target analyte. Physical modification can be carried out by adding other compound which act as a filler in the polymer. Meanwhile, chemical modification can be carried out by introducing specific functional group in the polymeric structure. The physicochemical properties of the sensing materials can be improved to suit the specific sensor application. In this work, polyurethane is chemically modified to produce a polymer with the positive charge in its structure. The positive charge of the molecule able to interact and forming bond with the negative charged analyte such as nitrate, phosphate and so forth via electrostatic interaction. To date, polymer has been modified in various form and used for the detection of heavy metals, nutrients, pathogenic diseases, gas, temperature and so forth.

Keywords: Optical Sensor, Polyurethane, Ion-Selective Membrane, Nitrate.

INVITED SPEAKERS

Id-370

Graphene Oxide and Graphene Quantum Dots for Optical Sensing Application

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Abstract: The usage of modified optical fiber used for sensing has attracted a lot of attention during the last decades. Not only because of their immunity from electromagnetics interference compared to their electrical counterpart, the localized physical changes around the sensing area ensure miniaturization of the sensors and allow remote sensing of multiple points using the same fiber. In this invited talk, we will present a few breakthroughs we gained by using a modified standard multimode fiber and coating the region with sensing elements of graphene oxide and graphene quantum dots in detecting alcohol and also animal fats. Tapered optical fiber sensors are particularly popular due to their high sensitivity towards their surroundings. Furthermore, their ease of fabrication makes them even more desirable as they are easily reproducible and reliable. The tapering causes a huge reduction in the size of the core and that leads to penetration of light signal into the cladding which in turn enables the interaction of the light with the surrounding medium which allow the tapered fiber to be employed as a sensor. The optical and electronic properties of graphene attract tremendous interest in the science of optical sensing. Graphene has high optical transparency and mobility. In addition, graphene characteristics are flexibility, robustness and environmental stability. In particular, graphene oxide(GO) and reduced graphene oxide(rGO) have been used as an composite layer in energy storage denses, biomedical applications and electronic components. Meanwhile, Graphene quantum dots (GQDs), as a new kind of quantum dots, are single or few-layer graphenes with a tiny size of only a few nanometers that have emerged and ignited tremendous research interest. Due to the pronounced quantum confinement and edge effects, GQDs assume numerous novel chemical and physical properties, and had an extraordinary optical and electrical phenomena which are not obtainable in other kinds of quantum dots.

Keywords: Multimode Fiber, Tapered Optical Fiber Sensor, Graphene Oxide, Reduced Graphene Oxide, Graphene Quantum Dots.

INVITED SPEAKERS

Id-372

Light Emission Properties of Axial ZnO/$Zn_{1-x}Mg_xO$ Single Quantum Well on Vertical ZnO Microrods

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Abstract: To date, the majority of published results for ZnO nanostructures have been related to various nanoobjects of pure ZnO without any additional quantum structures. However, more sophisticated structures are commonly required in many applications. There have been only very few reports on ZnO nanowires with $Zn_{1-x}Mg_xO/ZnO/Zn_{1-x}Mg_xO$ quantum structures grown by metalorganic vapor-phase epitaxy or pulsed laser deposition. Here, we report on a fabrication and optical properties of an axial $Zn_{1-x}Mg_xO/ZnO/Zn_{1-x}Mg_xO$ quantum well (QW) grown by molecular beam epitaxy (MBE) on a ZnO microrod prepared using a hydrothermal method. On the basis of cathodoluminescence (CL) spectra and the results of numerical modeling, we determine the QW width as 4 nm, as intended at the growth stage. QW thickness is confirmed using transmission electron microscopy. The emission of quantum well-confined excitons persists up to room temperature (RT). The strong RT CL indicates that increase of electron-hole overlap due to the quantum confinement of carriers efficiently limits an influence of non-radiative processes. The linewidth of the QW emission line at 5 K standing at 18–19 meV indicates a good structural quality of the sample, with sharp $Zn_{1-x}Mg_xO/ZnO/Zn_{1-x}Mg_xO$ interfaces. We use the fabricated structure to determine the carrier diffusion length (>280 nm) in ZnO using spatially resolved CL. Micro-photoluminescence results suggest, moreover, a strong increase of the electron-phonon coupling strength with increasing microrod size. The present work proves that MBE growth of a quantum structure on top of hydrothermally grown ZnO microrods, free of an undesired quantum structure formation in the space between the microrods and without any parasitic core-shell structures has been successfully performed. This work was partly supported by the Polish National Science Centre (NCN) Grant No. UMO-2016/21/B/ST5/03378 and No. UMO-2014/13/B/ST7/01773.

Keywords: Axial Quantum Heterostructure, ZnO Nanostructures, Plasma-Assisted Molecular Beam Epitaxy, Cathodoluminescence, Micro-Photoluminescence.

INVITED SPEAKERS

Id-375

Simulation on Application of QD-SOA to Some All Optical Logic Gates

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Abstract: We investigate performance of all optical logic gates based on quantum-dot semiconductor optical amplifier (QD-SOA). We present all optical NOR gate and digital comparator operated for 160Gb/s return-to-zero Gaussian pulse. In the NOR gate, single QD-SOA and optical filter are employed and optical clock signal is used as probe. In the digital comparator, three different configuration using different number of logic gates and QD-SOAs are shown. These logic circuits are based on nonlinear effects such as cross phase modulation and cross gain modulation caused at the optical amplification in QD-SOA. These effects influence the phase and gain of the optical signal and enables logic gates by appropriately configurating some optical devices including couplers, optical filter and so on. In the QD-SOA, we assume the three-level rate equations for wetting layer, excited state and ground state. The photon density and phase of the optical signal are given by solving differential equations representing the photon density and phase in conjunction with the rate equations. Based on numerical simulation, we evaluate the performance of the logical devices in terms of the extinction ratio (ER). We also demonstrate the effect of amplified spontaneous emission noise. It is found that the NOR gate can be achieved with logical correctness and high quality when the specified conditions are satisfied. In the digital comparator, the appropriate configuration can be selected according to the desired requirement in terms of circuit complexity, value of ER and sensitivity to injection current. This work was supported by JSPS KAKENHI Grant Numbers 17K06443 and 19K04400.

Keywords: Quantum-Dot, Semiconductor Optical Amplifier, Optical Logic Gate, NOR Gate, Comparator.

INVITED SPEAKERS

Id-376

Challenges in Optical Characterization of Hyperbolic Metamaterials

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Abstract: Hyperbolic Metamaterials (HMMs) are a class of engineered nanostructures to obtain exotic optical behaviors from which novel applications have been extracted. Optical characterization of hyperbolic metamaterials has proved to be a challenging topic when the goal is to minimize the errors that exist in any procedure employed for this particular purpose. We report on the recent approaches on the characterization of HMMs as well as our proposed method for achieving negligible mean-squared-errors (MSE) in a procedure that provides physically reasonable optical performances as expected by the direct calculations. For the purpose of characterization, several HMMs were designed based on different metallic layers in conjunction with TiO2. Physical Vapor Deposition has been employed to fabricate the designed structures. For the characterization step, a variable angle spectroscopic ellipsometry (VASE) technique has been utilized. In the latter stage, we have obtained MSE values of less than 1.0 in each case using a procedure we explain in this work. We compare the results of our VASE technique with other recent works published elsewhere and provide a discussion on the details of the differences.

Keywords: Optical Characterization, Ellipsometry, Metamaterials, Thin Film, Plasmonics.

INVITED SPEAKERS

Id-380

High-Power 3 μm Fiber Lasers and Amplifiers

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Abstract: Fiber laser technology has considerably improved in the last 20 years thanks to advances in low-loss optical fibers and high-power laser diodes. Fluoride fiber lasers, one of the noteworthy tools for generating coherent mid-infrared signal between 2 to 5 μm, have made outstanding progress in terms of compactness, reliability, high beam quality, and output power. In particular, laser emission near 3 μm is crucial for many applications such as spectroscopy, countermeasures and medicine. High power version of such laser emission is crucial to open new doors for potential applications, thus there is always an increasing demand for achieving higher output power parameters. Recent advances in 3 μm fluoride fiber lasers have led to slope efficiencies exceeding the Stokes limit by 15%, pulse energies of more than 100 μJ and an average output power of more than 42 W. In this talk, we will review the results obtained with different fluoride fiber laser systems and discuss the critical fiber-based components for achieving high slope efficiency, output power and pulse energy near 3 μm. Novel strategies to reach higher output power levels will also be presented.

Keywords: Fiber Lasers, Erbium, High-Power Lasers, Fiber Optics, Fluoride Fiber.

INVITED SPEAKERS

Id-383

Microshutter Systems for Optical Applications in Space

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Abstract: Microshutter Array(MSA) subsystems was developed at NASA Goddard Space Flight Center (GSFC) as multi-object selectors for the Near Infrared Spectrograph (NIRSpec) instrument on the James Webb Space Telescope (JWST).The subsystem will enable NIRSpec to simultaneously obtain spectra from >100 targets, which, in turn, increases instrument efficiency one-hundred fold. This system represents one of the three major innovations on the JWST that is scheduled to be launched in 2020 as the successor to the Hubble Space Telescope. Featuring torsion hinges, light shields, magnetic actuation, and electrostatic latching and addressing, microshutters are designed for the selective transmission of light with high efficiency and contrast. Complete MSA assemblies consisting of four quadrants of 365 x171 microshutters were successfully fabricated and tested, and passed a series of critical reviews for programmable 2-Daddressing, life tests, and optical contrast tests. The MSA subsystem was assembled on JWST telescope going through final tests at the telescope level. At the late stage of the JWST MSA system assembly, we began to develop the Next Generation Microshutter Arrays (NGMSA) for future telescopes. These telescopes will require a much larger field of view than JWST's. We modified the actuation mechanism from magnetic actuation for JWST to electrostatic actuation. We started the development of NGMSA 840x420 this fiscal year for future flight missions in space.

Keywords: Microshutter Array, Microshutter System, MEMS, Contrast, Objective Selector.

INVITED SPEAKERS

Id-387

Mems-Based Infrared Light Source and Detector

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Abstract: The thermal devices can work without cooling. This is different from the quantum devices based on the semiconductor bandgap which suffers from the thermal noise especially for the infrared (IR) application. For saving the operation power for cooling the device, the thermal devices become attractive to many applications. Here, (1) a light source and (2) a detector are described. The basic MEMS advantage is the low thermal conduction loss keeping the thermal energy at the specific position. (1) A microheater for the wavelength selective IR emitter shows the enhanced emission peak for CO_2 gas sensing using to the surface plasmon polariton. The thermal isolation is obtained using 2 μm-thick Si membrane having 5.4 mm outer diameter realized by the structure with the ring reinforcement. The underlying gold grating is designed to have 4.3 μm pitch. The emission at the wavelength of the absorption band of CO_2 gas is enhanced. Against input power, the intensity at the peak wavelength shows the steeper increase than the background intensity. The peak at 4.3 μm has the width of about 400 nm and CO_2 absorption band is inside. (2) A temperature-sensitive electrostatic resonator is realized. The resonator consists of two layers. The base layer is the tensile (600MPa) poly-Si. The larger thermal expansion of the top Al layer bends the structure, making the torsion bar slant. This increases the torsional spring constant. From the frequency change, the incident infrared can be measured. The twisting resonant frequency increases from 112 kHz at the rate of 426 Hz/K. The ratio is +3790ppm/K. This is more than 10-times larger in magnitude and opposite in direction compared to the temperature dependence of the material used indicating the high sensitivity. The temperature dependence of the transverse elastic moduli of Al and Si will give the ratio of -285 and -30 ppm/K, respectively. Part of this research is supported by Subsidy to Private Institution of Higher Education.

Keywords: Optical MEMS, Infrared Emitter, Surface Plasmon Polariton, Infrared Detector, Resonator.

INVITED SPEAKERS

Id-396

Ab-initio Calculations of $(C_5H_5)_2Zr(OCN)_2$ Infrared Spectrum

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Abstract: More cheap production of Zr isotopes is needed to use fission neutrons and, therefore, nuclear fuel more efficiently. $(C_5H_5)_2Zr(OCN)_2$ was chosen as a target gas molecule for isotopes separation by the laser assisted retardation of condensation method. To increase selectivity and efficiency of this method the accurate choice of laser pulse spectrum is most important. Since selective excitation of these molecules by CO_2 laser is assumed and their absorption spectrum is very narrow in overcooled rarefied gas flow, accurate information about their infrared spectrum is needed. Available experimental data, measured in KBr disk at room temperature, are not far enough accurate for this purpose. Hence, ab initio modeling is required for gaseous phase. On Hartree-Fock level of the theory, the basis cc-pVTZ was used for all atoms unless Zr, for simulation of which LANL2DZ-pseudopotential was applied. This work was supported by the Russian Science Foundation grant 17-11-01388.

Keywords: The Method of Isotope Separation by the Laser Assisted Retarded Condensation, $(C_5H_5)_2Zr(OCN)_2$ Isotopologues Spectroscopy, Quantum Control, CO_2 Laser, Quantum Chemistry.

INVITED SPEAKERS

Id-398

Acoustic Control of Recoilless X-Ray Photons: Formation of Ultrashort Pulses, Induced Resonant Transparency and Photon Slowing

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Abstract: We propose a technique for an arbitrary alteration of the temporal properties of single X-ray photons with energy 14.4 keV at room temperature via their transmission through a recoilless resonant absorber ^{57}Fe. The photons are emitted by a radioactive source ^{57}Co or Synchrotron Mossbauer source. In both cases the waveform of the emitted photons (time dependence of the photon detection probability or, equivalently, of the photon count rate) can be approximated by exponentially decreasing function with the decay time of 141 ns. The absorber is a stainless steel or iron foil enriched by nuclide ^{57}Fe. The absorber acoustically vibrates or moves according to a periodic or non-periodic law along the photon propagation direction. We show that the waveform of the transmitted photon is determined by the characteristics of the absorber motion, i.e., the amplitude and velocity of displacement, and the form of motion. Their variation allows transforming the smooth waveform of the photon into various regular and non-regular sequences of ultrashort pulses up to picosecond duration. One can independently control "on demand" the number of generated pulses, including a single pulse, the moments of appearance of pulses, as well as the duration of each pulse. In the case of acoustic vibration, the absorber can be made transparent for 14.4 keV photons. We acknowledge support by Russian Foundation for Basic Research (RFBR, Grants No. 18-32-00774 and No. 19-02-00852), as well as support by National Science Foundation (NSF, Grant No. PHY-150-64-67). The numerical studies were supported by the Ministry of Science and Higher Education of the Russian Federation under Contract No. 14.W03.31.0032. I.R.Kh. acknowledges support by the Foundation for the Advancement of Theoretical Physics and Mathematics “BASIS”. Y.V.R. acknowledges financial support (analytical studies) from the Government of the Russian Federation (Mega-Grant No. 14.W03.31.0028).

Keywords: X-Ray Photons, Ultrashort Pulses, Induced Transparency, Photon Slowing.

INVITED SPEAKERS

Id-405

High Speed VCSEL Transmission over Multimode Fiber for Data Center and Enterprise Networks

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Abstract: High speed optical channels for Data Center and Enterprise Networks are predominantly composed of laser optimized multimode fiber (MMF) and high speed vertical cavity surface emitting lasers (VCSEL). MMFs provide low cost and reliable channels with 50 micron core being more tolerant to connector tolerances without causing much channel loss. Direct intensity modulated VCSEL transceivers operating around 850 nm are relatively low cost and provide robust MMF channels unaffected by reflections and multipath interference. Data communication industry has been working on MMF-VCSEL based channels in the last few decades, and 10G Ethernet (IEEE 10GBASE-SR) has been the workhorse for data communication channels during this time. Modal and chromatic dispersion are two key parameters defining MMF channel performance among others. Chromatic dispersion is material dependent and therefore similar for different MMFs however the modal dispersion and modal bandwidth associated with it are the key parameters that set apart the different MMFs, OM3, OM4 and OM5 and link reaches that can be achieved with these MMFs. Beginning with the development of 10G Ethernet, industry developed a suite of measurement and characterization standards that allowed the development and manufacturing of OM3, OM4 and OM5 MMFs, and the use of VCSEL transceivers in MMF channels. Differential mode delay (DMD) measurement is a temporal pulse delay measurement when a single mode fiber is scanned across the core of MMF, allowing to identify the fast and slow mode groups in MMF. Depending on the DMD waveform profile, link performance of MMFs can be modeled/estimated, based on VCSEL-MMF launch condition. A modal chromatic dispersion compensation phenomenon has been invented by two different research groups that allows certain MMFs to perform better than others. Current MMF-VCSEL channels operate at nominal data rates of 25 Gb/s per lane around 850 nm spectral region as standardized in IEEE 802.3.by, and 50, 100 and 200 Gb/s using 4-level pulse amplitude modulation, also around 850 nm. There are also industry associations (MSAs) that utilize multiple wavelengths around 850-950 nm region to increase MMF channel capacity (e.g. SWDM4), in addition to a current IEEE project to utilize two wavelengths.

Keywords: Multimode Fiber (MMF), Modal Bandwidth, Modal-Chromatic Dispersion Compensation, VCSEL, SWDM.

INVITED SPEAKERS

Id-406

LAMOST Telescope, an Optical Fiber Application in Astronomy

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Abstract: LAMOST (Large sky Area Multi-Object Spectroscopic Telescope) is a reflecting Schmidt telescope specially designed to carry out spectroscopic sky survey. Helped by 4000 optical fibers connecting focal plane to its 16 spectrographs, LAMOST is one of most efficient telescopes in the world to obtain spectra of celestial objects. After seven years survey, LAMOST collected and released more than 10 million spectra of stars, galaxies and QSOs. In this talk, I will show some details of the application of optical fibers in LAMOST.
Keywords: Optical Fiber, Astronomical Telescope, LAMOST.

INVITED SPEAKERS

Id-411

Development of a Monolithically Integrated, CMOS-Compatible SiN Photonics Process Flow for Sensor and Medical Applications

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Abstract: ams AG is a leading provider of sensing solutions developing semiconductor sensors in a wide variety of fields, with optical sensing as one of the key competences. Since integrated photonics is a promising technology for new sensor systems, ams AG has been developing processes for fully integrated CMOS-compatible photonic components based on Si_3N_4. This talk will provide an overview on the processing of basic photonic building blocks and their optical properties and performance. We will also give examples for applications in the fields of optical coherence tomography and opto-chemical gas sensing. In the 1980s photonics started its way for common use in telecommunication technology, using optical fiber technologies. In recent years, also a variety of photonic sensors has been proposed and developed. One of the major drawbacks of most of these photonic devices has been the lack of integration into existing (semiconductor) production processes, so far. This integration is feasible using SiN material systems to process monolithically integrated CMOS-compatible photonic sensors in the visible and near-infrared spectrum. We will present the basic processing steps for the SiN photonic technology, the development of some critical processing steps such as SiN deposition and SiN etching as well as several photonic components (waveguides, splitters, etc.) with their optical properties. One of the applications presented relates to optical coherence tomography (OCT), a fast growing imaging technique in ophthalmology. Drawbacks of existing OCT systems are their high costs as well as their bulkiness, which prevents a wider spread use of OCT systems. One way to overcome both cost and size issues is to integrate optical and electrical components on a single chip. Part of this work was carried out in the framework of the projects COHESION (funded by the Austrian Research Promotion Agency (FFG), no. 848588), OCTCHIP (funded by the EU' Horizon 2020 research and innovation programme, no. 688173), and COLODOR (M-ERA.NET Transnational Call 2015, funded by the Austrian Research Promotion Agency (FFG), no. 854066, and the Bundesministerium für Bildung und Forschung, Germany).

Keywords: SiN Photonics, Sensor, CMOS-Compatible, OCT, Industry.

INVITED SPEAKERS

Id-412

Integrated Photonics–Technological Platforms and Applications

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Abstract. Since the very beginning of XXI century a rapid evolution of integrated photonic technologies is observed, manifesting itself in impressively efficient transfer of research results into fully functional products and fast route from the lab to the market. Photonic integrated circuits (PICs) offer unique advantages of miniaturization, low energy consumption, high reliability and reduction of manufacturing and packaging costs, similarly to all attractive features of integrated electronics, decisive for its omnipresence in the present world of information technologies. It seems that integrated photonics, differing from integrated electronics only in a type of information carrier and complementary in character may revolutionize the market of photonic applications. In this work the current capabilities and potential of the major technological platforms (silicon and indium phosphide) will be presented and discussed in the context of applications in optical communications and sensing, considered as the main drivers of integrated photonic market. The generic approach to prototyping of PICs will be characterized in detail. Also, there will be shown the results of the last few years of research on application specific photonic integrated circuits (ASPICs) conducted by the team of Eastern Europe Design Hub (EEDH) of Warsaw University of Technology, IMiO. In particular, two main ASPIC lines will be presented, addressing two abovementioned fields of applications – multichannel transmitters for fiber-optic access systems (WDM-PON) and integrated photonic interrogators for fiber Bragg grating (FBG) sensor networks. Also, a concept of ASPIC-based transmitter for few-mode optical fibers will be discussed, together with our first attempts to photonic-electronic integration.
This work has received support from the EU Horizon 2020 research and innovation programme under grant agreement No. 687777 (PICs4All) and by the National Centre for Research and Development through projects NIPPON (PBS3/A3/21/2015), OPTO-SPARE (PBS3/B9/41/2015) and NMKM+ (TECHMATSTRATEG1/348438/16/NCBR/2018).

Keywords: Integrated Photonics, ASPICs, Telecommunication, Sensing, Generic Approach.

INVITED SPEAKERS

Id-413

Progress in Re^{3+}-Doped Active Materials for Visible Light Sources

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Abstract: In this work we summarize our research on investigation of luminescent properties of materials doped with rare-earth ions dedicated to applications in visible light sources. The scope of our work covers two major groups of active materials: low phonon ZBLAN glasses and polymer nanocomposites activated with rare earth compounds. Slightly forgotten short-wavelength fiber lasers based on low phonon ZBLAN glasses may still constitute a simple and not fully explored alternative for semiconductor sources thanks to excellent beam quality, great heat-dissipating capability and relatively high output powers offered. In this work we present our latest results on emission properties of ZBLAN glasses doped with various RE^{3+} ions enabling obtaining efficient luminescence in UV-VIS spectral range, as well as our first lasing experiments with RE^{3+}:ZBLAN fibers. It should be noted, that despite impressive emission/lasing features the practical applications of ZBLAN glasses are limited due to poor mechanical properties and complicated manufacturing technology. The polymer-based composite materials, potentially offering excellent mechanical properties combined with efficient emission, low weight and easiness of manufacturing may help in overcoming this problem. The combination of polymer host and metal-organic complexes or RE-doped nanocrystals allows development of a new class of optically active material emitting light in the visible spectral range. In this work we summarize the results of several years of research on design and development of the PMMA-based composites activated with RE introduced either as a M-O complexes or inorganic nanocrystals, discussing pros and cons of both technologies and showing the progress in material's processing techniques. The research presented here have been supported by the National Science Centre, Poland, grants' numbers: 2011/03/B/ST7/01917, 2013/09/N/ST8/04347.

Keywords: luminescence, VIS, Rare Earths, ZBLAN, Polymer Composites.

INVITED SPEAKERS

Id-414

Few-Mode Optical Fibers-Concept, Technology and Applications

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Abstract: Dynamic development of Internet services such as streaming, P2P or IoT has resulted in the demand for continuous broadening of the transmission bandwidth. According to CISCO Visual Networking Index annual global IP traffic will reach 4.8 ZB per year by 2022 and the number of devices connected to IP networks will exceed the global population more than three times by 2022. Currently deployed techniques based on wavelength division multiplexing (WDM) do not seem to be efficient enough to satisfy the demand for extremely high data? rates. This stimulates intensive research on development of novel types of optical fibers, of extraordinary information capacities. One of the techniques considered as promising from this point of view is multiplexing in spatial domain. This work is focused on selected aspects of technology and transmission properties of few-mode fibers, optimized for operation around 1,55 μm and allowing significant increase of network capacity. In particular, both commercially available and laboratory solutions will be presented and discussed with respect of transmission parameters, main problems with characterization and potential deployment in real systems. Main problems related with few-mode fiber's design and optimization as well as technological issues will be discussed based on our first experimental results. In addition, methods for signal amplification with the use of few-mode active fibers will be shown. As a conclusions - the main directions of development of future few-mode fiber-optic communication networks will be discussed. This work has received support by the National Centre for Research and Development through project NMKM+ (TECHMATSTRATEG1/348438/16/NCBR/2018).

Keywords: Few-Mode Transmission, Telecommunication, Data Transmission, Spatial Multiplexing, Optical Fibers.

INVITED SPEAKERS

Id-420

Simulation/Design and Development of a Long Period Grating Fiber Sensor Device for Pathogen Bacteria Detection

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Abstract: The main purpose of the paper is to present the results obtained in simulation/design and development of a Long Period Grating Fiber Sensor (LPGFS) dedicated to "real time" detection of pathogen bacteria. The term "real time" refers to the fact that the main task this LPGFS is to detect pathogen bacteria in a short time (of maximum 5-10 minutes). This necessity arose mainly because presently the detection of such micro-organisms is accomplished by using slow biochemical methods, which, for example, need 48-72 hours for Escherichia coli detection. With a significant probability, during this long period the infected patients have enough time to die because of kidney renal blockage. In the paper there are presented results obtained in detecting Escherichia coli and Klebsiella pneumoniae. The paper is structured into three main parts: 1 - The first part refers to the simulation/design of a LPGFS most fitted to the proposed task as sensitivity, the possibility to build a portable sensor device incorporating the LPGFS. 2 - The second part consists of a simulation model of the bacteria metabolism. This biochemistry simulation model gives, for a given bacterium, the time shape of energy and concentrations of substances exchanged by the micro-organism with its ambient medium. 3 - The third part presents the results obtained in correlation of LPGFS absorption bands of its transmission spectrum with characteristic spectral absorption bands substances defined in Part 2 which are used as bacteria “markers”. This research is supported by the Romanian National Authority for Scientific Research by the Core Program project no. PN 19.18.02.02 and by MANUNET grant MNET17/NMCS0042.

Keywords: Long Period Fiber Sensor, Pathogen Bacteria Detection, Escherichia Coli.

INVITED SPEAKERS

Id-427

WDM of FSO Implementing Dual Hop of Optical Relaying Network Using Inline Cascaded of Optical Amplifiers for Connecting Backbone of the Palapa Ring with Rural Area

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Abstract: The palapa ring is networks of optical fiber communication system that connecting 34 provinces, 400 cities and 457 districts in Indonesia. This network is the breakthrough outcome to solve the problem of connectivity in Indonesia between each regions where as the largest islands nation in the world with the 17,504 islands, information broadcasting is the major issue to elevate the economic potential within the islands. The palapa ring is designed with rate bandwidth of 300 gbps for three regions, which are west, center and east where each one has been planned for 100 gbps allocation. Nonetheless, the problem of connectivity still rises where mostly citizen of republic indonesia live in the village of rural area that has range distance about tenth kilometers away from city or district. Thus, this condition is an issue that should be addressed in order to distribute information to diverse area where the citizens live. Regarding this problem, a scheme of free-space optical (FSO) communications is proposed as a bridge for connecting the users in the villages of rural area with the backbone of the palapa ring. FSO implements wavelength division multiplexing (WDM) system in order to enhance broadband of internet connection. FSO as the bridge of communication to reach rural area employs dual hop of optical relaying network. Each hop that is consist of many nodes is designed with inline cascaded of optical amplifiers as the optical signal amplification. The optical signal from the source of backbone after amplified with inline cascaded of optical amplifiers has robust characteristics in penetrating the atmospheric turbulence along the propagation path within each hop. Through this scheme, broadband information from a city or district can be distributed into rural area and the last mile access can be supported as well.

Keywords: Free-Space Optical Communications, Inline Cascaded Optical Amplifier, Optical Relaying Network, Relay to Relay, Optical Amplifier.

INVITED SPEAKERS

Id-430

DLW-STED Nanolithography for Photonic Networks and Devices

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Abstract: Presentation discusses the process of combining two relevant areas: the additive 3D printing method and the development of multicomponent photonic integrated circuits (PIC). Varieties of photonic systems are already actively used in various applications, but their designs are two-dimensional due to the limitations of lithographic techniques. Hence, great restrictions on the potential capabilities of photonic systems as a whole follow. To overcome these shortcomings, it is necessary to develop the foundations of an additive scalable and flexible optical technology for creating interconnects and optical structures, which will be able to solve problems such as the creation of interchip optical compounds, a variety of optical and quantum-optical systems on a chip (resonators, modulators, photon detectors, single-photon radiation sources, etc.). A new technology of optical connections (connectors, PWBs - Polymer Wire Bonds) between the elements of photonic integrated circuits (PIC) by two-photon femtosecond photolithography using both direct laser writing (Direct Laser Writing-DLW) and using an additional quenching laser (Stimulated Emission) Depletion-STED). The following are examples of created PWBs. To solve the problems of quantum optics, we need single-photon emitters with quantum dots, reaching a maximum average number of photons per pulse <n> = 1. We need a fast source in the GHz range at the telecommunication wavelength (where optical fiber losses are minimal), and a narrow emission line width to ensure multiplexing with separation by wavelength and, therefore, the possibility of further increasing the speed of quantum key distribution (QKD). Colloidal quantum dots are especially interesting for this purpose due to recent improvements in their purity and stability of single-photon radiation. The technological part of the work was supported by the Russian Science Foundation grant No. 15-19-00205, and the research was supported by the Russian Foundation for Basic Research grants 18-02-00811 and 16-29-11805.

Keywords: Femtosecond Laser, Photon Integrated Circuits, Two-Photon Photopolymerization, Optical Connectors, Electron, Confocal and Atomic Force Microscopy.

INVITED SPEAKERS

Id-432

Revisiting Swir Photo-Detection: Improvements Based on Sub-Wavelength Resonators

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Abstract: The extreme light confinement provided by nano-photonic structures pushes to revisit the photo-detector design. On the other hand introducing absorbing layers in nano-resonators demands dedicated electromagnetic design. This context is complex and requires specific design where both nano-photonic and semiconductor structures have to be optimized in parallel. It opens the way for performance improvements and new functionalities, introducing a new generation of photo-detectors with very promising features such as ultra-thin absorbing layers, device area much smaller than its optical cross-section, and on-demand carved optical response. The talk will be focused on an InGaAs-based photo-detector dedicated for imaging applications under low incident flux in SWIR band (around 1.5 µm). Design, fabrication and characterization of an InGaAs photo-detector deposited on a nano-structured gold mirror will be presented. Its optical and electrical properties will be discussed. Main features can be summarized as follows: The small thickness of the InGaAs absorbing layer (100 – 200 nm) allows suppressing the diffusion currents as well as reducing the generation-recombination currents in the space charge layer. It will be shown that the minimum value of the dark current is not necessarily reached for the thinnest absorbing layers. The setting of the coupling between the diffracted orders, allows optimizing this structure for various applications such as optimum absorption at 1.55 µm or in the whole SWIR band. As a result, experimental data show a maximum external quantum efficiency of 75% and a specific detectivity of up to 10^{13} cm.$\sqrt{Hz}$.W^{-1}.

Keywords: Photo-Detection, Infrared, Sub-Wavelength Optical Resonator, Optical Confinement, Electron Transport.

INVITED SPEAKERS

Id-433

Thermophotovoltaic System for Energy Scavenging

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Abstract: Rapid depletion of fossil fuels due to the growing demand of energy has resulted in a worldwide concern to improve the energy conversion efficiency. Yet, the energy conversion remains relatively low and huge amount of energy is wasted in the form of heat, leading to global warming issues. Recycling and recuperating even a small portion of energy losses could be life-saving and minimize the reliance on the fossil fuels. Thermophotovoltaic (TPV) system has appeared to be a potential candidate to capture, recover, and convert waste heat energy into useful electricity. This paper presents an overview on the recent development of TPV technology for waste heat recovery application. Each component in TPV system including emitter, filter and TPV cells is vital and can be engineered to achieve better heat-to-electricity conversion efficiency. Recently, researchers have shown great interest in near-field TPV system where higher power intensity can be captured by the TPV cell thus improving the overall system performance. Furthermore, the potential location for energy scavenging in thermal power plants is investigated based on energy analysis in previous literatures. This review will contribute to the knowledge for future development TPV system in waste heat recovery application while summarize the potential location for energy scavenging in thermal power plants. The authors gratefully acknowledge the UNITEN Internal Grant (J510050870) and the Tenaga Nasional Berhad (TNB) seeding fund (Project code: U-TG-RD-18-04), UNITEN R&D Sdn Bhd Consultancy Fund (Project code: U-SN-CR-18-06)

Keywords: Thermophotovoltaic, Waste Heat Recovery, Thermal Power Plant, Emitter, Thermophotovoltaic Cell.

INVITED SPEAKERS

Id-436

In Vivo Investigation of Peripheral Nerves Using Optical Coherence Tomography and Texture Analysis

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Abstract: Peripheral nerve surgeries are carried out for treatment of numerous peripheral nerve pathologies. In many cases, different pathologies affect the structure of the nerve. To investigate the nerve's structures, there are no methods for an in vivo high resolution assessment yet. Established in vivo imaging modalities, like high resolution ultra sound cannot provide a resolution that can resolve the smallest functional units of the nerve, the myelinated axons. We used a frequency domain optical coherence tomography system (FD-OCT) and investigated the structure of peripheral nerves in more than 30 surgeries in vivo. We acquired volumetric images using a hand probe, which was directly placed on the exposed nerve and covered by a sterile foil. Regarding these volumetric images, a texture analysis of the tissue was performed. By extraction of texture features from gray-level co-occurrence matrices, highlighting of connective tissue could be achieved. Furthermore, substructures of peripheral nerves could be identified in OCT images, executing a direct comparison of OCT images with corresponding histopathology slices of the same sample. The smallest structures, that could be found in both imaging modalities, are myelinated axons, responsible for the signal transmission in peripheral nerves. Noninvasive OCT imaging could enable the gathering of more structural information about peripheral nerves and their substructures in case of pathology, compared to the current need of tissue extraction for high resolution imaging of the tissue. Accordingly, OCT imaging of these structures holds great potential to improve diagnosis and subsequent treatment of peripheral nerve pathologies.

Keywords: Optical Coherence Tomography, Peripheral Nerve, In Vivo, Texture Analysis, Histopathology.

INVITED SPEAKERS

Id-441

Optical PAM-4 Transceiver with Active Back Termination and FFE/DFE/Threshold Adaptation in 40 nm CMOS Technology

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Abstract: Circuit techniques for high data rate optical PAM-4 transceiver are presented. At the transmitter side, the laser driver is composed of an asymmetric waveform equalizer and a 3-tap feed-forward equalizer (FFE) followed by a novel active-back termination (ABT) circuit. Incorporating with the FFE, the laser driver is capable of delivering multi-level amplitude modulation signals for 50 Gbps operation while circumventing bandwidth degradation caused by extra capacitive loading. Meanwhile, the asymmetric equalizer performs as a waveform predistorter to compensate the imbalance between the rising and falling data edges. In contrast to conventional passive termination with a resistive load, the ABT circuit alleviates eye degradation caused by signal reflections with a reduced power consumption. The termination resistance is tunable to match the characteristic impedance of different laser diodes. At the receiver side, a fully integrated optical receiver consisted of a transimpedance amplifier, a variable gain amplifier, an automatic threshold tracking (ATC) circuit, a 1:4 demultiplexer, and a quarter-rate clock and data recovery circuit combing with decision feedback equalizer (DFE) is described. Both the ATC and DFE are adaptive by an on-chip sign-sign LMS (SSLMS) engine. By using the adaptive ATC, it reduces the BER induced by the harmonic distortion of the receiver front-end by more than 20 X, and relaxes the hardware complexity of the quantizer. The whole receiver is capable of operating at 32 Gbps in 40 nm CMOS technology. The authors would like to thank Taiwan Semiconductor Manufacturing Company (TSMC), Hsinchu, Taiwan, for chip fabrication under the TSMC University Shuttle Program, and funding support from Mediatek and the Ministry of Science and Technology (MOST), Taiwan, under Research of Excellence Program.

Keywords: PAM4 Transceiver, Active Termination, FFE, DFE, Threshold Adaptation.

INVITED SPEAKERS

Id-442

Observation of Anomalous pi Modes in Floquet Topological Photonics and Its Application to Non-Adiabatic Elimination

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Abstract: Recent progresses on Floquet topological phases have shed new light on time-dependent quantum systems, which exhibit significantly different stroboscopic behaviors from their static counterparts, such as the emergence of anomalous Floquet topological phases (i.e., pi modes) in one-dimensional (1D) Floquet systems. However, to our knowledge so far, experimental observation of these exotic topological modes has never been reported. In this work, by periodically bending ultra-thin metallic microwave arrays of coupled corrugated waveguides, we successfully realized a photonic version of the periodically-driven 1D Su-Schrieffer-Heeger model. Through theoretical calculations, numerical simulations and experimental measurements, we observed the Floquet-engineered topological pi modes emerging at certain driving conditions and propagating along the array's boundary. Especially, the driving conditions of Floquet-engineered topological pi modes are the typical characteristics for 'topological Floquet engineering'. The dependences of the driving frequencies and the initial input positions (i.e., Floquet gauges) are observed experimentally at the non-adiabatic transition between the extremely slowly-driving limit and infinitely high-frequency limit in our photonic Floquet system, which haven't been widely noticed for the physics communities yet. Our novelty also lies in the flexible tuning of the driving conditions and highly-integration of the corrugated microwave waveguides fabrications. Therefore, our microwave platform can serve as a powerful 'Floquet simulator' for exploring various phenomena related to time-dependent dynamics, such as Thouless charge pumping, non-adiabatic elimination and driven topological phase transitions.

Keywords: Floquet Topological Insulators, Topological Photonics, Microwave Waveguide Array, Optical Analogy and Quantum Simulation.

INVITED SPEAKERS

Id-445

Application of Electromagnetic Charge Effect for Development of Optical Sensors

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Abstract: During our studies it was found that during interaction of electromagnetic field with matter, the irradiated body begins to generate an alternating electrical signal. These results are grouped under the name Electromagnetic echo effect (EMEE). The measured signal is a function of the state of the body. In the present work, some of the new types of optical sensors created on that basis are discussed. Such sensors are for control of: speed and diameter of fog droplets, fog emergence, impurity emergence in fog, evaluation of the number and diameter of fog droplets, processes at the threshold of laser ablation and phase transitions in liquid crystals. Also, a scanning system has been developed for visualization of irregularities on surfaces. This work has been funded by FP7-SEC-2012-1 program of the EU Commission under grant number 312804 and partially supported by the Bulgarian Ministry of Education and Science under the National Research Programme "Young scientists and postdoctoral students" approved by DCM # 577 / 17.08.

Keywords: Optical Sensors, Fog, Scanning System, Laser Ablation, Field-Matter Interaction.

INVITED SPEAKERS

Id-453

Latest Advance in Specialty Fiber Glass Processing for Fiber Laser and Photonics Applications

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Abstract: Specialty fibers glass processing plays an important role in dissimilar fiber inter-connection and all-fiber fused fiber components and devices, which are widely used for various industrial and research applications. In this paper, we discuss latest advance of fiber glass processing techniques based on CO_2 laser and filament fusion methods for specialty fiber processing, including mode-field adapting of dissimilar fibers, fiber combiner fabrication, fiber end-caps, and all fiber “microscopic” probes. We illustrate underlying fundamental optics and process for producing these devices and show some practical examples. We also describe applications of these deviced for high power fiber laser and photonic fiber sensing applications. Author acknowledges contribution from Mike Harju, John Faustino, and Sam Ghalmi for this work.

Keywords: Fiber Processing, Specialty Fiber, Filament, CO_2 Laser, Fiber Laser.

INVITED SPEAKERS

Id-455

Nano Semiconductor Photocatalytic Materials Design toward Methane Oxidation under Ambient Conditions

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Abstract: Because of the high C–H bond energy as well as the non-polar feature of CH_4 molecules, oxidation of methane under mild conditions remains a challenging task for both C1 utilization and atmospheric environmental cleansing. In this talk I would like to share the main research activities on methane oxidation in our group. The main results include: (I) Photocatalytic oxidation of methane over $SrCO_3$ decorated $SrTiO_3$ nanocatalysts via a synergistic effect. By using a sol–gel method $SrCO_3$ decorated $SrTiO_3$ nanocatalysts with an average particle size of ~25 nm were readily prepared, which surprisingly showed efficient performance for photocatalytic oxidation of methane with the activity close to fourfold of P25, a benchmark photocatalyst. Further investigation revealed a synergistic effect between $SrCO_3$ and $SrTiO_3$ when combined together into a composite material as both of which are totally inactive for methane oxidation if used respectively. (II) Photocatalytic oxidation of methane over silver decorated zinc oxide nanocatalysts. We will show that when the particle size of zinc oxide is reduced down to the nanoscale, it exhibits high activity for methane oxidation under simulated sunlight illumination, and nano silver decoration further enhances the photo-activity via the surface plasmon resonance. The high quantum yield of 8% at wavelengths of 400 nm and over 0.1% at wavelengths of 470 nm achieved on the silver decorated zinc oxide nanostructures shows great promise for atmospheric methane oxidation. Moreover, the nano-particulate composites can efficiently photo-oxidize other small molecular hydrocarbons such as ethane, propane and ethylene, and in particular, can dehydrogenize methane to generate ethane, ethylene and so on. This work was financially supported by the National Natural Science Foundation of China (Grant Nos. 21577143 and 51872311), the Natural Science Foundation of Fujian Province (Grant Nos. 2017J05031 and 2018I0021), and the Frontier Science Key Project of the Chinese Academy of Sciences (QYZDB-SSW-JSC027).

Keywords: Photocatalysis, Semiconductor, Hydrocarbons, Methane Oxidation, Nanomaterials.

INVITED SPEAKERS

Id-456

Optomechanical Lab on Fiber Accelerometers

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Abstract: In the last decades, taking advantage from the disruptive progress achieved in the optimization of fabrication processes and material integration strategies onto optical fiber substrates, we assisted to a substantial growth of optical fiber miniaturized devices ("Lab on Fiber") with unprecedented performances and new functionalities. While most of the target applications of Lab on Fiber (LOF) focus on life science applications, LOF technology has the capability to be further exploited in a large number of other industrial scenarios. In particular, the synergy between Lab-on-fiber and Optomechanics has the potential to enable the engineering and integration of opto-mechanical micro and nano-systems with optical fiber technology allowing the manipulation of the light flow by means of powerful opto-mechanical interactions and opening new ways to detect weak mechanical effects with unprecedented performances. In this contribution, we present the research activities carried out at the University of Sannio related to the development of Optomechanical Lab on fiber accelerometers. We developed LOF accelerometers based on the integration of micro-opto-mechanical cavities with the optical fiber tip. We designed the mechanical structures with different performances features specialized for target applications. In particular, a LOF accelerometer was designed for seismic surveillance applications. The sensor response was first characterized in laboratory, exhibiting a resolution down to 0.44μg/√Hz over a 3 dB frequency band of 60 Hz. To demonstrate the sensor capability to operate in a realistic seismic surveillance system, the developed sensors were continuously used in combination with a commercial seismic sensing network. During the field trial, the LOF sensor registered the ground acceleration associated with the seismic sequence that struck central Italy on October 30, 2016. Further activities have been devoted to the design and realization of LOF accelerometers, based either on cantilever structures or on membranes, featuring different mechanical features and thus leading to different performances of the final accelerometer, by retaining the same principle of operation. Either cantilever and membrane based Lab on fiber accelerometers exhibited a sensitivity of about 0.1nm/(m/s^2) on a 3dB-bandwidth of 5 kHz with a resolution down to 100μg/(Hz)$^{1/2}$.

Keywords: Optical Fiber Sensors, Lab on Fiber, Fiber Optic Accelerometer, Seismic Accelerometer.

INVITED SPEAKERS

Id-460

Design and Synthesis of Photosensitive Liquid Crystals and Their Application in Light-Tunable Flexoelectric Domains

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Abstract: Liquid crystals (LCs) represent not only highly efficient opto-electronic materials used in many aspects of our daily lives, but also intriguing state of matter being present from huge screens of smart windows down to cell membranes of living organisms. In the last years, there has been an increasing interest in multifunctional LCs, i.e., materials whose properties can be tuned by multiple external stimuli. Hence, many magnetic and photosensitive LCs have been synthesized and their physical properties studied. To address both, magnetic and photosensitive properties within a single material, a magnetic nanoparticle can be decorated with photosensitive ligands and such modified nanoparticles can be used as smart dopants into a liquid crystalline host. This lecture will be focused on design and synthesis of novel photosensitive materials, and investigation of their photosensitive properties in a mesophase, i.e. modulation of mesomorphic behaviour by light. The main focus will be put on photosensitive bent-core LCs. These materials are intensively studied due to their polar order and capability of symmetry breaking, which is given by the bent shape of molecules. These features impart to bent-core materials properties interesting for their application in non-linear optics. Basic principles for characterization of the mesophases and identification (quantification) of photo-responsiveness of the materials will be discussed. The potential application of the novel materials in fabrication of flexoelectric domains and their utilization in laser light focusing and diffraction will also be discussed. The work was supported by Czech Science Foundation 18-14497S.

Keywords: Bent-Core Liquid Crystals, Photosensitive Liquid Crystals, Flexoelectric Effect, Laser Light Diffraction.

INVITED SPEAKERS

Id-463

Time-Dependent Wavefunction-Based Methods for Intense Laser-Driven Multielectron Dynamics

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Abstract: High-field physics and ultrafast science are rapidly progressing toward a world-changing goal of direct measurement and control of the electron motion in matters. To theoretically investigate intense laser-driven multielectron dynamics, the multiconfiguration time-dependent Hartree-Fock method has been developed, which, though powerful, suffers from exponential increase of the computational cost with respect to the number of electrons. To overcome this difficulty, more cost-effective time-dependent multiconfiguration methods have been developed, which substantially extend the applicability of accurate multielectron simulations. Furthermore, we have recently succeeded in formulating time-dependent coupled-cluster method using time-dependent orbitals, called TD-OCC method , which, based on Kvaal's pioneering work, realizes gauge-invariant (equivalent for length-gauge and velocity-gauge treatment of laser-matter interaction) and size-extensive (uniform accuracy for increasing number of particles) description of multielectron dynamics. In this talk, I will summarize theory, and present our full three-dimensional implementation of the methods for atoms and molecules. The efficient implementation enabled ab initio description, beyond single-active-electron approximation or time-dependent density functional theory, of high-field phenomena directly relevant to experiments, e.g, nonsequential double ionization of noble gas atoms, high-harmonic generation (HHG) enhanced by laser-induced electron recollision, and laser polarization-dependent multichannel and multielectron effects on HHG from molecules.

Keywords: Hartree-Fock, TD-OCC.

INVITED SPEAKERS

Id-465

Wave Optics and Algorithms of Interactive Virtualization in the Environment of Flash-CC

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Abstract: The wave optics – considers light distribution, by means of Huygens' principles which pass through the power relations. Nevertheless, the considered in optics, all wave phenomena, by means of optical instruments are based on laws of wave optics. For example, the interference and the diffraction. Many tasks of the theory of optical installations are based on laws of wave optics. In this work, algorithms of mathematical communications of wave optics, i.e. laws of interference, diffraction of light rays, are considered on the studied virtual and interactive installation on the computer when passing light through a bi prism of Frenel and the diffraction grating, etc., as in an actual pilot unit. Optical processes of an interference and diffraction are visualized and interactively virtualized by means of the computer program Adobe Flash-CC environments. The laboratory work was made on a research of processes of wave optics is very effective at development of this course, and the technology of creation of VIL described in this article, is very relevant for creation of the similar virtual and interactive laboratories (VIL) in other objects. This virtual interactive laboratory development is introduced in educational process of the Kazakh National Womens Training University, Eurasian technological university and is successfully applied in tutoring.

Keywords: Algorithm, The Virtual Interaktivization, Wave Optics, Interference, Diffraction, Experiment of Young.

REGULAR SESSIONS

Id-291

Solution-Derived Transition Metal Oxides as Carrier Selective Contacts for High Efficiency Perovskite Solar Cells

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Abstract: Organic–inorganic halide perovskite solar cells (PSCs) have achieved a great success in recent years with a demonstrated PCE increasing rapidly from 3.8% to 23.7% for single junction devices. Most high performance PSCs consist of a perovskite absorber sandwiched between an electron transport layer (ETL) and a hole transport layer (HTL), which extracts electrons (holes) and blocks holes (electrons) from the absorber efficiently. Inorganic carrier transport materials have extracted extensive attentions due to their higher mobility and better stability. Particularly, the excellent carrier selective transport property of several different transition metal oxides has been highlighted by their recent application in organometallic halide PSCs, due to the favorable band alignment formed between halide perovskite absorber and oxides HTL and ETL. In this talk, I will introduce our recent researches on the fabrication of solution-derived transition metal oxides thin films including NiO_x, ZnO, In_2O_3 and SnO_2, and their applications as the selective contacts for perovskite solar cells will also be discussed.

Keywords: Solution-Derived, Transition Metal Oxides, Selective Contacts, Perovskite Solar Cells.

REGULAR SESSIONS

Id-297

Micrichannel Plate Properties in Strong Magnetic Field

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Abstract: Microchannel plate photomultiplier tubes (MCP PMT) can work in a high magnetic field having an excellent gain and time resolution. The influence of the magnetic fields up to 4.5 T on the parameters of several MCP PMTs of different designs was investigated. PMTs with two, three and four MCPs were simulated and tested in magnetic fields. Description of mathematical models for fast photo detectors based on microchannel plates (MCP) in three-dimensional formulation is given. The models include calculations of photoelectron collection efficiency in the gap photo cathode - MCP, gain factor of secondary electron cascades in the channels, the particle scattering in the gaps between the plates, taking into account the fringe fields and strong external magnetic fields. Comparisons of numerical and experimental data are given. The dependencies of major device parameters vs. of applied voltage, pore size, and magnetic field magnitude have been studied. Dependencies of the time resolution, the gain and the photoelectron collection efficiency on the magnetic field are presented. This work was (partially) supported by the Russian Science Foundation (Project no.16-12-10221).
Keywords: Microchannel Plate, Monte-Carlo Simulation, Magnetic Field.

REGULAR SESSIONS

Id-312

Analysis and Simulation of Turbulence Effects on Gaussian Beam Propagation Based on Generalized Modified Atmospheric Spectrum

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Abstract: Atmospheric turbulence has been extensively studied for many years in physics and engineering disciplines. When a laser beam propagates through the atmosphere, it can be affected by different optical phenomena including scattering, absorption, and turbulence. Turbulence effect of the atmosphere results from changes of the refractive index such as different size eddies that affect optical wave propagation through the atmosphere. These changes of refractive index cause different variation for the propagating laser beam such as beam wandering, beam spreading, and image jitter. All these effects can severely influence the beam quality and decrease the performance efficiency of the system in some applications including free space optical communication, LIDAR-LADAR applications, and directed energy weapons systems. There are many models for atmospheric turbulence. However, turbulence power spectrum models can be generally classified by two types: the Kolmogorov models and the non-Kolmogorov models. The Kolmogorov spectrum is with the power law value of 11/3, whereas the non-Kolmogorov models allow to changes the power law value in the range between three and four depending on applications. And there are many spectra which has specific inner and outer scale like Tatarskii, von Karman, Kolmogorov and generalized modified spectra. In this study, the generalized modified atmospheric spectra model is applied to non-Kolmogorov turbulence model. We numerically and analytically perform the calculation of ratio of changes between beam wander and beam spreading at different intervals. And we examine the influence of some parameters on beam propagation. We form a graphical user interface using Matlab and perform all the simulations via the gui. All results are discussed and compared with literature.

Keywords: Atmospheric Turbulence, Optical Communications, Laser Beam Propagation.

REGULAR SESSIONS

Id-314

Numerical Simulation of Heat Transfer and Damage Development Due to High Energy Laser Irradiation on Different Target Materials

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Abstract: Lasers are known for their spatial and temporal specificity in delivering heat energy to the material. Therefore, high power continuous wave lasers are used not only in material processing such as cutting, drilling, welding, marking but also in high energy laser applications. These studies focus on the effects of high energy laser in the irradiance (energy per area) on materials. The directly applied energy is absorbed and causes damage through intense localized heating. These defects depend upon complex melting and solidification phenomena happening due to the interaction of high energy laser with the material. In this paper, a thermal physics model of continuous wave laser damaging on stainless steel and composite material is developed in COMSOL Multiphysics which is the finite-element solver based on heat transfer theory. The model is used to predict the temperature field, heat affected zone and thickness material removal that high energy laser irradiation causes in specific materials. The heat transfer model is created in an axisymmetric domain. Thickness depth and radius are the two dimensional modeled. A heat transfer model applies the heat diffusion equation to a domain and boundary conditions to the edges of that domain. The laser incident on the upper boundary is irradiated as a surface heat flux. The study is useful to understand material behaviour under the laser irradiation. When we compare the numerical results to experimental results, they are nearly similar. We plan to share all these studies on the conference.

Keywords: Laser-Material Interaction, Heat Transfer, High Energy Laser, Material Damage.

REGULAR SESSIONS

Id-339

Optical Resonance in As_2Se_3-Au Plasmonic Planar Waveguides for Chemical Sensors Applications

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Abstract: At the metal – dielectric interface, at certain conditions, surface plasmon-polariton waves can be forme. Based on this phenomenon there were proposed miscellaneous photonic devices. The used structure to excite the plasmon-polariton waves consist in a metallic film (usually gold, which has low optical losses) deposited on a prism base. With near 50 nm film thicknesses the plarmon-polariton wave is excited by the light propagates in the prism under a certain resonance angle, which value depends on the refractive index of ambient medium. The surface plasmon resonance curve was proved to be very narrow. In this way, a high sensibility to refractive index of medium was obtained. This led to the development of label-free chemical sensors with high sensitivity. In this paper was studied the chemical sensors sensibility of this type in a multi-layer planar structure in which over the metallic film an As_2Se_3 amorphous chalcogenide film with high refractive index of 2,8 was deposited. The semiconductor As_2Se_3 film forms a planar plasmonic waveguide. It was found that for the certain film thicknesses in the range of 400-900 nm planar guide mode can be excited using a BK7 conventional optical glass prism. Depending on the film thickness, the modes spectrum, confinement level and resonance curve shape varies, all influencing the sensor sensibility. There were evidenced the conditions for increasing chemical sensors sensibility. The results contain numerical simulations and experimental studies for the wavelengths lying in the spectral range of 800-1550 nm, an important domain for optical fiber networks.

Keywords: Plasmonics, Optical Sensors, Amorphous Chalcogenide.

REGULAR SESSIONS

Id-351

Clinical Efficacy of Photodynamic Therapy for Pre-Malignant CIN and Malignant Invasive Cervical Cancer

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Abstract: Treatment of uterus cervix HPV-associated pathologies should include anticancer and antiviral treatment effect with organ anatomical and functional integrity retention. The objective of this clinical retrospective study is to investigate the antitumor and antiviral (HPV) efficacy of photodynamic therapy (PDT) in patients with pre-malignant CIN and malignant invasive cervical cancer. Total number of PDT trial case was 512 cases: 302 - HSIL, 190 - Ca in situ, 20- cervical cancer T1N0M0. It was used Photoditazine or Photolon sensitizer (active substance - chlorin e6) and was administered intravenously over 2-3 hours before irradiation. Irradiation protocol for laser (662 nm): 1 stage - cervical canal treatment with cylindrical diffuser 4 cm length (400 J/cm^2); 2 stage - cervical canal treatment with microlens and polypositional irradiation technique (300 J/cm^2 in each field). PDT Anticancer and antiviral efficiency assessment was conducted after 1,5; 3; 6; 24 months after PDT. Complete remission (CR) in group of patients with HSIL was found in 279 (92,4%) patients (91%); with Ca in situ - 184 (96,8%); with cervical cancer T1N0M0 - 17 (85%) have complete focuses regression. In 11 patients after PDT and approved recovery is found pregnancy, proceeded without complications. Pregnancy and childbirth are without any complications. The effectiveness of photodynamic therapy, antitumor and antiviral efficiency in the treatment of precancerous and initial cervical cancer has been evaluated. This study suggests that PDT can be recommended as new management on the patients with pre-malignant CIN lesions including carcinoma in situ and relatively early invasive cancer of the uterine cervix.

Keywords: Cervical Cancer, HPV, Photodynamic Therapy, CIN, Clinical Case.

REGULAR SESSIONS

Id-379

The Principle and Implementation of X-Ray Communication and Its Application in Re-Enter Plasma Sheath

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Abstract: X-ray communication (XCOM) is a novel space communication method which was introduced by NASA in 2007. X-rays have much shorter wavelengths than both infrared and radio. In principle, XCOM can send more data for the same amount of transmission power, which could permit more efficient gigabits-per-second data rates for deep space missions. Besides, X-rays can pierce the hot plasma sheath that builds up as spacecraft hurdle through Earth's atmosphere at hypersonic speeds. NASA planned to demonstrate the performance of XCOM on the International Space Station in 2019. Firstly, we studied the physical process of X-ray transmission in space and established a theoretical model including X-ray power transmission equation and error analysis formula. Secondly, based on the grid-controlled X-ray emission source and the focused single-photon detector, we built an X-ray communication demonstration system to verify the theory. And the experimental result corresponds with the theoretical calculation quite well. Currently, we obtained 1 Mbps communication speed's demonstration with 10^{-6} bit error rate. Finally, in order to verify the feasibility of applying X-ray to transmit information in plasma sheath. We built an experimental system and achieved the first interaction experiment between X-ray and dynamic & non-uniform plasma. The simulation and experiment results indicate when the number and energy of emit X-ray photons are large enough, X-ray communication will produce less attenuation characteristics in the re-enter plasma layer. These results indicate that X-ray communication will has a great potential in space communication and 'blackout region' communication.

Keywords: X-Ray Communication, Re-Enter Plasma Sheath.

REGULAR SESSIONS

Id-382

Microwave Photonics Characterization and Application of Long-Wavelength VCSELs in Atypical Regimes

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Abstract: Progress in developing microwave photonics (MWP) solutions is mainly following the progress in low cost and high power efficient optical sources in the telecom and radar areas. Among other semiconductor laser technologies, long-wavelength vertical cavity surface emitting lasers (LW-VCSELs) are regarded as an enabler for superior features in high-performance photonic circuits, and have a great potential to do so for MWP as well. In fact, the application of LW-VCSELs emitting in the telecom wavelength range (1.3-1.6 μm) is expected to benefit from the available optoelectronic components already developed in the framework of information and communication technology. However, as compared with other applications of VCSELs (datacom, sensing, interconnection, etc.), their use in MWP requires paying further attention to the spectral purity, noise, single-mode operation, and linearity features. Specifically, the possibility of wavelength division multiplexing and the low sensitivity to electromagnetic perturbations of optical fiber-based transmission allow the introduction of novel concepts into on-board or ground-based modules for antenna’s remote control, signal distribution and processing of broad-bandwidth analogue signals. Development of electrical-to-optical converters is in fact a continuous challenge for lower noise and higher linearity, which would be fully compatible with the required dynamics in microwave-band radar phased-array antennas and upcoming wireless telecom systems. Therefore, for the next generations of telecom and radar photonics-based microwave systems, it is imperative to find solutions for increasing the spurious-free dynamic range (SFDR) of built-in units and links. Besides, the penetration of optoelectronic technologies into modern radio-engineering systems has also been realized through the optical implementation of a large number of vital functions like microwave signal’s optical fiber distribution, beam-forming, adaptive filtering or analog-to-digital conversion. In view of these trends, LW-VCSELs are becoming increasingly attractive for optical fiber–based applications, thanks to their well-known engineering and cost benefits. This work was supported by the Russian Foundation for Basic Research, Grant No. 18-29-20083 and 17-57-10002.

Keywords: Microwave Photonics, Optoelectronic Processing, Period Doubling, Resonant Photodetection, Vertical Cavity Surface Emitting Laser.

REGULAR SESSIONS

Id-397

Reversibility of Mechanical Properties in Laser-Cartilage Reshaping

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Abstract: Cartilage reshaping under laser radiation is new medical procedure used for non-invasive correction of pathologic curvature of the tissue. Newly designed rolls are used for determining of the safe and effective modes of laser reshaping of cartilage. Opto- and thermo-acoustic techniques were applied to monitor operation mode of laser irradiation of the tissue in the rolls. To determine an optimal laser irradiation mode the rolls adopted with the piezo-transducer. This transducer was used to control tissue mechanics during its laser irradiation. Plane samples of the tissue selected from fresh rib cartilage have bought from the shop and were reshaped in the rolls into bent form. Shape monitoring of the bent samples after its conservation in physiological condition was carried out. Kinetics of curvature of the reshaped cartilage samples was studied using digital imaging and image processing. The kinetic behavior of cartilage reshaping observed in our experiment is explained by the mechanics of laser-irradiated poroelastic tissue. It is known, that the kinetics of cartilage deformation is described by the bi-phase theory of viscoelasticity of soft tissues. This result is important in preparation of cartilaginous implant of the proper shape in pathologic cartilage replacement. This work was supported by the Russian Foundation for Basic Research (Project №18-29-02124 MK).

Keywords: Laser-Cartilage Reshaping, Optoacoustic Control, Cartilage Deformation Kinetics, Pathologic Cartilage Replacement, Implant.

REGULAR SESSIONS

Id-428

Phononic Entanglement Concentration via Optomechanical Interactions

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Abstract: Because of low dissipation, tunable coupling to other quantum systems, and low speeds of propagation in phononic waveguide, mechanical resonators and their entanglement have potential applications in quantum information processing (QIP). We propose the first protocol of entanglement concentration for nonlocal phonons from separated quantized mechanical modes. We combine the optomechanical cross-Kerr interaction with the Mach-Zehnder interferometer. By means of twice optomechanical interactions and the photon analysis with respect to the output of the interferometer, we achieve ideal entanglement concentration about less entangled nonlocal phononic Bell and Greenberger-Horne-Zeilinger states. Our protocol is useful for generating and preserving phononic entanglement for the use of high quality phonon-based quantum information processing. This work was supported by National Natural Science Foundation of China under Grants No. 11654003 and No. 11174040.
Keywords: Phonon, Entanglement Concentration, Optomechanical System.

REGULAR SESSIONS

Id-429

Tracking and Understanding Laser Damage Events: From Micro-Defects to Nano-Precursors

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Abstract: Laser damage of optical elements in high power laser systems is a longstanding problem since the invention of first laser. Driven by construction of high power laser facilities all over the world, laser damage researches are in a long period of prosperity in the past fifty years. The basic damage mechanisms, thermal and nonlinear damage, established in 1970s told us the story of laser damage events, but laser damage problems are still challenging the laser community and industrials as the laser power grows higher and higher with the developments of the laser technologies. Furthermore, the micro-defects initiating thermal damage depend on the fabrication processes of various optical elements. The comprehensive metrologies were developed to tracking the origin of the micro-defects come along with fabrications. The influences of defects were analyzed, and optimization of fabrication processing and the post treatment measures were adopted to relieve damage. However, there are lots of laser damage events still puzzled us, especially for the UV wavelength or the ultra-short pulse laser. The damage events usually appeared as very small pits or pinpoints which may correlate to nanoscale damage precursors. Unfortunately, it is difficult to detect nano-precursors by traditional optical measures because the precursors are optical invisible for most cases. Novel methods were developed to retrieve the characteristics of the precursors. Moreover, the intensity dependent NLA indicated that the defect states in the band gap can be manipulated by laser intensity, and laser conditioning were employed to decrease NLA and enhance the damage resistance.

Keywords: Laser Damage Events, Metrology, Defects, Laser Damage Precursors, Thermal Absorption.

REGULAR SESSIONS

Id-431

Probability Theory in Conditional-Averaging Ghost Imaging with Thermal Light

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Abstract: In ghost imaging with thermal light (GITL), the bucket signals are analog signals playing the role of weights in the algorithms of image reconstruction. However, diverse bucket signals seemed to be completely ignored in conditional-averaging GITL, which was recently proposed by two groups. Even so, positive and negative ghost images were obtained by averaging just partial reference signals. To understand this effect, one needs to determine the statistical relation between random bucket signals and reference signals. Here, we apply probability theory to GITL by regarding thermal light intensities as stochastic variables, and then deduce the joint probability density function between the bucket and reference signals. Positive and negative images are formed in ensemble averaging of the product of the reference signal and two logic quantities of the bucket signals. We adopt a simplified GITL model on the basis that thermal light intensities fulfill Gaussian statistics. The visibility and contrast-to-noise ratio of these images in conditional-averaging GITL are analyzed in detail in both theory and experiment. Furthermore, considering the actual situation, such as the transmission distance is very long, or the signal attenuation in the transmission process is very serious, we perform an experiment of remote conditional-averaging GITL and verify that the image quality is maintained when the bucket signals are extremely attenuated. Our method can be applied to any ghost imaging scenarios in which the specific statistics of the optical source are given. This work was supported by the National Natural Science Foundation of China under Grants No. 11474027, No. 11674273, No. 11735005, and No. 61675028, the National High-Technology Research and Development Program of China under Grant No. 2013AA122902, and the Interdiscipline Research Funds of Beijing Normal University.

Keywords: Conditional-Averaging Ghost Imaging, Probability Theory, Negative Exponential Distribution, Attenuated Bucket Signals.

REGULAR SESSIONS

Id-450

Refractive Index Measurements of ZnO/TiO_2 Thin Films via Prism Coupler for Possible Using in Optical Biosensors

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Abstract: Prism coupler is a device to measure of refractive index with high accuracy over 0.001 and thickness of thin films. In this study, two different molar ratios of ZnO/TiO_2 thin films were produced to evaluate measurements of refractive index of the films via Metricon 2020 Prism Coupler. The molar ratio of 1:1 and 0.5:1 of ZnO/TiO_2 films were prepared via sol-gel dip coating method. The measured refractive index of ZnO/TiO_2 thin films was lower than the theoretical refractive index value due to porous structure of the films. Scanning Electron Microscopy (SEM) images has supported to this porous structure and thickness of the films which was taken from the surface and the cross section of the films, respectively. When the molar ratio of ZnO was decreased from 1 to 0.5, the measured refractive index of the films decreased with increased porosity. The nanoporous structure of the films as a substrate to immobilize recognition elements (DNA, protein, etc.) with Prism Coupler as a transducer are promising components to accomplish high sensitive optical biosensors. We acknowledge funded from Gebze Technical University with the project BAP 2018-A105-54.

Keywords: Prism Coupler, TiO_2/ZnO Thin Films, Sol-Gel Dip Coating, Optical Biosensors.

REGULAR SESSIONS

Id-468

Surface Processing of Mold Metals Using Solid-State Laser

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Abstract: Surface roughness is one of the most important a parameters which effects surface properties. Corrosion resistance, appereance, optical and tribological properties are some of them. To enhance surface properties sanding and mechanical polishing methods are used in industry. These methods are mostly applied manually and automatic solutions are not suitable for free-forms surfaces. Manual application is time comsuming, hard and costly. Morover surface quality is not standardized and restricted by operator's hand skills. Hand skilled people are very rare. Especially for automation application, surface processing by laser can solve all of these problems and it is very cheap and effective. Polishing by laser is far faster than manual method and does not deform surface. Turning and manual polishing cause metal chips, oily and dusty surface but laser processing does not have such dirt. It allows to conserve surface form and does not cause mass loss. For most producers, mechanical polishing is expensive and it takes a lot of time. Electro-chemical polishing processes have harmful effects on environment. Laser polishing which started to use in recent years can be applied to most alloys and metals. Therefore it is a powerful alternative to conventional polishing methods. Laser polishing can be described roughly as a process which laser power melt metal surfaces locally between 100-200 micro meter width and melted metals flows to cavity without any mass loss. This process can reduce roughnes on the surface. There are plenty of researches about this process and they are very hopeful. Polishing mould surfaces is crucial to get desired brightness and roughness properties. Especially moulds which used in glass production and optical industry effects products' quality directly. Therefore they should not exceed restricted roughness value. Similarly in automotive industry roughness of processed parts effects painting quality and cost. They also need smooth surface to get bright and smooth parts. Mould brightness is very important for product quality. For example; during injection process, plastic fulled steel pores means plastic sticked to steell surface. In this research; laser polishing by a fiber laser which controlled by a robotic arm will be applied on mould surface made of spheroidal graphite cast iron (GGG70) which used to manufacture hoods. After process effects of laser polishing on surface will be observed and measured by parameters that roughnes, hardness, wearing etc.

Keywords: High Power Laser, Mold Metals, Roughness, Surface Processing by Laser.

POSTER SESSIONS

Id-285

Modeling of Dual-Junction Tandem Based on InGaP/GaAs Heterojunction Stacked on A Ge Solar Cell

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Abstract: In this work, an analytical model is used to describe the elctrical characteristics of a dual-junction tandem solar cell performing a conversion efficiency of 32.56% under air mass 1.5 global (AM1.5G) spectrum. The tandem structure consists of a thin heterojunction top cell made of indium gallium phosphide (InGaP) on gallium arsenide (GaAs), mechanically stacked on a relatively thick germanium (Ge) substrate which acts as bottom cell. In order to obtain the best performance of such a structure, we simulate for both the upper and lower sub-cell the current density-voltage, power density-voltage, and spectral response behaviours taking into account the doping-dependent transport parameters and a wide range of minority carrier surface recombination velocities. For the proposed tandem cell, our calculations predict that optimal photovoltaic (PV) parameters, namely the short-circuit current density (J_{sc}), open-circuit voltage (V_{oc}), maximum power density (Pmax), and fill factor (FF) are 28.25 mA/cm^2, 1.24 V, 31.64 mW/cm^2, and 89.95%, respectively. The present study could turn useful to support the design of high efficiency dual junction structures by investigating the role of different materials and physical parameters.

Keywords: Analytical modeling, Tandem solar cell, Spectral response, Conversion efficiency.

POSTER SESSIONS

Id-286

Synthesis and Characterization of Nickel Nanoparticles Supported on Aluminum Oxide

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Abstract: Due to their peculiar qualities, metal-based nanostructures have been extensively used in applications such as catalysis, electronics, photography, and information storage, among others. New applications for metals in areas such as photonics, sensing, imaging, and medicine are also being developed. Significantly, most of these applications require the use of metals in the form of nanostructures with specific controlled properties. The properties of nanoscale metals are determined by a set of physical parameters that include size, shape, composition, and structure. In recent years, many research fields have focused on the synthesis of nanoscale-sized metallic materials with complex shape and composition in order to optimize the optical and electrical response of devices containing metallic nanostructures. In this work, we study nickel nanoparticles supported on aluminum oxide, prepared by impregnation with ionic exchange. In a first stage, the fixing conditions of the nickel precursor on aluminum oxide are optimized. In the second stage, the samples are calcined at various temperatures (T=250, 350, 500, 750 and 950°C). Several experimental techniques are used for the characterization of the samples at the various stages of their elaboration (UV-visible, SEM, EDX, DRX, and FTIR). A change of morphology of the aluminum oxide grains was observed by Scanning Electron Microscope. The X-rays diffraction shows the formations of nanoparticles Al_3Ni_2 of near size 5,5 nm calcined at 750°C. At superior temperature, its size increases following the phenomenon of coalescence .The spectrometry FTIR allowed observing peaks of vibration of links Al-O, Al-OH, Al-O-Al and Ni-O.

Keywords: Optical Properties, Nickel Nanoparticles, Ionic Exchange, Spectrometry FTIR.

POSTER SESSIONS

Id-337

A Technique for Measuring the Spatially Distrubuted Scattering of Single Crystal Fibers

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Abstract: Most of the transmission loss in single crystal fiber is scattering loss, which is attributed to the structural defect characteristic of single crystal fiber. It is significant work to obtain the spatial scattered light of single crystal fiber, which is the basis to know the internal defects of SC fiber and help to improve the defects. A device is designed for measuring spatially distributed scattering of single crystal fiber. This device is used to measure the spatially distributed scattering light intensity and total scattering intensity of single crystal fiber. A He-Ne laser is used as the light source. The device can measure only part of the optical fiber that extends into the detection area.The integrated sphere is used to measure the total scattered light intensity and input light intensity of single crystal fiber. During measurement, the photodetector moves along the axial direction of the single-crystal fiber or rotates around the radial direction of the fiber to obtain the spatially distributed scattering light intensity of the fiber. At present, the Ti:sapphire single crystal fiber samples have been measured. The diameter of this single crystal fiber sample has a diameter of 0.8mm and a length of 38mm. The length of the sample detected in the measuring device is 10mm. The total scattering rate was 20.4% and the spatially distributed scattering rate ranges from 0.1% to 3%.The uneven distribution of scattered light may caused by the internal scattering particles or the inhomogeneity of the material.

Keywords: Single Crystal Fiber, Spatially Distributed Scattering.

POSTER SESSIONS

Id-338

3D-Nanomanipulation and Characterization Using Extreme Small Nanotweezers for SEM/TEM/Optical Microscopy

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Abstract: Recent progress in different type of microscopy is the result of the applications of the basic ideas of fundamental photonics and opto-electronics and high speed, high resolution image processing. Particularly, fluorescence microscopes, confocal microscopy which demonstrates higher resolution, and significantly improves optical sectioning have succeeded in 3D structure reconstruction and super wavelength resolution imaging. For study many nano-objects in super resolution sub-wavelength optical, scanning electron (SEM), atomic force (AFM), focus ion beam (FIB) microscopes it is the techniques, which can provide 3-D nanomanipulation of the nano-objects, including pick up and place, bending, rotation and other mechanical type of movement with controlled nanometer resolution. In this report we present the new 3D-nanomanipulation and characterization system of different nano-objects in different type of microscopes using the smallest shape memory nanogripper. This nanogripper can provide mechanical work in vacuum, liquid and air. The overall size of nanogripper can be of the same order as the nano-objects. This makes the process of nanomanipulation simple and intuitive. Such nanogripper is attached to the end of nano-position system and represents end-effector. The actuation can be controlled by heating using laser beam heating or electric current heating. The work was supported by RFBR – grant No 17-57-45129 and grants from Department of Science and Technology, Government of India "DSTO 1759 (INT/RUS/RFBR/P-287)".
Keywords: Microscopy, Nanotool for Microscopy, Nanomanipulation inside Microscope, Nanogripper.

POSTER SESSIONS

Id-410

Photochromic Recording Media with Photomodulated Luminescence

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Abstract: The results of the development of optical fluorescent film materials for applications as recording media for two-photon three-dimension bitwise optical memory with nondestructive luminescent readout are presented. It was shown that photochromic diarylethenes in combination with organic phenalenone or inorganic quantum dots CdSe/ZnS make it possible to manufacture multilayer rewritable optical disks. Polymer layers based on irreversible light–sensitive chromones are acceptable for making optical disks of the archival type. Information capacity of the disks including alternating light-sensitive and wave-guide polymer layers may be more than 1TB. This work was supported by Russian Foundation for Basic Research (project 18-33-00010Bel) and the Belarussian Foundation for Basic (project F18R-074).

Keywords: Photochromism, Diarylethenes, Chromones, Luminescence, Optical Memory.

POSTER SESSIONS

Id-417

Structural, Optical and Electrical Properties of an Electron Beam Evaporated TiO_xN_y Films as Selective Solar Absorber Coatings

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Abstract: Titanium oxinitride (TiO_xN_y) solar absorber coatings was deposited onto Cu, Si and glass substrates using electron beam evaporation technique for different oxygen partial pressure. XRD showed diffraction patterns correspond to the (111), (200) and (220) orientation of TiN_x phase. The preferred orientation of the films changed as a function of oxygen partial pressure. XPS revealed the intensity of both Ti $2p_{3/2}$ and Ti $2p_{1/2}$ increases as a function of oxygen flow, and also shifted towards higher binding energy, indicating more oxidized state of Ti species than that of TiO_2 due to incorporation of nitrogen atoms. Formation of uniformly distributed spherical like particles and an increase in surface roughness of the TiO_xN_y films were observed as a function of oxygen partial pressure as depicted from SEM and AFM, respectively. Ellipsometric and resistivity measurements showed the TiO_xN_y films shifted from metallic behaviour to semiconductor as a function of oxygen. A solar absorptance value of 0.94 in the solar spectrum region and a low thermal emittance value of 0.05 were achieved for the TiO_xN_y solar absorber coatings prepared at the oxygen partial pressure of $7.5x10^{-5}$ Torr due to both interference and intrinsic absorption. This study confirmed that a single layer of TiO_xN_y film can be a good candidate as selective solar absorber.

Keywords: Solar Absorber, TiO_xN_y, Oxygen Flo, Structure, Optical Properties.

POSTER SESSIONS

Id-424

Silicon Nanodiodes for Wireless Opto-Electric Stimulation of Excitable Cells

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Abstract: Electrical stimulation has been efficacious and widely used to treat diseases, but it is limited by the need for wiring electrodes, mechanical invasiveness, inability to target specific cells and generation of unprecise electrical impulses. Nanoscale implantable devices which can be remotely actuated by light to stimulate specific cells can open advanced therapeutic pathways. Here we present silicon nanodiodes for controllable wireless opto-electric stimulation of excitable cell. The silicon nanodiodes can be fabricated through a scalable and cost-effective combination of colloidal lithography and deep Si etching, with tunable diameter, length and density. As representative structure, we analyze silicon nanowires with longitudinal p-n junction and Au cap (with diameter 200 nm, length 1μm). To evaluate the opto-electric properties of these Si nanodiodes in physiological medium, we tested the light induced current and voltage for continuous, sinusoidal and pulsed laser (808 nm) conditions in a three electrodes electrochemical workstation. We proved that the nanodiodes can effectively separate photo-generated charge carriers compared to the uniformly doped p-type Si, and reduce the high capacitance observed in flat pn substrates. Interestingly, the high frequency illumination enables minimizing the capacitance effect to induce large photocurrent, which can be beneficial for efficient cellular excitation. We also show that by inverting the diode direction, we can generate reversed current and voltages, which will determine whether cathodic or anodic reaction induced at the nanodiodes-cell biointerface. The substrates are biocompatible and enable efficient cell culture for the different arrays densities. We finally assess the efficacy of the Si nanodiodes for opto-electric stimulation on HEK cells, by successfully depolarizing the cell membrane and modulating the intracellular K^+ dynamics. Our results show a new nanotechnology for cellular modulation, which may be broadly applied for implantable nanodevices and opto-electric therapeutics in the clinic. Financial support from Chinese Scholarship Council and projects MAT2016-77391-R, PCIN-2016-093 are gratefully acknowledged.

Keywords: Silicon Nanodiodes, Opto-Electric, Stimulation of Cells.

POSTER SESSIONS

Id-439

Upconversion Luminescence Properties of Tm^{3+}/Yb^{3+} Co-Doped CdF_2 Single Crystals

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Abstract: Photonic materials are nowadays of great importance in view of their multiple applications. They are present in topical areas of technology such as display screens, lighting lamps, biophysics, communication devices, solid-state lasers, etc… Materials doped with luminescent rare earth ions occupy a vanguard place among these photonic materials. This is due to the unique properties of rare earth ion luminescence. Such ions possess 4f–4f transitions shielded by the outer orbitals, leading to the sharp, monochromatic emission and long luminescent lifetime. The materials inserting these ions are in the form of crystals, glasses and glass-ceramics or in the form of nanoparticles generally having relatively low phonon energies. In this context, we are interested in studying the luminescence properties of CdF_2 single crystals codoped with Tm^{3+} and Yb^{3+} ions according to different excitation processes. We present the fluorescence properties of CdF_2 crystals by directly exciting the activator ions or via the sensitizer ions. The spectroscopic properties of the main emitting levels have been investigated and discussed.

Keywords: Optical Materials, Luminescence, Rare Earth, Upconversion.

POSTER SESSIONS

Id-451

Application of Electromagnetic Charge Effect for Development of Optical Sensors

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Abstract: During our studies it was found that during interaction of electromagnetic field with matter, the irradiated body begins to generate an alternating electrical signal. These results are grouped under the name Electromagnetic echo effect (EMEE). The measured signal is a function of the state of the body. In the present work, some of the new types of optical sensors created on that basis are discussed. Such sensors are for control of: speed and diameter of fog droplets, fog emergence, impurity emergence in fog, evaluation of the number and diameter of fog droplets, processes at the threshold of laser ablation and phase transitions in liquid crystals. Also, a scanning system has been developed for visualization of irregularities on surfaces. This work has been funded by FP7-SEC-2012-1 program of the EU Commission under grant number 312804 and partially supported by the Bulgarian Ministry of Education and Science under the National Research Programme "Young scientists and postdoctoral students" approved by DCM # 577 / 17.08.

Keywords: Optical Sensors, Fog, Scanning System, Laser Ablation, Field-Matter Interaction.

Workshop on Optical Coherence Tomography (OCT)

Kemer/Antalya - Turkey

November 4-9, 2019

Plenary Speakers

Alex Vitkin University of Toronto, Canada

Invited Speakers

Alexey Feofanov	Lomonosov Moscow State University, Russian Federation
Michal Hricovini	Slovak Academy of Sciences, Slovakia
Sureshkumar Murugesan	Vels Institute of Science, Technology and Advanced Studies, Pallavaram, Chennai, Tamil Nadu, India
Sergey Alexandrov	National University of Ireland, Ireland
Camila Dale	University of São Paulo, Brazil
Jun Zhang	Sun Yat-sen University, China
Lev Matveev	Russian Academy of Sciences, Russian Federation
Kohei Soga	Tokyo University of Science, Japan
Miguel Puertas-Mejía	Universidad de Antioquia, Colombia
Farzad Salehpour	Tabriz University of Medical Sciences, Iran
Jens Möller	Ruhr University Bochum, Germany
Vladimir Y. Zaitsev	Russian Academy of Sciences, Nizhny Novgorod, Russia
Iouri Borissevitch	Universidade de São Paulo, Brazil

PLENARY SPEAKERS

Id-454

Photon Mayhem: Using Light for Structural and Functional Assessment of Biological Tissues

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Abstract: Medicinal photonics (biophotonics) includes a variety of therapeutic (effects of light on tissue) and diagnostic (effects of tissue on light) applications. In this talk, the latter category will be highlighted, with emphasis on methods actively investigated in our laboratory – optical coherence tomography speckle based functional imaging and tissue polarimetry for anisotropy monitoring. Both of these approaches rely on the wave nature of light (coherence and polarization, respectively) and offer unique biophysical information on tissue structure, composition, and function.

Keywords: Optical Coherence Tomography, Functional Imaging, Tissue Polarimetry.

INVITED SPEAKERS

Id-302

The Spectroscopic and DFT Analysis of Photochemical Processes in Quinazolinone-Derived Schiff Bases

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Abstract: Light-induced photoisomerization plays an important role in a number of chemical and biological processes in nature. Many photochemically-induced processes are associated with biologically active derivatives of Schiff bases. Present contribution deals with the analysis of photochemical processes of the series of quinazolinone-based Schiff's bases studied by EPR and NMR experiments together with DFT calculations. The EPR data has proven the generation of reactive radical species. Photoactivation resulted in the generation of reactive paramagnetic intermediates in DMSO under atmospheric conditions. Spin-trapping technique and simulation of the EPR spectra revealed the presence of multiple spin adducts in the system. High-resolution NMR spectra showed formation of the new structures due to UV irradiation. The analysis of 1D and 2D spectra confirmed formation of the syn-isomer because of rotation around the N–N bond in the –N–N=CH– array. The isomerization process is relatively slow (up to several hours) and the re-establishment of the thermodynamic equilibrium may take up to two months depending upon structure of the investigated derivatives. DFT calculations enabled the detailed study of the investigated derivatives in terms of structure, excited states and the energy profiles. The obtained data showed that the isomerization process proceeds via S1 state transitions resulting into the formation of two isomers with similar structure. Further information about the results will be discussed in our contribution.

Keywords: Photochemistry, Schiff Bases, Isomerization, EPR, NMR.

INVITED SPEAKERS

Id-333

Interactions of Nucleosomes with Proteins: Single-Particle Fret Microscopy Studies

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Abstract: DNA is tightly packed in the nucleus, and special proteins check genome integrity, repair damages and provide controlled access to genomic information intelligently unpacking and packing DNA. Mechanisms of action of such proteins require detailed investigation to advance gene engineering and medicine. These mechanisms are studied by us at the level of single nucleosomes using single particle Förster resonance energy transfer microscopy (spFRET microscopy). We developed a set of fluorescently labeled mononucleosomes of different structure assembled from core histones and DNA of variable length containing a strong nucleosome-positioning sequence. A donor-acceptor pair of labels introduced into neighboring gyres of nucleosomal DNA or into linker DNA enables probing of nucleosome structural changes in the complexes with the studied proteins, while spFRET technique provides recognition of various conformations of nucleosomes and types of complexes simultaneously formed in a solution. In the present report we discuss the possibilities of structural studies of nucleosome-protein interactions with spFRET microscopy on the basis of both published results and new experimental data obtained in the studies of nucleosome complexes with linker histone H1, chaperone histone FACT and poly(ADP-ribose)polymerase 1. The studies were supported by Russian Science Foundation (grant 19-74-30003). PARP1 studies were supported by RFBR (grant 17-54-33045).

Keywords: Nucleosome, spFRET, FACT, PARP1, Microscopy, Single Molecule.

INVITED SPEAKERS

Id-348

Molecular Mechanisms Involved on Photobiomodulation-Induced Analgesia on Experimental Diabetic Neuropathy

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Abstract: Peripheral neuropathy (PN) caused by diabetes mellitus is one of the most common complications of diabetes, affecting about 50% of patients. Among the many symptoms of diabetic peripheral neuropathy (DPN), stands out the development of chronic pain, which affects mainly the extremities, presenting itself as exacerbated responses to noxious stimuli (hyperalgesia) and as pain in response to light or not painful stimuli (allodynia). Conventional treatments available for neuropathy, including the associated pain, are still inadequate, unsatisfactory and benefit only a small number of patients. In clinical practice, photobiomodulation (PBM) becomes increasingly popular, once it promotes early nerve regeneration, resulting in significant improvement of motor and sensory disabilities caused by various types of lesions in peripheral nerves. Although the effects are satisfactory, the mechanisms by which these effects occur are still unknown. In this study, the effects of lasertherapy (660 nm, 30 mW, 1.6 J/cm^2, 15 sec, 0.28 cm^2) on the treatment of DPN-induced pain and nerve damage was assessed in an experimental model of streptozotocin-induced diabetic neuropathy in mice. PBM induced antinociception in neuropathic pain-mice dependent on the central release of opioids. After 21 consecutive applications, LLLT increased nerve growth factor (NGF) levels and induced structural recovery, increasing mitochondrial content and regulating Parkin in the sciatic nerve of mice with DPN. Together, these data provide further insights into the mechanisms involved in lasertherapy, emphasizing its therapeutic potential in the treatment of DPN.

Keywords: Photobiomodulation, Analgesia, NGF.

INVITED SPEAKERS

Id-349

Removal of Saturation Effects in Endoscopic Swept Source Oct Imaging

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Abstract: Swept source optical coherence tomography (SSOCT) is a high-resolution, noninvasive optical imaging technique capable of cross-sectional imaging of biological tissues in micrometer scale. Integrated with fiber-optic endoscopic scanning probes, endoscopic SSOCT is especially attractive in internal organ imaging. However, endoscopic OCT imaging is usually compromised by saturation artifacts due to strong signals from highly reflective areas such as interstitial fluid, catheters and guide wires, etc. In a common case that detected signals exceed the dynamic range of the system, bright lines accompanied with a band of artifacts across tissue depth due to Fourier transform of saturated signals will degrade the OCT imaging quality in particular A-lines and cause loss of information in the areas with strong artifacts. Since the limited bit depth of the analog to digital converter (ADC) is usually the bottleneck of the input range of the system, one solution is to increase the bit depth of the used ADC. However, a high performance ADC with a high bit depth and high sampling rate sufficient for SSOCT imaging is either costly or not available in the market. A cost-effective and real-time technique to remove saturation effects in SSOCT imaging especially in endoscopic imaging is still absent. In order to compensate the saturation artifacts in endoscopic SSOCT images, we presented a design based on a dual channel detection technique. The detected interference signal was split by a broadband directional coupler into the two channels of an ADC. The signals that exceeded the input range of the ADC were reconstructed by combining the signals from two channels. The experimental results showed that this cost-effective design can efficiently remove the saturation artifacts in endoscopic SSOCT images and improve the dynamic range of the system by more than 10 dB.

Keywords: Swept Source Optical Coherence Tomography, Endoscopic OCT, Saturation Artifacts.

INVITED SPEARKERS

Id-350

Photoprotective Potential of Natural Extract from High-Altitude Plants and Marine Algae from Colombia

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Abstract: The excessive exposition to ultraviolet radiation (UVR) of sun spectrum has a significant role in several biochemistry processes in animals and plant species which could be destabilized, resulting in cell damage. In human beings, this radiation can cause multiple dermal disorders such as skin cancer, erythema, melanoma, photoaging, etc. All of them may stimulate numerous processes associated to premature aging such as depigmentation, skin wrinkling, folds and distortions. Therefore, the use of natural extracts is an approach to reduce the UV-generated ROS-mediated photodamage, immune-suppression and skin cancer. The aim of this study was to evaluate the photo-protection capacity in vitro of extracts of plants from high altitude ecosystems in Antioquia, and macroalgae from Colombian Caribbean Sea. The results in most of the extracts evaluated showed a broad-spectrum UVA-UVB with antioxidant capacity in vitro. B. antioquensis displayed the highest absorption coefficient in UVB-UVA range among plants and algae under study. Furthermore, the gel formulations containing the crude extract of B. antioquensis showed significant values of UVAPF, UVA/UVB ratio, critical wavelength (λc) and SPF indicating interesting photostability and antiradical capacities. All these properties could be improving to satisfy the requirements for broad-spectrum UVB/UVA protection. Finally, the findings suggest that most of the extracts could be a potential source of a new natural sunscreen compounds with photostable and antiradical properties and a feasible candidate for further study as a potential commercial cultivar for human consumption. Authors would like to thank Colciencias (Contract 259-2017) and Universidad de Antioquia (Fondo de Internacionalización, Reparación de equipos from Vicerrectoría de Investigación, CODI proj. 2019-25210) for providing financial support. We thanks to S. Rincón, M. Silva, Y. Monsalve for their assistance.

Keywords: Photoprotection, UV Radiation, Biodiversity.

INVITED SPEAKERS

Id-355

A Brief Report on Hemocompatible, Photodynamic, Anti-Microbial Behaviour of Phloroglucinol Succinic Acid (Pgsa) Dendrimer

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Abstract: Cancer is a group of about 100 diseases characterized by abnormal uncontrolled cell growth. Most cancer related deaths are due to metastasis which is responsible for ~90% death rate. Till now, an important and long-term goal of the pharmaceutical industry is to develop therapeutic agents that can be selectively delivered to specific areas in the body to maximize the therapeutic index. About 3.5 decades ago, the first developed nanoparticles were initially used as carriers for vaccines and cancer chemotherapy agents. It is well known that the design of new drug delivery systems with the ability to carry toxic or poorly soluble bioactive molecules in aqueous media is highly motivated for the need of improving drug effectiveness and to minimize side effects. Photodynamic therapy has been emerged as an alternative and complementary treatment modality for cancer. This can be carried out by oxidizing the biologically important molecules at cellular level by the combined action of light, photosensitizer (PS) and molecular oxygen. Intensive research has been carried out to reveal the fact about the dendrimers to act as a successful nano carrier and to have hemocompatibility, photodynamic efficacy, antimicrobial activity, which mainly depends on the structural factors (i.e., distribution of surface charge). In this context, Phloroglucinol Succinic Acid (PGSA) Dendrimer was synthesized and appropriately characterized. The haemocompatibility behaviour of the PGSA dendrimer with a photosensitizer, Protoporphyrin IX (PpIX) was investigated without any surface modifications. Enhanced photodynamic efficacy of this delivery system with PpIX was studied by in vitro studies in HeLa and HEp-2 cancer cells with a simple red light source (Light Emitting Diode) and its IC50 dose were evaluated. In addition to this, the ROS production efficiency of PpIX in free and dendrimer encapsulated forms were characterized spectroscopically with L-tryptophan by its emission characteristics. I am very thankful to Dr.S.Ganesan, Professor, Department of Medical Physics, Anna University, Chennai-25, for encouraging my research thrust and Vels Institute of Science, Technology and Advanced studies for financial support.

Keywords: Cancer, Nanoparticles, Drug Delivery Systems, Hemocompatibility, Antimicrobial Activity.

INVITED SPEAKERS

Id-357

Biscyanine Dyes and Nitrofuran Derivatives – New Classes of Photosensotizers for Photodynamic Therapy

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Abstract: In last decades the photochemotherapy (PCT) is successfuly applied in the treatment of various deseases including cancer. However, photoactive compounds (photosensitizers, PS) actually used in PCT possess various limitations, such as low absorption in spectral region of phototherapeutic window, prolonged elimination from the patient organism, etc. Moreover, the use of the PS excited state as an active substance limits the PCT effectivity since the excitation energy can be dissipated via undesirable processes. This stimulates the search for new more effective PS and new PCT ways based on the formation of light induced non-excited active species, such as free radicals. In this work we present studies on the photoactivity toward B16F10 and C8161 melanoma cells of cyanine dyes with two chromophores in comparison with Photogem, the PS actually applied in PCT, and a nitrofuran derivative nitrofurantoin, which releases NO radical when irradiated by visible light. The high photoactivity of both objects has been demonstrated. The author is indebted to the Brazilian Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for financial support (project N^0 304863/2017-3).

Keywords: Photochemotherapy, Limitations, Biscyanines Dyes, Nitrofuran Derivateves, NO Release.

INVITED SPEAKERS

Id-368

Visualization of Sub-Micron Structure Using Nano-Sensitive Optical Coherence Tomography

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Abstract: Optical coherence tomography (OCT) is a non-invasive label-free depth resolved imaging technique, analogue of the ultrasound imaging. OCT facilitates cellular level structural and functional imaging of living tissues, but the structural sensitivity and resolution of intensity based imaging are fundamentally limited to microscale. Detection of structural changes in biological samples at nanoscale poses a significant challenge to both researchers and healthcare professionals. Furthermore, when considering physiological processes, it is desirable to be able to resolve these structural changes both spatially and temporally. Here, we present a novel method, nano-sensitive OCT (nsOCT) for detecting depth resolved nanoscale structural changes of sub-micron structure non-invasively. This technique is based on adaptation of the recently developed spectral encoding of spatial frequency (SESF) approach to depth resolved imaging using OCT. Our talk describes the principles of this technique and demonstrates the feasibility of different modalities of the nsOCT by monitoring internal structural changes within different objects, including human skin in vivo. Structural changes can be visualized at each point in the sample over space or time. The experimental results show new possibilities for the study of structural changes, without the need for biomarkers or labels. Thus, nsOCT could potentially offer exciting and far-reaching opportunities for early disease diagnosis, as well as myriad applications for researchers. This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreements no. 761214 and no. 779960. The materials presented and views expressed here are the responsibility of the author(s) only. The EU Commission takes no responsibility for any use made of the information set out.

Keywords: Biomedical Optics, Label Free Imaging, Optical Coherence Tomography, Nano-Sensitivity, Sub-Micron Structure.

INVITED SPEAKERS

Id-378

Materials and Device Development of Near Infrared Photonics for Biomedical Applications

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Abstract: Transparency of biological tissues is controlled by bending or absorption of light that basically propagates straight ahead. Namely, the bending causes the scattering loss, which cannot be avoided by the improvement of camera sensitivity or intensity of illumination. The bending, reflection, refraction and scattering, is caused by the light speed change in biological tissues which is understood with a term “refractive index.” The famous Rayleigh scattering only matters for long distance propagation of light in cases such as understanding of blue sky or optical fiber communication with km order propagation but has nothing to do with biological tissues. As average, the membranes of biological tissues has refractive index of 1.43, while that of water is 1.33. Due to the random orientation of the membranes in tissues, the light is scattered to random directions to make tissues opaque. In recent years, various clearing chemicals are proposed to make biological tissues transparent. However, any of these chemicals are difficult to keep the biological tissues alive. The consideration of the refractive index leads us to consider the dielectric moment. The combination of the dielectric constant, ε, and permeability, μ, decides the light speed as $c = {}^{1}/_{\sqrt{\varepsilon\mu}}$. The dispersion is controlled by the resonant absorption of light in UV range by electrons and IR range by the vibration of electric dipole moment due to molecular vibration. The closer to the UV or IR, the more the optical loss is. As a result, near infrared wavelength range between 800 nm and 2000 nm is known as “biological window” to be transparent for biological tissues. The authors have developed fluorescent materials and devices of the near infrared photonics for biomedical applications such as photodynamic therapy, thermometry and endoscopy.

Keywords: Near Infrared, Bioimaging, Photonics, Fluorescence, PDT.

INVITED SPEAKERS

Id-390

OCT Speckles Statistics: Simulation, Evaluation and Signal Processing for Tissue Mapping

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Abstract: We present computationally effective numerical simulation for speckle pattern probability density function (PDF) evaluation in OCT. This approach is performed in spectral domain and based on the wave-beam model in scalar approximation for each spectral component scattered from the randomly distributed scatterers that enough for close to reality speckle statistic formation. This numerical simulation can be performed to obtain speckle pattern PDF without sophisticated analytical convolution of the scatterer statistics as well as without computationally expensive Monte-Carlo photons propagation and electromagnetic field simulation procedures. This model is validated on the base of previous controlled phantom experiments and analytical derivations. As a practical example we perform the PDF evaluation from low concentration that allow to develop speckle-statistics characterization of low scatterer concentration regions in OCT. The study was supported by RFBR project no. 19-02-00645 (in part of numerical simulations of OCT-signal statistics) and Russian President Grant No MK-3416.2018.2 (in part of low scatterer concentration characterization).

Keywords: Optical Coherence Tomography, Speckle, Pattern Recognition, Optical Diagnostics for Medicine, Tissue Characterization.

INVITED SPEAKERS

Id-436

In Vivo Investigation of Peripheral Nerves Using Optical Coherence Tomography and Texture Analysis

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Abstract: Peripheral nerve surgeries are carried out for treatment of numerous peripheral nerve pathologies. In many cases, different pathologies affect the structure of the nerve. To investigate the nerve's structures, there are no methods for an in vivo high resolution assessment yet. Established in vivo imaging modalities, like high resolution ultra sound cannot provide a resolution that can resolve the smallest functional units of the nerve, the myelinated axons. We used a frequency domain optical coherence tomography system (FD-OCT) and investigated the structure of peripheral nerves in more than 30 surgeries in vivo. We acquired volumetric images using a hand probe, which was directly placed on the exposed nerve and covered by a sterile foil. Regarding these volumetric images, a texture analysis of the tissue was performed. By extraction of texture features from gray-level co-occurrence matrices, highlighting of connective tissue could be achieved. Furthermore, substructures of peripheral nerves could be identified in OCT images, executing a direct comparison of OCT images with corresponding histopathology slices of the same sample. The smallest structures that could be found in both imaging modalities are myelinated axons, responsible for the signal transmission in peripheral nerves. Noninvasive OCT imaging could enable the gathering of more structural information about peripheral nerves and their substructures in case of pathology, compared to the current need of tissue extraction for high resolution imaging of the tissue. Accordingly, OCT imaging of these structures holds great potential to improve diagnosis and subsequent treatment of peripheral nerve pathologies.

Keywords: Optical Coherence Tomography, Peripheral Nerve, In Vivo, Texture Analysis, Histopathology.

INVITED SPEAKERS

Id-437

Oct Elastography for Imaging Microscopic Deformation and Strain of Tissue: The 20 Year Perspective after Seminal J. Schmitt's Publication

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Abstract: By the end of 1990s, ultrasound-based elastography allowing for evaluation of stiffness of biological tissues has become sufficiently matured for realization in commercialized ultrasound platforms. These realizations were based on the compressional principle: the tissue should be subjected to approximately uniaxial stress with the possibility to fairly freely expand laterally. In such a case the tissue deformability in the axial direction is determined by the Young modulus E rather that the bulk modulus K that determines the velocity of ultrasound and varies very weakly in contrast to strong variability of the Young modulus. The Young modulus in "soft" biological tissues (i.e., except for bones) is with a high accuracy proportional to the shear modulus G, E=3G. Thus, measurements of either modulus G or shear modulus E give equivalent information about the tissue stiffness. The shear stiffness strongly depends on the particular tissue type and its state and thus is a valuable diagnostic parameter. When using compression of the tissue by a piston one creates in its vicinity nearly uniaxial stress, then the resultant distribution of strain (i.e., local deformation) in this region represents the distribution of the inverse Young modulus. In view of this the primary problem in realization of the compressional variant of elastography is reconstruction of local strains. The problem of strain reconstruction in ultrasound can be solved using the correlational tracking of axial displacements of scatterers in the compared ultrasound scans. Then the so-reconstructed displacement field should be numerically differentiated to find the sought local strains. This principle was proposed in medical ultrasound in the beginning of 1990s and by the end of 1990s was ready for realization in commercialized devices. The transfer of this apparently simple principle to optical coherence elastography was proposed in 1998 by J. Schmitt and looked fairly straightforwardly feasible. However, practically useful realization of the compressional elastography in OCT appeared to be not that simple and took about 15 years. The reported studies were supported by Russian Sceince Foundation grants Nos 16-15-10274 (in part of the development of advanced strain-mapping methods) and 18-75-10068 (in part of the development of OCE-based segmentation of tumorous tissues).

Keywords: Optical Coherence Tomography, Optical Coherence Elastography, Strain Mapping, Stiffness Mapping.

REGULAR SPEAKERS

Id-395

Brain Photobiomodulation Therapy: A Cutting-Edge Technology in Neurorehabilitation

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Abstract: Photobiomodulation therapy (PBMT) using red to near-infrared light is gaining increasing interest in a wide range of brain applications ranging from neurological and psychological disorders to improving brain functions in healthy subjects. The present study reviewed published pre-clinical and clinical studies regarding PBMT of the brain or neuronal cultures. We searched Web of Science and PubMed databases from 1967 to June 2019 using 233 relevant keywords. Results were reduced to peer-reviewed original articles. Conference papers were not included and samples were limited to publications written in English. We found 56 in vitro, 129 in vivo, and 55 clinical original articles. Cytochrome c oxidase has been proposed as the main PBMT photoacceptor which has the peak light absorption at approximately 600 to 880 nm. Brain PBMT enhances cerebral blood flow by releasing nitric oxide and also improves cerebral hemodynamics. Moreover, PBMT ameliorates oxidative stress, neuronal cell death, and neuroinflammation and can potentially stimulate synaptogenesis and neurogenesis. Transcranial, intranasal, intraaural, intraoral, and intravascular approaches have been put forward as non-invasive light delivery methods for brain PBMT. Furthermore, the feasibility and safety of the invasive intracranial brain PBMT have been reported in animal models of Parkinson's disease. An abscopal effect of PBMT on the brain when delivered non-transcranially, has also been suggested. Although the number of clinical studies has not yet reached a satisfactory mass to support mainstream clinical acceptance, the majority of reports so far indicate neuroprotective benefits and good tolerability of PBMT. Further research into its efficacy and mechanisms is warranted.

Keywords: Photobiomodulation, Laser, LEDs, Brain Function, Neurons.

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