Book of Abstracts

INTERPHOTONICS 2018

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INVITED SPEAKERS

Id-005

New Biophotonic Materials from Persistent Luminescent Particles Containing Bioactive Glasses

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Abstract: In 1969, L.L. Hench discovered 45S5 (Bioglass®), a new biomaterial that degrades within the body leading to the precipitation of a hydroxycarbonated apatite layer at its surface. One of the drawbacks of bioactive glasses lies in the difficulties in imaging them in-vivo. In bone cements and bone implants, radio-opacity is crucial in order to allow an easy follow-up of the dissolution and resorption after implantation. The field of optical imaging has expanded rapidly due its direct applications in imaging the vascularization, tumors and grafted cells using photons as the information carriers. Maldiney et al. demonstrated highly sensitive in-vivo detection using nanoparticles with persistent luminescence in near infrared. Persistent luminescence (PeL) or afterglow is a form of emission which continues after the removal of the irradiation source. In this presentation, we report our latest work on the processing of PeL bioactive bodies obtained by sintering glass particles with PeL microparticles (MPs) such as $SrAl_2O_4:Eu^{2+},Dy^{3+}$. The impact of sintering temperature on the PeL of the MPs is discussed and correlated to the particles degradation as evidenced by SEM/EDX. The sintered bodies were immersed in simulated body fluid (SBF). The dissolution of the glass and of the MPs was assessed by ICP-OES. The change in the MPs morphology and composition and in the PeL was investigated as a function of the immersion time in SBF.

Keywords: Bioactive Glass; Persistent Luminescence; Optical Materials.

INVITED SPEAKERS

Id-007

Medical Application of SERS Cellular Imaging

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Abstract: Surface-enhanced Raman scattering (SERS), as an ultrasensitive vibrational spectroscopic technique, has been applied to many analyses, especially in medical sciences in the past decade. To pursue optimum quality of SERS tags, various metal nanoparticles (NPs) and nanocluster based SERS substrates have been reported. However, another major influence factor, the reporter molecule, has not been studied as extensively as SERS substrates; rational design, screening, and systematic characteristic investigation of novel reporters have been rarely addressed until now. With the aid of density functional theory (DFT) calculations, herein, an alkyne-modulated surface-enhanced Raman scattering (SERS) palette is constructed based on rationally designed 4-ethynylbenzenethiol derivatives for spectroscopic signature, Au@Ag core for optical enhancement and an encapsulating polyallylamine shell for protection and conjugation. For the preparation of three kinds of targeting SERS probes, we choose three well-documented target molecules of HeLa cells for our demonstration: recent studies have revealed that folate (FA) and luteinizing hormone-releasing hormone (LHRH) can be used as cancer target molecules, since FA-Rs (FA-receptors) and LHRH-Rs (LHRH-receptors) are overexpressed in the tumor cellular membrane, CALNNR8, a polypeptide chain containing multiple arginine, can help the nanoparticles to enter cells quickly. HeLa cells were treated with three kinds of SERS probes simultaneously for 12 h before being imaged by a Raman microspectrometer. The alkyne reporters were successfully encapsulated in the polyallylamine (PAH, MW = 17 000) shell through the Ag−S bond between the reporters and the NPs surface. The Raman spectrum was acquired from position “1” on the HeLa cell, which illustrates that three kinds of labeled particles were existing at this position. The peaks at 2105, 2158, 2212 cm^{-1} within the cellular Raman-silent region come from the labeled OPE0, OPE1, and OPE2 coated SERS probes, respectively; and the peak at 1580 cm^{-1} is their mutual peak. The efficiency of the alkyne-modulated SERS palette for triplex cellular imaging was also clearly demonstrated. Even for the pigment rich plant cell (e.g., pollen), the alkyne-coded SERS tag can be highly discerned on two-dimension distribution impervious to strong organic interferences originating from resonance-enhanced Raman scattering or autofluorescence.

Keywords: SERS; Cellular Imaging.

INVITED SPEAKERS

Id-015

Ultrafast Laser Plasma Doping - A Novel Approach to Photonic Materials and Devices Engineering

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Abstract: Glasses are generally not susceptible to large structural changes leading to functional properties - especially optical properties post formation- due to the lack of appropriate processing methods and the uniqueness of the glass formation. The conventional techniques for surface modification of glasses are ion exchange, thermal diffusion and ion implantation by accelerated ions which are limited by the type of the glass or its composition and the specificity of cations. The doping of multiple and atomically dissimilar ions into silica/silicate glasses using an ultrafast laser processing method allowed the formation of a new type of silicate glass surfaces offering superior optical and mechanical properties suitable for a number of applications in photonics, sensing, displays and anti-counterfeiting applications. Doping achieved at record levels allows us to fabricate short compact optical devices. This new processing method can be extended for surface engineering of silicon, metal and polymeric materials for a number of applications an these will be reported at the talk.

Keywords: Femtosecond Laser; Integrated Photonics; Rare Earths; Planar Waveguides; Laser Glass.

INVITED SPEAKERS

Id-018

Fluorescent Optical Microresonators for Optofluidic Sensor Applications

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Abstract: Optofluidics has attracted great interest as an emerging field in photonics, which combines fluidic media with solid resonant structures to achieve integrated optical devices, including high quality lasers. One of the most interesting applications of optofluidic devices is as optical sensors. The optofluidic device can be remotely interrogated using an external laser and the optical response may depend on physical parameters, such as temperature, strains, or on biochemical factors, such as chemical composition, glucose concentration, etc. In our laboratory, we have investigated two types of optofluidic devices in the last years. One is based on a simple planar Fabry-Perot (FP) microcavity formed by two tailored dichroic Bragg mirrors prepared by reactive magnetron sputtering deposition. The microresonator is filled with the liquid solution, which is monitorized through the detection of the resonant FP modes. The second kind of microresonator is formed by an optical fiber surrounded by the liquid medium. The cylindrical geometry of the optical fiber supports Whispering Gallery Modes (WGMs), which are very sensitive to the physical-chemical parameters of the medium. Different types of fluorophores have been used to provide the fluorescence, which couples to the resonant modes of the cavities and are analyzed to detect changes in temperature or in biochemical composition. In this talk we will show the main results that we have obtained in optical sensing using these optofluidic devices. Moreover, taking advantage of the high quality factor of the cavities, we have obtained laser emission from the fluorophores. Consequently, we were able to study the optical sensor device both in the fluorescence regime (under low excitation pump power density) and in the laser regime (under high excitation pump power density). A detailed comparison allows deducing the advantages of each regime. Financial support from Spanish Ministry of Economy and Competitiveness (Agencia Estatal de Investigaciónn, AEI) and EU-FEDER (MAT2016-79866-R), (MAT2016-75586-C4-4-P) is acknowledged.

Keywords: Optical Sensors; Fabry Perot; Microcavity; Whispering Gallery Modes.

INVITED SPEAKERS

Id-022

Atmospheric Effects of Depolarization in Free Space Communication: How to Overcome It

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Abstract: Free space optical communication is the best option when fiber connectivity is not possible, such as those involving mobile modules or satellites, and when directional communication is required. Polarization keying has an additional advantage over on-off key scheme, since a bit loss is not mistaken for a zero bit. Using different states of polarization simultaneously also allows for dense coding of information. However, polarization modulation suffers from atmospheric effects such as fog or smoke, which leads to scrambling of polarization due to multiple scattering. We have examined a method of differential measurement of state of polarization, which further can be mapped onto bit zero or one. We have simulated atmospheric conditions within laboratory and showed that the differential method allows for a very low bit error rate, even in presence of dense fog or smoke. We explain this result in terms of 'snake' photons, first proposed by R. R. Alfano. A mathematical modeling of the above scheme using formalism of Stokes parameters clearly indicates the validity of this result, showing that information can be extracted even in presence of a significantly high depolarization.

Keywords: Polarization Keying; Depolarization; Ballistic Photons.

INVITED SPEAKERS

Id-023

Multichannel Si Photonic Crystal Filters with Fine-Tuning Capability of Individual Channels for Sensing and Optical Interconnect Applications

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Abstract: This paper presents a theoretical and experimental demonstration of Fabry-Pérot (FP) resonators based on a Si-air one-dimensional photonic crystal (1D PhC) with coupled triple-cavity modes (or defects). These defects are obtained by filling selected air channels in the 1D PhC with an actively reconfigurable fluid. Simulations of the optical properties of these FP resonators were performed in the wide infrared spectral range. It is shown that by changing the refractive index, *n*, of the fluid simultaneously in all three channels, a set of narrow triple resonance peaks can be obtained within wide stop-bands of different order in the infrared range. In addition, at certain values of *n*, splitting of the triple resonance peaks into a doublet and a single peak with a significantly larger quality factor, $Q \approx 21000$, occurs. Prototype devices based on Silicon-On-Insulator platform were fabricated and characterized by electro-optical and spectroscopic measurements. The electro-optical measurements demonstrate the possibility of refractive index manipulation of the filler in the FP channels individually or simultaneously. The use of high-order resonances and stop bands significantly extends the tuning range. The coupled FP resonator design is CMOS compatible and these composite FP resonators have potential applications in biochemical and biomedical sensing, as well as for filtering and tuning of bandwidths in wavelength-division multiplexing systems integrated on silicon.

Keywords: 1D Silicon Photonic Crystal; Fabry-Perot Resonators; High Quality Factor.

INVITED SPEAKERS

Id-030

Silicon Photonic Interconnect for High Performance Multicore Processors and Hardware Accelerators

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Abstract: Network on Chip is a scalable interconnect platform for multicore integrated circuits. Optical Interconnect (OI) in its several forms is emerging as a high performance alternative to existing solutions for connecting both on-chip and off-chip electrical components. Typical high performance (Giga FLOPs) multi-core processors and many-core accelerators contain tens and thousands of computing cores respectively due to decades of aggressive CMOS device scaling. The performance ceiling is not due to lack of better transistors nor is it due to architectural or algorithmic issues. The caveat to achieving Tera FLOPs performance is the energy dissipation bottleneck of on-chip communication using copper interconnect. Emerging interconnect solutions like LASER based Wavelength Division Multiplexed (WDM) silicon-photonic links, wireless broadcast links, RF coplanar waveguides, Carbon Nano Tubes (CNTs) and Graphene Nano Ribbon (GNR) wires are being researched to overcome the communication power wall and deliver higher performance with higher technology costs. All the above solutions may be deployed as Network on Chip (NoC) to connect several processing cores together on the same chip. Emerging interconnect NoCs are expected to solve the communication power-bandwidth problem of multi and many core systems. However they have their own limitations. CNT and GNR are difficult to fabricate with standard CMOS process flows and process variations may offset benefits. RF and wireless links create Electro Magnetic Interference (EMI) and need additional beam forming circuitry with architectural techniques to ensure low Bit Error Rates. LASER based Photonic NoC not only has higher area requirement (WDM optical infrastructure) but also is temperature sensitive and has limited scalability (constrained by off-chip broadband LASER power). A relatively new type of Quantum Dot Light Emitting Diode (QDLED) based photonic (on-chip) interconnect may also be used. Instead of using a high power off-chip LASER that acts as a source of multiple wavelengths, the new solution utilizes multiple low power and small on-chip QDLEDs that source fewer wavelengths but nevertheless have the same performance as LASER based photonic NoC at much lower energy dissipation. Large number of QDLED links and their broadcast ability helps in realizing high radix crossbar topologies that have been designed for connecting 256 cores together on a chip.

Keywords: Optical Interconnect; Photonic Network on Chip.

INVITED SPEAKERS

Id-035

Green Emitting Phosphor Coupled TiO_2 Nanotubes as Effective and Efficient Photocatalyst for Pollutant Elimination

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Abstract: Synthesized titanium dioxide nanotubes (TiO_2-NT) coupled with commercial green emitting phosphor have been successfully prepared using simple solvothermal method. Unique optical property of green emitting phosphor enable anatase phase TiO_2-NT with large surface area to adsorbed ultra-violet (UV), visible (Vis) and near infra-red (NIR) lights simultaneously to proceed photocatalytic reactions effectively. The photocatalytic activities of the photocatalysts were evaluated for the degradation of pollutant under the illumination of UV, Vis light emitting diodes (LEDs) and NIR lights. In this study, methyl orange (MO) dye solution was used as pollutant model. According to the photocatalytic results, the calculated photonic efficiency of MIR light induced photocatalytic activity of samples was much higher than those of UV and Vis LEDs light responsive ones. Another important finding in this study is the presence of green emitting phosphor allows running photocatalytic experiments with short on/long off illumination. This result pave the way towards a new generation of photocatalysts that can operate efficiently on extremely low or without irradiation power in sustainable pollutant elimination applications.

Keywords: Phosphor; TiO_2 Nanotubes; Photocatalyst; Pollutant.

INVITED SPEAKERS

Id-036

Application of Ag Nanoparticles Grown by Dewetting Process to SERS and Solar Cells

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Abstract: The exploitation of materials at the nanoscale, and their integration into optoelectronic devices, are nowadays regarded as highly preferential solutions to overcome performance limitations in different types of applications. Those presented here concern the increase of efficiency of physically thin film silicon (Si) solar cells and of weak Raman signals for molecular detection (one scattered photon per million incident), employing metal nanoparticle (MNP) structures made of silver (Ag) which is the most effective material for plasmon-enhancement in solar cells and Raman Spectroscopy. Thermal evaporation assisted by electron beam (e-beam) was used to deposit uniform thin layers of Ag, which then underwent a thermally-induced morphology transformation from a thin film (TF) to an array of NPs by a solid-state dewetting (SSD) mechanism. A novel procedure, involving a one-step methodology, without any post-deposition thermal procedures, is presented. This resulted in the direct arrangement of individual nanoparticles suitable for Surface Enhanced Raman Spectroscopy (SERS), with good control of their size and shape. The nanostructures that required a post-annealing process were essentially used for light trapping in solar cells. In this case, a rapid thermal annealing (RTA) process was used, yielding highly reproducible and uniform plasmonic surfaces within a very fast (<10 min) annealing time when compared to other commonly employed annealing processes (>1 hour). The final results showed that microcrystalline silicon (μc-Si:H) solar cells deposited on improved ultra-fast plasmonics back reflectors (PBR), with Ag NPs with sizes of about 200 nm, exhibit an overall 11% improvement on device efficiency, corresponding to a photocurrent of 24.4 mA/cm2 and an efficiency of 6.78 %; against 21.79 mA/cm2 and 6.12 %, respectively, obtained on flat structures without NPs. For SERS applications, a remarkable 10^9 signal enhancement was obtained using rhodamine 6G (10^{-8} M) as the test analyte, and a new kind of cost-efficient SERS substrate (cardboard plates) was investigated for low-cost, flexible and disposable bio-detection devices. Besides such advantages, cardboard substrate proved to be a high-efficient, uniform and stable SERS substrate.

Keywords: Ag Nanoparticles, SERS; Solar Cells.

INVITED SPEAKERS

Id-038

Optical parametric Oscillators Based on Novel Mid-infrared Nonlinear Materials

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Abstract: Mid-infrared (mid-IR) window of the electromagnetic spectrum has a wealth of information pertaining to many molecules of importance involved in variety of applications ranging from spectroscopy to laser surgery. For example, mid-IR radiation in 5900-6600 nm wavelength range, constituting the absorption bands of amide I (6000 nm), water (6100 nm) and amide II (6450 nm) are of interest for human surgery, because of the simultaneous absorption by proteins and water. In the absence of conventional lasers at these wavelengths, optical parametric oscillators (OPOs) represent a powerful and viable solid-state sources of coherent radiation in the mid-IR with wide tunability. However, mid-IR OPOs, pumped at 1 μm, mainly relied on the oxide-based nonlinear materials such as MgO-doped periodically poled $LiNbO_3$ (PPLN), practically limiting the spectral coverage to 4 μm, imposed by the onset of absorption. (MgO:PPLN). Alternatively, OPOs based on chalcopyrite crystals such as $ZnGeP_2$ can generate mid-IR radiation up to 10 μm, but must be pumped above 1 μm to avoid two-photon and residual absorption. As a result, the quest for new nonlinear materials to generate mid-IR radiation beyond 4 μm pumped by the well-established Nd-based lasers at 1064 nm, recently led to the development of cadmium silicon phosphide, $CdSiP_2$ (CSP) and orientation-patterned gallium phosphide (OP-GaP). Their large bandgap, improved thermal and optical properties with high nonlinearity together with noncritical phase-matching, make them attractive nonlinear material candidates for mid-IR generation. In this talk, I will present latest advances in the development of high-power, mid-IR OPOs based on various nonlinear materials including MgO:PPLN, CSP and OP-GaP.

Keywords: Optical Parametric Oscillators; Mid-infrared Laser; Novel Nonlinear Materials.

INVITED SPEAKERS

Id-040

Diffuse Optic Tomography Techniques for Biomedical Imaging

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Abstract: Diffuse optic tomography (DOT) technique is the molecular biomedical optic imaging modality. DOT has instrumentation and mathematical image reconstruction parts. In instrumentation, electronic, optic and mechanic combinations are made for laser data acquisition process. Basically, DOT devices have source and detector units. Depend on the source and detector placement on tissue surface, geometry might be transmission through, back-reflected, cylindirical ring or spherical. Laser positions constitute source unit. Laser photons with specific wavelength are sent through tissue from surface. Depend on the imaging molecules different laser wavelengths can be selected. Molecules have different absorption coefficients depend on the laser wavelength. Detector units might be pin semiconductor photodiodes, CCD or CMOS imaging units. Different approaches might be used for DOT geometrical source-detector placements for transmission through, back-reflected, cylindirical ring or spherical models. For instance, multi-sources and multi-detectors might be placed as they are in chess table format for back-reflected imaging geometry. DOT modality can also be divided into three major branches depend on the run principle. Continuous Wave (CW), Frequency Domain (FD), and Time Resolved (TR) techniques are using different laser sources. CW technique is using steady state continuous wave laser as the source unit. FD technique is sending different frequency range laser inside the imaging tissue. TR technique is using picosecond laser. All of these techniques are trying to investigate tissue molecule concentrations and distributions by using acquired data in image reconstruction algorithms. Generalized image reconstruction algorithms are using mathematical inverse problem solutions which might be algebraic reconstrution technique (ART), regularization (Tikhonov-Morozov discrepancy), or sub-space (conjugated gradient) methods.

Keywords: Biomedical Optic Imaging.

INVITED SPEAKERS

Id-048

Thermal Sensitivity of Phase and Propagation Delay in Hollow-Core Fibres

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Abstract: Optical fibers enable the propagation of optical signals over large distances. Although the power of a propagating signal is relatively insensitive to fluctuations in the ambient temperature, its phase ϕ and propagation time τ through the fiber are not. A standard single-mode telecom fiber suffers from propagation time temperature sensitivity $d\tau/dT$ of 39 ps/km/K (at 1550 nm wavelength). This can pose significant challenges in many diverse application areas of optical fibers in physics and engineering. A value of 39 ps/km/K equates to a phase temperature sensitivity of about 48 rad/m/K. This can adversely affect many applications relying on fiber interferometers (e.g. fiber optic sensors or interferometric measurement techniques). Here, we review our recent results in which we show why and how Hollow-Core Fibres (HCF) are significantly better than solid-core fibres in terms of their thermal propagation time/phase change insensitivity. Further, we show how we proposed, designed, and demonstrated a HCF in which the propagation time is fully insensitive to temperature variations. The extremely low levels of thermal sensitivity of propagation delay through an optical fiber we have demonstrated should bring significant improvements in many applications, e.g., in precise frequency and time transfer, in telecom stable latency of signal, and helping to open up emerging new fields such as relativistic geodesy. We acknowledge EPSRC (AirGuide Photonics, EP/P030181/1) for finantial support).

Keywords: Optical Fibres; Hollow Core Fibres.

INVITED SPEAKERS

Id-050

The Two Polarization Planes of Light and Its Use at the Fiber Optic Sensors

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Abstract: When subjected to heat treatment on a sensory optical fiber with equally excited polarizing planes, the birefringence causes their time shift, which results in a change in the instantaneous states of light polarization. The thesis deals with the measurement of polarization states on the output of single-mode optical fiber after passing through this temperature sensor. The polarization states are measured after conversion to optical power using a photodiode. The conversion of polarization changes to optical power is provided by a linear polarizer. The results are compared with a professional measurement technique on a Poincaré sphere using a polarimeter. When both polarization modes of a high-birefringence optical fiber, such as PANDA-like PMFs are excited, the two modes propagate at different velocities. With such excitation, the propagation rates and thus also the resulting phase shift are sensitive to external influences, the temperature in the first place. The dependence on temperature is dominant because it is the principal physical substance of the birefringence change in these fibers. While the temperature of the fiber will depend on the heat absorbed, the possibility exists of using it for detecting the change in temperature or absorbed heat. Due to the mechanisms of heat transfer through conduction, flow and radiation, the mechanism of heat absorption and thus temperature changes are very unstable. This can therefore be only used for the thermal field disturbance sensor.

Keywords: Fiber Sensor; Polarization Maintaining Fiber; Optical Fiber; Birefringence; Temperature Field Disturbance.

INVITED SPEAKERS

Id-052

Visible Light Responsive Wide Band-Gap Oxides: Potential Application in Photocatalysis

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Abstract: 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.) leads to the formation of interfacial charge transfer (ICT) complexes and appearance of absorption in more practical visible-light spectral region. Comprehensive characterization of synthesized materials involving transmission electron microscopy, X-ray diffraction analysis, nitrogen adsorption–desorption isotherms and various spectroscopic techniques was performed. The density functional theory (DFT) calculations with periodic boundary conditions were performed in order to estimate the energy gaps of various inorganic/organic hybrids. 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 photocatalytic performance of surface-modified wide band-gap oxides with benzene derivative in oxidation and reduction light-driven processes, respectively.
Keywords: Interfacial Charge Transfer Complexes; Wide Band-Gap Oxides; Optical Properties; Density Functional Theory; Photocatalysis.

INVITED SPEAKERS

Id-055

Experimental Limitations of Rare-Earth-Doped Luminescent Nanosensors

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Abstract: The advantages of luminescent nanosensors, as non-contact local sensing and high sensitivity, have foster the development of this field and their use in diverse areas as nanomedicine and advanced technologies. However, the improvement of the reliability of these systems is still needed, as many phenomena taking place during the measurement process could alter the measured values. In this work, the effect of luminescence self-absorption, solvent absorption, and excitation power dependence on the performance of rare-earth-doped SrF_2:Nd and SrF_2:Yb,Tm colloidal nanoparticles acting as luminescent nanosensors is studied. If a luminescent nanosensor suffers either from self-absorption of its emitted luminescence due to an overlap between its emission and absorption, or from absorption of its emission by the solvent (see figure on the left), or the spectral shape of its emission changes with the excitation power (see figure on the right), as those shown in this work, its performance could be dependent on the experimental conditions. Consequently, it would be an unreliable luminescent nanosensor. A set of recommendations as *in situ* calibrations and the control over certain experimental parameters are suggested as preventive methods to improve the reliability of luminescent nanosensors. This work has been partially supported by the Ministerio de Economía y Competitividad de España (MAT2016-75362-C3-1-R), by the Instituto de Salud Carlos III (PI16/00812), by the Comunidad Autónoma de Madrid (B2017/BMD-3867RENIM-CM), by the European Comission (NanoTBTech), and "cofinanciado con Fondos Estructurales de la Union Europea". This work has been also partially supported by COST action CM1403. L.L.P. thanks the Universidad Autónoma de Madrid for the "Formación de personal investigador (FPI-UAM)" program.

Keywords: Rare-earths; Luminescence; nanosensor.

INVITED SPEAKERS

Id-056

Development of a Self-sustainable PV - Energy Supply System for Domestic Consumption

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Abstract: This work discusses a systematic approach for the development of a solar powered self-sustainable energy system. Its premise is to develop an energy system that would allow an energy user to have a net zero energy bill, this could be further development to encompass users in remote locations which are not connected to mains energy systems. A self-sustainable energy system configurations are of interest to many groups and users, and as we run down fossil fuels they will have to become more widely used and accepted methods for energy capture storage and use. This work intends to prove a more cost effective solution to off grid systems that are currently available and provide a cost effective solutions to consumers. This research investigates a typical self-sustainable energy system configuration and looks to develop a performance optimisation model. The potential benefits of such a system design is investigated using data collected at a specific location and the performance of the system under variable conditions are determined. The work goes onto describe an optimal design and implementation of an efficient self-sustainable home energy system. The second part of the work looks at the private housing sector and focuses on its requirement for grid based energy systems. A self-sustainable approach to cope with the energy demands in the housing and buildings sector is proposed. An advanced demand management tool is also described. Finally, a discussion regarding how the consumer can manage their individual energy storage systems to ensure that they are not reliant on grid based systems, but also to ensure that they can control the flow of energy to and from their home. The premise being to maintain the maximum amount of post meter energy possible and avoid both feeding in and drawing from the grid. A grid-connected consumer can use an demand side energy management system to help them monitor and control the amount of energy that they allow to flow into and out of the grid. This results shows that it is possible to monitor and control energy from a domestic user's point of view to enable them to minimise their dependency on the grid, reduce their bills and have payback periods better to those of current grid connected Photo Voltaic systems alone.

Keywords: Energy; Power Management; Storage; Solar.

INVITED SPEAKERS

Id-059

Enhanced Optical Properties of Neodymium Doped Tellurite Glass for Advanced Laser Glass

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Abstract. The study of the luminescence of a laser glass for radiative emission is essential for determination of the performance because it determines the emission region at certain wavelength. In general, most of laser glasses use conventional phosphate-glass doped with neodymium. But phosphate laser glass has low optical sensitivity and large thermal expansion. These disadvantages may cause the increasing of inherent sensitivity to back-reflected light or failure of the laser glass. Tellurite glass is an exception material that possesses high optical sensitivity and low thermal expansion as compared with phosphate glass. A series of tellurite based glass (ZnO-B_2O_3-TeO_2) with Nd^{3+} ions doping has been investigated for application as a laser glass. The refractive index of the glass series are enhanced in the range of 1.760 ~ 1.863. Several absorption bands are observed from the UV-Vis spectra of the glass series which are caused by 4f-4f transitions. The Judd-Ofelt parameters of the glass series are shown to follow the trend of $\Omega_2 < \Omega_4 < \Omega_6$. The enhanced orange and red emission peaks are found in the glass series. On top of that, the violet emission of upconversion are found in the glass series. Hence, the investigated glass materials may provide a potential material for novel laser glass.

Keywords: Luminescence; Borotellurite Glass; Neodymium Oxide; Laser Glass.

INVITED SPEAKERS

Id-061

Doped Sol–gel Silica Glasses for Radiation Dosimetry in Harsh Environment

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Abstract: In the field of new techniques for radiotherapy, also in harsh environment such as in nuclear facilities or in space industry, ionizing radiation dosimetry requires monitoring over long distances and/or spatial resolution of the measurement. For these applications, fibered solutions seem particularly adapted, but in this domain, new sensitive materials, able to be drawn into fibers, are needed. Hence, this communication will focus on the potentialities of doped sol-gel silica glasses for in vivo or high rate dose remote dosimetry measurements. We will present first the optical properties of a cerium-doped sol–gel vitreous rod, obtained by densification either in air or in helium atmosphere. Such a glassy rod has been jacketed in a quartz tube and then drawn at high temperature to a cane, which has been used as active material in a fibered remote X-ray radiation dosimeter. The sample exhibited a reversible linear radioluminescence intensity response versus the dose rate up to 30 Gy s^{-1}. These results confirm the potentialities of this material for in vivo or high dose rate remote dosimetry measurements. The second part of this talk will be devoted to sol-gel silica glasses activated with various concentrations of Cu^{+} ions. The light emission from a sol–gel-derived Cu-doped silica glass was studied under 10 keV X-ray irradiation using a fibered setup. Both radioluminescence (RL) and optically stimulated luminescence (OSL) were analyzed at different high dose rates up to 50 Gy/s and for different exposure times, yielding accumulated doses up to 50 kGy (in SiO_2). At low dose rate, the scintillation mechanisms are similar to photoluminescence, involving the Cu^{+} ions electronic levels, contrary to the nonlinear domain (for dose rates higher than 30 Gy/s). This RL, as well as the OSL, could be exploited in their linear domain to measure doses as high as 3 kGy.

Keywords: Sol–gel; Silica Glass; Cerium Ions; Photoluminescence; Radioluminescence.

INVITED SPEAKERS

Id-062

PbS Quantum Dots and Nanocomposites for Solution Processed Broaband Photodetectors

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Abstract: The paper presents several types of solution processed photodetectors: hybrid device- PbS QDs/c-Si photodetector; PbS QDs photoconductor; ZnO NWs-PbS QDs:P3HT photodetector; reduced graphene oxide (RGO):P3HT nanocomposite/n-type silicon photodetectors. The aim was to develop low-cost, high-sensitivity, broad spectral range photodetectors. We focused on solution processable materials based on quantum dots (QDs) and/or reduced grapheme oxide (RGO) and nanocomposites that can be synthesized in large quantities through solution routes such as spin coating, dipping, casting, and can easily be integrated with many substrates, including silicon and flexible foils. Plasmonic nanostructures have been used as well to improve the photocurrent generation by light trapping and/or electromagnetic field local enhancement due to the excitation of localized surface plasmons (SPPs). The device structure, fabrication process and characterization results will be presented. All photodetectors show high responsivities over a broad spectral range, from 300 to 1550 nm. The work was supported by the Romanian National Research Programe PN III, project PN-III-P2-2.1-PED-2016-0307 TemptSys and IMT-Bucharest Core Program MICRO-NANO-SIS.

Keywords: Photodetector; Lead Sulfide (PbS) Colloidal Quantum Dots (QDs); Reduced Graphene Oxide; Hybrid Nanocomposites; Photoconductor.

INVITED SPEAKERS

Id-064

From Fundamental Spectroscopy of MOFs to Lighting Applications

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Abstract: Among the possibilities to develop new efficient smart-materials and devices capable to reduce the energy consumption, Metal-Organic Frameworks (MOFs), a class of hybrid organic-inorganic crystalline porous compounds, have emerged as excellent materials for a wide range of energy-related applications. The use of luminescent MOFs for lighting applications has also raised great attention due to their great versatility (the emission can be originated by the linkers, the metal-clusters or a combination of both), synthetic flexibility (exchange of linkers and metal clusters) and the possibility to encapsulate different fluorophores. In this lecture, we present and discuss results of using a Zr-NDC MOF and different guest@Zr-NDC (guests= Coumarin 153 (C153) and DCM) composite materials as the electroactive layers of new OLEDs. We unveil the photoluminescent properties of these materials, using different steady-state and femtosecond—millisecond time-resolved techniques. From the experiments, we have established that the Zr-NDC materials emission originates from the monomers and excimers of the NDC linkers. We also elucidate the ultrafast and slow events involving the interaction of the linkers with the Zr-oxide clusters. When C153 and DCM dyes are encapsulated into Zr-NDC MOF, an energy transfer from Zr-NDC MOF to each dye is observed upon irradiation. Moreover, we have also demonstrated that both, the excimer formation in Zr-NDC and the energy transfer from Zr-NDC to encapsulated guests, are still occurring when the materials are dispersed into polymeric matrixes, which is essential for incorporating these materials into the LED devices. This work was supported by the MINECO through project MAT2014-57646-P.
Keywords: MOFs; LEDs; Sensors; Ultrafast Laser Spectroscopy.

INVITED SPEAKERS

Id-065

New Functionalization of 2D Photonic Macroporous Silicon Structures under the High-Pressure Oxidation

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Abstract: Last years 2D photonic macroporous silicon structures has found application in nanophotonics and optoelectronics due to new structural and physical properties, the possibility of integration in chips. Recently we evaluated addition functionalization of 2D macroporous silicon after high-pressure oxidation. The splitting energy of LO- and TO-phonons in IR absorption spectra and high-resolution X-ray diffractometry allowed to identify structural features of oxidized macroporous silicon and to compare results with EPR signal intensity and GHz radiation absorption. The splitting energy of LO- and TO-phonons in IR spectra is depended on the SiO_2 thickness. The maximum built-in charge in oxidized macroporous silicon structures at SiO_2 thickness 15-20 nm is formed at condition of maximal stoichiometry and minimal residual deformations on the Si-SiO_2 boundary. The reduction of residual deformation at d_{SiO2}>200 nm accompanied by slowing of stress growth and formation trìdimìte and orthorhombic phases of SiO_2 under conditions of the high pressure in thick SiO_2 (800-1200 nm) due to cylindrical symmetry of macropores and big thermal expansion coefficient of SiO_2. The stoichiometry and residual deformations on the border Si-SiO_2 in oxidized macroporous silicon correlate with hydrogen bond concentration. P_b center concentration increase with the phonon splitting energy and SiO_2 thickness. Structural SiO_2 reorganization to cristobalìte β with orthorhombic phase increase the concentration of paramagnetic P_b centers, EPR signal amplitude and GHz radiation absorption. Thus, variation the thickness of SiO_2 layers in oxidized macroporous silicon permit to change high-frequency signals that is perspective for development filters with power dissipation and electronically controlled antennas.

Keywords: Macroporous Silicon; High-pressure Oxidation; Modification.

INVITED SPEAKERS

Id-066

Electro-Optical Effects in 2D Photonic Macroporous Silicon Structures with Nanocoatings

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Abstract: 2D macroporous silicon is promising material for integrating silicon photonics with nanoelectronics in structures with the required geometry and large effective surface. This determines electro-optical effects in macroporous silicon: Franz-Keldysh electro-optical effect at the direct band-to-band optical range, as well as the linear impurity Franz–Keldysh effect at the weak electric field approximation and the Wannier–Stark electro-optical effect within the strong electric field approximation in the mid-infrared (MIR) range. 2D macroporous silicon shows Franz-Keldysh oscillations in the electroreflectance spectra of direct band-to-band optical transition due to the intrinsic electric field on the macropore surface with 1.7 nm depth. In view of the potential barrier on a macropore surface one should take into account recharging of the local surface centers at energies below that of the indirect band-to-band transition. The experimental MIR absorption spectra of macroporous silicon agree well with the corresponding spectral dependences of the electro-optical energy and the imaginary part of permittivity in the weak electric field approximation, thus confirming realization of impurity Franz–Keldysh effect. In addition, we investigated the MIR light absorption oscillations in 2D macroporous silicon with microporous and SiO_2 layers, CdTe, ZnO, CdS surface nanocrystals taking into account the electro-optical effects at strong electric fields. The resonance electron scattering on surface bonds and realization of the Wannier–Stark effect were confirmed. In this case, the Wannier-Stark effect is due to the large-time electron scattering as compared with the period of its oscillations in the strong electric field of illuminated "silicon-nanocoating" boundary.

Keywords: Macroporous Silicon; Coatings; Electro-optical Effects.

INVITED SPEAKERS

Id-067

In vivo and Ex vivo Scoring of Liver Fibrosis by Diffuse Reflectance and Fluorescence Spectroscopy: A Happy Cross-communication Story between Engineers and Physicians

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Abstract: Liver fibrosis is characterized by accumulation of extracellular matrix proteins in the hepatic parenchyma affecting both liver function and composition. Progression of liver fibrosis results in cirrhosis (F4), a serious illness affecting hundreds of millions of patients worldwide. Thus, it is extremely important to devise novel tools to discriminate among early (F1), intermediate (F2), and advanced (F3) stages of liver fibrosis. Here, we show novel implementations of diffuse reflectance and fluorescence spectroscopy to score liver fibrosis in paraffin-preserved human liver specimens, carbon tetrachloride-treated rats, and patients. *Ex vivo*, intensity of diffuse reflectance in preserved specimens significantly decreased as the fibrosis level increased at the wavelength range of 450-750 nm. At 650 nm, all grades of fibrosis were clearly differentiated from each other. In parallel, both spectral shape and fluorescence intensity significantly differed among F0, F1, F2, F3, and F4 with sensitivity and specificity higher than 90% and 95%. *In vivo*, the liver of carbon tetrachloride-treated rats and cirrhotic patients was examined in real-time by ambulatory laparoscopic surgery. F3 and F4 livers from experimental rats and patients exhibited an increase in the intensity of diffuse reflectance at 365 nm with respect to F0 control livers. Notably, fluorescence intensity at 493 nm increased accordingly to fibrosis degree, allowing us to accurately discriminate patients with early liver fibrosis (F1 and F2) from those showing severe liver fibrosis (F3 and F4). These results support the use of diffuse reflectance and fluorescence spectroscopy to score hepatic fibrosis in patients with chronic liver disease.

Keywords: Liver; Fibrosis; Cirrhosis; Diffuse Reflectance; Fluorescence.

INVITED SPEAKERS

Id-074

Efficient Persistent Room Temperature Phosphorescence in Amorphous Polymers under Ambient Conditions

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Abstract: Persistent emission with a long lifetime (> 0.3 s) from organic materials can only be observed at a low temperature, because of the significant nonradiative deactivation pathway that occurs at room-temperature (RT). If organic materials with persistent RT emission in air could be developed, they could potentially be utilized for a variety of applications. Here, amorphous polymeric materials with efficient persistent RT phosphorescence (RTP) are developed by minimizing the nonradiative deactivation pathway of triplet excitons. The nonradiative deactivation pathway is dependent on both nonradiative deactivation of the phosphor and quenching by diffusional motion of the polymer. The rigidity and oxygen barrier properties of the polymeric materials used as the host suppressed the quenching, and the aromatic hydrocarbon used as the phosphor is highly deuterated to minimize nonradiative deactivation of phosphorescence. The polymer also plays a role of quenching triplet oxygen generated by ultraviolet irradiation. In this presentation, we discuss the relationship between the chemical structure and mobility of polymers and phosphorescence lifetime. Red-green-blue persistent RTP with a lifetime > 0.3 s in air is realized for a amorphous polymers. The pure organic amorphous polymers are nontoxic and abundant, and would be useful for background-independent imaging applications. Thus, identification of appropriate materialsdesign to achieve efficient persistent RTP in air could be significantly important for the next generation imaging technology and display applications.

Keywords: Persistent Room Temperature Phosphorescence; Polymer.

INVITED SPEAKERS

Id-075

Visible Light Communication in Industry 4.0

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Abstract: Radiofrequency (RF) based wireless networks are showing up more commonly in industrial environments with the introduction of Industry 4.0 standard. The RF-based networks have a drawback of more complex network design challenges, not the least of which are concerns about cybersecurity. The visible light communication (VLC) is considered to be a promising candidate since: the spectrum is free to use; It can be easily integrated with any network interface Fieldbus; it is secure; it is reliable; it is high speed; installing it is a one-time expenditure (cost effective solution). With the adoption of industry 4.0, the Industrial IoT (IIoT) and the industrial internet, the demand for the interconnection of industrial automation equipment and computing system has never been pushed along at a faster rate. It can be easily predicted the VLC has the potential to be a key enabler in the quest for Industry 4.0 since the potential bandwidth is so much greater than Wi-Fi. Up till now, the industry has relied on the Fieldbus technology for its major automation tasks. To maintain a Fieldbus and deploying it is a major problem. Also since Fieldbus was introduced in 60's there hasn't been much improvement in the data rates to cope up with the industrial demands. VLC is a potential technology which can be used to solve this problem. By using VLC, which operates at a much higher data rate than Wi-Fi and Fieldbus, it can also extend the range. Since LEDs are installed everywhere in an industry, it can be deployed anywhere where LEDs are and keeping the communication secure. As VLC operates at a visible light range it is immune to radio frequency interference. So it can also be used in a sensitive area where EMI can cause a problem. In this paper, a Bi-directional VLC system is proposed which is capable to handle two type of data traffic shown: Industrial automatic instructional set for the automated industrial machine; It can also provide connectivity to a user for user data (internet). The system can be integrated with Fieldbus interfaces.

Keywords: Visible Light Communication; Industry 4.0; Bi-directional Communication; IIoT; Fieldbus.

INVITED SPEAKERS

Id-077

Switching with Light: A Palette of Opportunities with Photochromic Materials

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Abstract: Through photochromic materials, light enables a spatio-temporal control over the activation-deactivation of physical-chemical functions. Photochromic switches can be designed to be converted with electromagnetic radiation all over the UV-vis light spectrum. Color, transmittance, refractive index, dipole moment and electrical conductivity are some of the physical-chemical properties that reversibly change by irradiation with light of suitable wavelength because of an isomerization that converts the species in a stable or metastable photoproduct. This feature has an impact in a wide range of applications in the field of optics, optoelectronics and, more recently, in pharmacology and life science. Thanks to their modular synthesis, which enable the production of multiple functional compounds, good optical fatigue resistance, geometrical shape changes, and fast response a variety of photochromic devices can be conceived and assembled, and their performances tuned and maximized through a suitable molecular design and material processing.

Keywords: Photochromic Switches; Photochromic Devices.

INVITED SPEAKERS

Id-078

Mid-Infrared Photonics: LEDs and Photodiodes for Sensing Applications

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Abstract: In the field of mid-infrared photonics, much effort has been devoted to LEDs and photodiodes based on narrow-gap III-V-related semiconductors. Spectral-matched mid-IR "LED-photodiode" optrons can be successfully used for sensing applications since the strong absorption bands of many gases and liquids (C_xH_y, H_2O, CO_2, CO, CH_3Cl, OCS, H_2S, HCN, NH_3, NO_2, SO and others) lie in the spectral range of 1.6-5.0 μm. In this review we present our recent results, including investigation aspects of the multi-element devices, as well as new approaches to the design of GaInAsSb/GaAlAsSb and InAs(Sb)/InAsSbP photodiodes. A new method of increasing the emission power of LEDs and spectral sensitivity of photodiodes due to multiple re-reflection of photons has been suggested. We have developed the high-efficiency LEDs with peak wavelengths of 4.4 μm and 4.6 μm for detection of CO_2 and CO, respectively. The using of nanosecond pulse modes enable us to decrease nonradiative Auger recombination and to reach higher values of LED peak power and quantum efficiency. Most recently, new GaSb-based photodiodes with long-wavelength threshold of 1.85 μm for room temperature operation have been designed. A unique method of GaSb growing made it possible to achieve capacity of the photodiodes of 70–110 pF for a sensitive area of 300 μm in diameter. The work was supported in part by the Russian Foundation of Basic Research (RFBR) under Grants No.17-52-16029 and No.18-52-00027.

Keywords: Mid-infrared Photonics; Narrow-gap III-V Semiconductors; Light-emitting Diodes (LEDs); Photodiodes; Optrons.

INVITED SPEAKERS

Id-081

Plasma Actuator Stability Monitoring using Fiber Bragg Grating Sensor

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Abstract: This paper presents fiber Bragg grating (FBG) sensor to monitor plasma stability of dielectric barrier discharge plasma actuator based on measurement of plasma force and temperature. The DBD plasma actuator consists of two electrodes separated by a 1.0 mm of discharge gap. Kapton tape having a good dielectric constant was attached on the surface of one of copper (Cu) electrode as a layer to prevent arc formation. Two plasma actuators with each has five and seven dielectric layers were fabricated. Two FBG sensors were installed in which one was in perpendicular position to the direction of the electron bombardment and the other one in parallel. Experimental results revealed that the FBG sensor installed in perpendicular to the electron bombardment has shown higher Bragg wavelength shift compared to the one installed in parallel. The plasma force and the temperature increases as the applied voltage is increased. It was found that when the applied voltage reached around 3.5 kV with five dielectric layers and 4.5 kV with seven dielectric layers of the plasma actuator showed fluctuation pattern due to the transformation of glow plasma into filamentary discharges. This work has successfully monitoring plasma stability based on plasma transformation from glow to filamentary discharges to arc formation.

Keywords: Dielectric Barrier Discharge; Fiber Bragg Grating; Filamentary Discharge; Non-Thermal Plasma Stability.

INVITED SPEAKERS

Id-082

Volume Holographic Gratings in Photopolymeric Materials Doped with Quantum Dots for Distributed Feedback Lasers

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Abstract: The study is intended for the holographically assisted design of a photopolymeric quantum dots-doped active laser medium for distributed feedback lasers. As the hologram is being formed, quantum dots concentration as well as the media refractive index modulations both are being induced through mass transfer processes during photopolymerization. The quantum dots concentration modulation sets up the luminescence synchronization, while the refractive index modulation ensures the emergence of resonance frequencies for laser light generation without an optical cavity. The distributed feedback assures high efficiency and low-threshold generation. The width of generated light spectrum depends directly on the refractive index modulation of a hologram and can reach values of about 0.05 nm. The wavelength of the generated radiation can be varied in the narrow range during the generation itself by the temperature-induced alignment of the spatial period of the grating; in the moderate range - during the recording of the hologram; in the wide range - during the composite making - by doping it with quantum dots having different luminescence spectra. Utilization of the gradient (alloyed) semiconductor quantum dots enhances luminescence quantum yield and minimizes blinking. The set of parameters influencing the final local grating morphology, which in its turn dictates optical properties, includes: kinetics of photopolymerization, the length scale (grating spacing) and kinetics of the diffusion, compatibility of quantum dots with both the prepolymer syrup and final polymer matrix. The optimization of these and other relevant parameters by means of computer simulation in frames of the appropriate model is discussed.

Keywords: Polymers; Nanoparticles; Nanocomposites; Photoprocesses; Photopolymerization.

INVITED SPEAKERS

Id-084

Graphene-Coated Tip Fiber Optic Chemical Sensor for Nitrate Sensing Application

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Abstract: Nitrate, a negatively charged ion (NO_3^-) or an anion is widely found in the environment and food products. Nitrate is a major nutrient required for plant growth. Hence, the nitrogenous fertilizer – the main sources of Nitrate are routinely applied to agricultural lands to increase the crop production. Various techniques have been employed for the detection of Nitrate including spectrophotometric methods, electrochemical analysis, chromatographic methods, and capillary electrophoresis but each method has its own merits and drawbacks. This paper proposes the detection of Nitrate using optical sensing technology via fiber optic chemical sensor. A tip fiber optic chemical sensor (FOCS) based probe is proposed for Nitrate sensing application. The simple fabrication of tip FOCS is coated with Graphene using drop casting method to detect the Nitrate at different concentration. Graphene has been proved as an excellent Nitrate adsorbent in chemi-sorptive nature. The reflected power increases as the Nitrate concentration increases. Without coating with Graphene, the bare tip FOCS has sensitivity of 1.3×10^{-3} dBm/ppm. However, the sensor sensitivity is significantly enhanced to 1.47×10^{-2} dBm/ppm, 11 times higher than bare tip FOCS after coating due to adsorption of Nitrate on Graphene surface as shown. The simple experimental setup makes it reliable for lab use and in-situ monitoring.

Keywords: Optical Sensor.

INVITED SPEAKERS

Id-086

Performance of Quantum Key Distribution

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Abstract: Quantum key distribution (QKD) has focused on improving transmission performance over a fixed end-to-end connection between a single pair of quantum endpoints, to provide the flexibility and scalability. Possible with point-to-point optical links, optical-layer multiplexing, switching and routing of quantum signals.

Keywords: Quantum Key Distribution.

INVITED SPEAKERS

Id-089

Precision Measurements of Physical Values Based on Fiber-Optical Sensors with Impulsive Modulation of Optical Stream Intensity

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Abstract: Features of the optical stream, as a carrier of the signal, along with the features of the fiber-optical channels of its channeling, provide fiber-optical sensors (FOS) a number of advantages over traditional (electric) sensors. Significant advantage of FOS is their absolute indifference to electromagnetic fields, as obstacles, of any intensity and origin. Along with this, meters based on analogue of FOS, that continuously modulate some of the parameters of an optical stream (intensity, frequency, phase, or polarization), have a fundamental limitation of accuracy of measurement. Their maximum achievable minimum relative error of measurement (provided absolute stability of the parameters of all elements of the measuring path and the individual bandwidth of the electric tract): where $h\nu$, P_0 are the quantum energy and the intensity of the optical flow in the measuring FOS path. When using Ga-As laser as a source of optical flow with $P_0 = 10^{-3}$ W, and $\nu = 3.5 \cdot 10^{14}$ Hz, γ_{min} is $\sim 3 \cdot 10^{-6}$ % $Hz^{-0.5}$. In real measuring devices with analogue FOS the value of γ_{min} worsens to $\sim 10^{-2}$ %. In this case, navigation of the autonomous motion of intercontinental missiles and the tasks of geophysics require standard accelerometers, respectively, with γ_{min} $10^{-3} \div 10^{-5}$ % and with a threshold sensitivity of 10^{-12} *g* or less. The search for ways to improve the metrological capabilities of the FOS has led to the need of rejection of analog modulation principles and transition to discrete modulation principles. To do this, during the modulation of the optical stream in the FOS new, but not optical parameters, are introduced into it, and the role of the recipients of information is shifted onto them. Thus, all the advantages of the FOS are preserved - the optical carrier remains an information carrier, and the problem of accuracy of measurements is transferred to non-optical areas where it is solved properly. Given the existing possibilities of precision measurements of time intervals, the best suited to our requirements is our time-pulse modulation of the intensity of the optical stream. The information parameters of the pulse sequence may be the time intervals specified by the optical pulses. Based on the above considerations, a new class of FOS with impulse modulation of the intensity of optical flow (IFOS) for precision digital meters of physical quantities has been developed.

Keywords: Fıber-Optical Sensors; Modulation of Optical Stream Intensity.

INVITED SPEAKERS

Id-091

GaN Directional Micro LEDs Based on Evanescent Wave Coupling

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Abstract: There is a great current interest in micro-LED (μLED) display which is expected as a low-power-consumption, high-brightness, and high-resolution display for next-generation wearable and portable electronics. However, it is still very challenging to realize a full-color μLED display. This is because that the present μLED technology which is based on the direct etching of a flat LED wafer, typically by the inductively-coupled plasma (ICP) technique, has a number of fundamental limitations. For example, defects induced by ICP etching on the sidewall surface of a μLED will greatly reduce the quantum efficiency of the μLED especially in the low current density region, which is crucial to the operation of a display. A more serious problem of the present μLED is that a large amount of light is emitted through the sidewall surface in the lateral direction. This will not only reduce the brightness of a μLED display, but will also cause crosstalk among display pixels, making the realization of a high-resolution display difficult. We recently proposed a novel directional μLED by employing the evanescent wave coupling effect in a small truncated cone structure as a promising device to overcome the fundamental limitations of the conventional μLED. In this talk, I will first give a review on the basic characteristics of this device. Then, preliminary results towards the experimental realization of this device in the GaN material system will be presented.

Keywords: Micro LED; GaN; Directionality; Evanescent Wave Coupling.

INVITED SPEAKERS

Id-092

Targeted Imaging and Drug Delivery for Prostate Cancer Cells using Upconversion Nanoparticles Functionalized with Phosphate Micelles

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Abstract: We report the effective synthesis of biocompatible upconversion nanoparticles (UCNP)-loaded phosphate micelles and successful delivery of UCNPs and drugs to prostate cancer cells via secreted phospholipase A2 (sPLA-2) enzyme cleavage of the loaded micelles for the first time. The activity of the (sPLA-2) enzyme toward the synthesized micelles was investigated and confirmed by LC-MS. TEM results showed that the micelles have a size distribution of 80 to 150 nm, whereas UCNP-loaded micelles range from 200 to 350 nm, indicating the successful loading of UCNPs. The selective release of UCNPs to prostate cancer cells rather than other cells, specifically cervical cancer cells, was observed and confirmed by a range of bioimaging studies. Moreover, cytotoxicity assays confirmed the biocompatibility of the UCNP-loaded micelles. In addition, the proposed method was successfully utilized for selective drug delivery of estramustine phosphate, anti-prostate cancer drug, to prostate cancer cells. Drug encapsulation efficiency (EE%) was found to be 81.432% and release efficiency (RE%) was found to be 91%. Encapsulated drug was tested on in vitro application, and cytotoxicity test confirmed the selective delivery of estramustine on prostate cancer cells.

Keywords: Upconversion Nanoparticles, Prostate Cancer; Phospholipase A2.

INVITED SPEAKERS

Id-095

Advanced Silicon Nitride Platforms for Photonic Integrated Circuits

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Abstract: Large-scale monolithic integration of complex photonic functions became a reality in the last few years with applications ranging from telecommunication and data center to instrumentation or life sciences applications. Imec has been pursuing for the last 10 years extensive developments in silicon and silicon nitride photonic circuits through its own 200 mm CMOS pilot line with several products on the market for a broad range of industrial customers. This paper will review some of the key challenges to be addressed for the development of SiN photonic platforms with a special emphasis on the process side where almost each layer of the photonic stack needs material engineering to fit the requirements of these new applications. Silicon nitride has a relatively high index contrast material which allows implementation of complex optical functions while keeping the chip form factor small and having the benefit of very low propagation loss. Moreover, the benefit of the use of advanced tools for lithography like 193 nm stepper allows extremely small features to be patterned down to 70 nm which can be used as tapers. The dose mapping capability improves the control of the linewidth control other the wafer. Advanced deposition schemes have been deployed for tight control layer thicknesses and refractive index. Additionally to enhance device functionalities various types of filters and planar lenses have been developed however their insertion in the photonic stack requiring specific wafer bow strategy as well as special attention to the interfaces to avoid delamination of the layers. Our platforms cover applications with wavelength from 532 nm up to 2.4 um with either LPCVD or PECVD silicon nitride layers for the core material of the waveguide. The LPCVD silicon nitride has been optimized for very low propagation loss of 0.1 dB/cm and 1 dB/cm at 1520 nm due to the N-H bound and at 2200 nm due to O-H bound respectively. By nature the level of stress is very high in LPCVD-SiN layer and must been controlled for robust processing and high process yield. Thanks to its relatively low thermal budget (<400°C) compatible with post-processing on top of CMOS PECVD silicon nitride is the candidate of choice for numerous applications using imagers. The PECVD-SiN has been tuned with two main drivers: low propagation loss 0.5 dB/cm at 532 nm and low autofluorescence for life sciences applications.

Keywords: Silicon Nitride Photonics; Waveguide; Processing.

INVITED SPEAKERS

Id-098

Photoluminescence of ZnO Micro Structured Thin Films Prepared by the Spray Pyrolysis Method

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Abstract: ZnO micro-structured thin films are produced by the spray pyrolysis method on glass, silicon, and aluminum substrates at a substrate temperature of 350 °C. The precursor solution is prepared using zinc chloride ($ZnCl_2$) as the raw material, where it is dissolved in distilled water. The films are characterized using X-ray diffraction (XRD), scanning electron microscopy (SEM) with X-ray energy dispersive spectroscopy analyzer (EDS), UV-VIS spectroscopy, and photoluminescence. From X-ray diffractograms, it is found that all films displayed the hexagonal (wurtzite) structure. SEM observations showed three dimensional (3D) microstructures. Photoluminescence measurements are recorded using a laser beam of wavelength 365 nm. Structured PL spectra are obtained at room temperature, where a deconvolution peak fit and second derivative of the PL curves are used to detect the peaks. All results are thoroughly discussed and compared with literature. These results are very important for optoelectronic industry, solar cell photovoltics, gas sensing, and other photonic applications.

Keywords: ZnO; Spray Pyrolysis; Microstructures; Photoluminescence.

INVITED SPEAKERS

Id-105

Influence of Arcing in Air on EWF for Silver-Metal Oxide (Ag-MeO) Electrical Contacts

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Abstract: Photoemission of electrons has been observed in silver-metal oxide (Ag-MeO) electrical contacts before and after hundreds of electric arcs in air. The electron work function (EWF) about electrical contacts (Ag-ZnO (92/8), Ag-SnO2 (88/12) and Ag-CdO (88/12)) has been measured photoelectrically under UHV conditions. An interesting behaviour highlighted by this investigation is that Ag-CdO exhibits stable electron emission properties since after 50 or after 500 electric discharges in air, the EWF remains practically constant. Ag-CdO is a remarkable material for its low welding tendency, and its resistance stability. However, the European Union regulation imposes restrictions on the use of Cadmium in electrical contacts because of its toxic nature. Nowadays, Ag-CdO is advantageously replaced by environmentally friendly materials, such as Ag-SnO_2 and Ag-ZnO.

Keywords: Photoemission; Electrical Contact.

INVITED SPEAKERS

Id-106

Effects of Spatial Dispersion in Symmetric and Asymmetric Semiconductor Quantum Wells

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Abstract: From the Fresnel reflection laws follows that when the incident light is in S or P linear polarization, the reflected light must also be in the S or P polarization correspondingly. However, it was founded that this is not so. The reason for this deviation from the Fresnel law is spatial dispersion. In this paper we investigate the effects of polarization conversion at light reflection and show that the components of the tensor of dielectric susceptibility linear in the wave vector lead to polarization transformation when light is reflected from quantum well (QW) structures. The effect of these components is amplified in many times near exciton resonances. The nature of these contributions to the susceptibility tensor is related to the spin orbital interaction in the structures that do not have a center of spatial inversion. The absence of an inversion symmetry in turn can be related both to the volume properties of the crystal lattice and to the asymmetry of the structure as a whole. Both cases were investigated: the conversion of polarizations in a symmetric structure with quantum well and in an asymmetric structure in the presence of magnetic fields. In a symmetric QW structure, the conversion of polarizations was conditioned by the «bulk mechanism». From the dependence of the amplitude of this signal on the incidence angle, the contribution to the exciton dispersion linear in the wave vector was found. For a symmetric QW based on ZnSe/ZnMgSSe, the constant at linear in the wave vector term in the exciton dispersion induced by the spin orbital interaction is $\kappa_0 \approx 0.14$ эВ$\cdot$Å. In an asymmetric QW in the presence of external magnetic fields applied in the plane of incidence, the conversion depending on the field, can be caused only by the asymmetry of the structure as a whole. The obtained experimental data show that the degree of polarization conversion for structures based on CdTe and GaAs has a close value of 0.2% in the field of 1T.

Keywords: Quantum Wells; Excitons; Spatial Dispersion.

INVITED SPEAKERS

Id-110

Zero-index Mediums Using Two Dimensional All-dielectric Photonic Crystals

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Abstract: In this talk, the conditions for the mapping of the accidentally induced Dirac-like points (DLPs) in the band structures of the two-dimensional (2D) dielectric photonic crystals (PCs) to an effective zero-index medium (ZIM) will be discussed. The results of different 2D square lattice dielectric PCs, such as dielectric rods of square and circular cross sections, and core-shell rods in square lattice, will be presented and the conditions under which these PCs can mimic effective zero-index medium will be discussed. It was found that the PCs with the DLP formed by dipole and quadrupole moments cannot be mapped to an effective ZIM. The effective ZIM can only be realized in PCs with the DLP if the DLP is formed by monopole and dipole moments and is at low enough frequency. Furthermore, there should be only one propagating band in the extended states above the DLP frequency.

Keywords: Zero-index Mediums; Photonic Crystals.

INVITED SPEAKERS

Id-112

Luminescence Bioassays of Different Complexity: Bacterial Cells, Enzyme Reactions, and Fluorescent Proteins

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Abstract: Luminescence feature of bioassay systems provide a proper registration of biological responses. Luminescent function, being a physiological parameter of organism, is registered with simple physics devices. This type of registration is not time consuming, it provides a lot of experimental results under comparable conditions, which is essential for their statistical treatment. The most known luminescent bioassay is based on luminous marine bacteria. The bacteria of two natural marine genera, Photobacterium and Vibrio (P. phosphoreum, P. leiognathi, V. fischeri and V. harveyi) as well as recombinant Escherichia coli strains bearing bacterial genes are widely used for this purpose. Intensity of bacterial luminescence is sensitive to the presence of toxic compounds; therefore, the marine bacteria have been widely used to assess environmental toxicity for several decades. Development of bacteria-based ecological toxicity assay is now in a progress, including radiation toxicity. Current tendency to simplification of bioassay systems resulted in development of enzymatic assays. As opposite to the cell-based assay, the enzymatic assay estimates rates of biochemical reactions under toxicant influence. Physicochemical basis for the bioluminescence enzymatic assay was elaborated in review by Kudryasheva, changes in efficiency of primary physicochemical processes (energy, electron, and hydrogen transfer) under exposure to compounds of several types (fluorescent dyes, organic and inorganic oxidizers, metal salts) were analyzed and compared to the rates of the enzymatic reactions and bioluminescence intensity. The following studies developed this approach using additional groups of compounds and radioactive elements.

Keywords: Luminescence Bioassay; Toxicity; Fluorescent Protein; Enzymes; Bacteria.

INVITED SPEAKERS

Id-113

Can Quantum Dot Sensitized Solar Cells be a Potential Contender of Energy Crisis?

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Abstract: Nowadays energy crisis in society is major global challenge against scientific community. Growth and development of any country depends on sustainable energy solutions. Among all type of renewable energy sources, solar energy is prominent choice due to low cost, facile and easy availability in tropical and sub-tropical regions. To harness the solar energy, Silicon (Si) solar cells are commercially available in market at large scale. It is well established and proven technology which provides good stability and photo-conversion efficiency of approximately 17%. As per theoretical calculations, conventional Si solar cells can achieved maximum efficiency limited to 33.7% which is calculated by Shockley and Queisser. Thin film solar cells include dye sensitized solar cell (DSSC), organic solar cell, quantum dot sensitized solar cell (QDSSC), solid state quantum dot solar cell and perovskite solar cell, are flexible in nature and have low cost fabrication with potential to achieve power conversion efficiency up to 44.7% which is superior to conventional Si solar cells. In 1991, DSSC with optically active sensitizing material such as Ru based dye was first introduced to achieve low cost and efficient solar cells. Dyes were replaced by new type of light absorbing material i.e. quantum dots (QDs) for designing QDSSC. Due to quantum confinement, QDs have unique opto-electronic characteristics such as size dependent tunable energy band gap and carrier multiplication (i.e. multiple exciton generation effect-MEG).Cd and Pbbased chalcogenide QDs are commonly used sensitizing materials in QDSSCs. But, due to highly toxicity of Cd or Pb materials, 'Green' QDs are being explored for application in QDSSC. Green QDmainly includes I–III–VI_2group compounds such as $CuInS_2$ (CIS), $CuInSe_2$ (CISe), CuInSeS (CISeS), core shell structure of CIS-ZnS (CIS-Z) etc. In QDSSCs, the highest reported efficiency is 12.75% as per our best of knowledge. Interfacial charge transfer processes in QDSSCs suffers fromvarious recombination losses due to insufficient charge transfer and mismatch of charge transfer rate. Asthe reported efficiency of QDSSCs is still less than that of perovskite solar cells (PSCs), extensive research on the optimization of material selection and material engineering is required. In this paper, an insight on QDSSC along with interfacial charge transfer mechanism is presented.

Keywords: Quantum Dots; QDSSC; Fabrication Techniques; Photoanode.

INVITED SPEAKERS

Id-120

The Use Laser Welding and the Keyhole Effect for Increase of Thermal Efficiency of the Solar Absorber

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Abstract: The basic idea of solar absorber thermal gain increase is the keyhole effect utilization during which the radiation is absorbed by multiple reflections on cavity walls. The lattice of pyramidal or conical cavities on the solar absorber surface can be formed to create structured surface leading to its overall absorptivity increase and to the reduction of surface absorptivity dependence on the solar radiation incident beam angle changes caused by the daily and annual solar cycles. This contribution concludes the results of simulations of the effect of cavity geometry, geographical position and absorber orientation on its thermal gain with respect to the technological manufacturability of cavities. Furthermore, the real construction of the absorber with structured surface using laser welding and parallel hydroforming is briefly described.

Keywords: Keyhole; Solar Absorber; Hydroforming; Multiple Reflections; Absorption Efficiency.

INVITED SPEAKERS

Id-126

Application of Angle Diversity Technique to Optical Wireless Communication Systems for Smartphones

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Abstract: Much attention has been paid to optical wireless communication (OWC) systems since the systems have a possibility to offer wideband communication channel, e.g., inside building environment. In this context, the application of the OWC technology to smartphone communication is of great interest. It is possible to construct the angle diversity receiving systems using multiple receivers on the surfaces of a smartphone device to achieve stable communication when a smartphone moves around two-dimensionally and rotates three-dimensionally. An angle diversity configuration with multiple receivers facing different directions have been reported, but the literature is only focused on the condition when the receivers are supposed to move around two-dimensionally, but three-dimensional rotation of the device has not been well considered. In this paper, we consider the OWC systems for a smartphone that is supposed to move around two-dimensionally and rotate three-dimensionally. Computer simulation has been performed for the maximal-ratio combining of the output of four receivers placed on the top, front, right, and left surfaces of a smartphone device. It has been made clear that the diversity receiving systems using four receivers give stable signal-to-noise ratio performance under realistic usage condition of a smartphone. It has also been found that a semi-angle field-of-view of a receiver should be at least 60 degrees to achieve stable performance.

Keywords: Optical Wireless Communication; Visible Light Communication; Angle Diversity; Maximal-ratio Combining.

INVITED SPEAKERS

Id-129

InfraRed Fiber Optics for Photonics Applications in 2-16 µm Range

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Abstract: Well known fused silica fiber optics with high transmission in 0.2-2.2 µm range is used for a broad non telecom applications for a long time, but there is the strong market demand for fiber optics in in “finger-print” Mid IR-range 2-16µm. More than 30 year ago this demand on various applications in spectroscopy, laser power delivery, pyrometry sensing and IR-imaging has initiated an intensive development of new types of IR-glass fibers, Hollow Waveguides (HWG) and Polycrystalline IR-fibers (PIR-fibers). Progress in innovative technology of PIR-fibers (produced by extrusion from Silver Halide crystals), HWG and IR-glass fibers will be reviewed for comparison and selection of the best solutions for key areas of applications. Their main applications will be presented with the comparison of key exploitation parameters: Laser cables for power delivery of IR-lasers like Er:YAG; CO- & CO_2-laser, etc.; Spectroscopy probes for reaction/ process monitoring in lab/ industry and for biomedical diagnostics, including detection of tumor margins; IR-endoscopes or bundles to enable non-contact temperature control and IR-imaging. Finally, the most advanced laser, spectroscopy and sensing IR-fiber systems will be reviewed with the analysis of new development trends and estimation of the growing market needs.

Keywords: Mid Infrared Fiber Optics; Spectral Probes; Cables and Bundles; Laser Medicine; Fiber Sensors.

INVITED SPEAKERS

Id-130

Highly Ordered and Stable Inorganic-organic Hybrid Quantum Structures Based on II-VI Compounds

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Abstract: Translational symmetry ensures phase coherency of a physical process among different units of a crystal, and thus produces collective quantum effects beyond the sum of the units. Any significant physical and/or chemical fluctuation, which typically exists in a semiconductor alloy or self-assembled or artificially grown nanostructure array, would hinder our ability to study and use the collective behavior relying on this coherency. Man-made structures remain as one of the central interests since semiconductor superlattices were proposed by Esaki and Tsu in 1970. Unfortunately, man-made structures with genuine long-range order are rare. Here a new family of inorganic-organic hybrid quantum structures provides us a unique opportunity to explore coherency quantum phenomena in man-made structures. These self-assembled hybrid structures are ultra-thin slabs or atomic chains of II-VI semiconductors interconnected or coordinated by small organic molecules, exhibiting very high degree of structural perfectness comparable to a typical binary semiconductor. Furthermore, they exhibit several extraordinary properties (e.g., exceedingly strong exciton-polariton absorption, zero thermal expansion). By varying either the inorganic or organic component, one can tune the coupling between the inorganic units to achieve quasi-1-D, quasi-2-D, and 3-D super-structures with tailored material properties for different basic research interests and potential applications (e.g., room temperature exciton-polariton condensation, high efficiency UV emission and detection, p-type transparent conducting material).

Keywords: Organic-inorganic Materials; Exciton; Absorption; Photoluminescence; Raman.

INVITED SPEAKERS

Id-131

Application of an Opto-Electronic Oscillator in Radio Access Networks

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Abstract: The opto-electronic oscillator (OEO) is one of the well-known technologies able to produce a low phase noise signal in high-frequency applications. The OEO is composed of optical and electrical devices, where the optical part with a low-loss optical fibre behaves as a high-quality resonator and the electrical part plays a role for feedback with the necessary amplification and phase conditions. One of main advantages of the OEO is that the phase noise does not depend on the operating frequency, since with the higher frequency the quality of the optical resonator increases. In today's Radio Access Networks (RANs), one of the main requirements is to have a low-phase-noise signal for backhaul solutions. The low-phase-noise signal is required to have an efficient high bandwidth and spectral efficiency as well as a low latency. If the OEO is placed in the central office of the RAN, the base-station of the RAN can be simplified and the low-phase-noise signal from the central office can be distributed to the base-stations. In order to have an efficient central office with an OEO, there are some challenges to be taken into consideration. In this talk we will focus on these challenges and solutions as well as possible methods to improve the efficiency of the OEO application in a RAN.

Keywords: Opto-Electronic Oscillator; Radio Access Networks; Optical Communication; Phase Noise.

INVITED SPEAKERS

Id-132

Structural Rearrangements in Mononucleosomes Induced by Potassium and Sodium Ions: Single Particle FRET Analysis

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Abstract: Single particle fluorescence microscopy in combination with Förster resonance energy transfer (FRET) effect was used to study the structure of mononucleosomes assembled from core histones and short DNA containing a strong nucleosome-positioning sequence. Local changes in the nucleosome structure induced by potassium and sodium ions were analyzed by introducing a donor-acceptor pair of fluorescent labels in the different parts of the nucleosomal DNA or DNA linkers and measuring FRET efficiency. This approach enabled us to reveal and characterize different conformations of nucleosomes simultaneously present in a solution. We found that Na^+ and K^+ differentially affect structure of both linker and nucleosomal DNA and nucleosome stability. At physiological concentrations potassium ions stabilize the nucleosomal structure, whereas sodium ions slightly destabilize it. At a higher ionic strength both Na^+ and K^+ induce unwrapping of nucleosomal DNA, which is more pronounced and less reversible in the former case. We report that Na^+ and K^+ also differentially modulate functional interactions of protein factors with the nucleosome. We propose that the lower size of sodium ions enhances their ability to compete with histones for the ionic interactions with DNA near the entrance/exit of DNA in/from a nucleosome and facilitate unwrapping of DNA from the histone octamer. We conclude that K^+ ions, which prevail within cells, are less disruptive for various chromatin-associated processes than Na^+ ions, and these differences should be considered in molecular biology studies. The studies were supported by Russian Science Foundation (grant 14-24-00031). Experiments with PARP1 were supported by RFBR (grant 17-54-33045).

Keywords: Single Molecule; Fluorescence; Nucleosome, Structure.

INVITED SPEAKERS

Id-133

Effect of Low-Power Laser Irradiation Time on Human Blood Cells

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Abstract: Low-power laser is currently used in several medical specializations such as physiotherapy, dentistry, and dermatology, and so on. Several studies showed positive effects of laser therapy on biological systems. In contrast, other studies indicated that laser induced unwanted changes in cell structure and biological systems. Due to the discrepancy in the results of studies, I wanted to study the effect of low power laser on one of the biological systems experimentally. Therefore, I investigated whether the exposure to low-power diode laser induces denaturation in red blood cell (RBC) membrane protein composition, and determines the irradiation time for when denaturation of membrane protein process begins. The results indicated that an irradiation of RBCs by low-power diode laser for 20 min did not cause any change in membrane protein composition, whereas increasing the irradiation time to 30 min caused denaturation of membrane proteins, resulting in the formation of membrane cross-bonding in a considerable number of RBCs, and the percentage of denatured cells increased in a dose-dependent manner to the irradiation. This talk presents a detailed explanation of my research that was carried out to investigate the effect of a low-power diode laser (50mW) irradiation on the structure of membrane proteins of human RBCs over time. In this talk, also, the molecular mechanism of changes in cell composition and its functions induced by laser irradiation will be explained according to the research results.

Keywords: Low Power Laser; Irradiation Time; Red Blood Cells.

INVITED SPEAKERS

Id-136

Optical Comparator for PSK-modulated Signals by Using Serially-Cascaded Delay Line Interferometer

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Abstract: All-optical comparator is desirable to realize large-capacity, fully-transparent and energy-efficient communication systems, as it is considered to be a fundamental component to perform a most of the operations including a packet switching, label recognition, error detection and correction, and so on. However, most of the previous studies have been confined to OOK modulation format, not PSK modulation. In this paper, the author provides a novel optical comparator designed for QPSK-modulated signal, which comprises 8-bit length of code word, by using a serially-cascaded delay line interferometer. The proposed comparator yields the constellations having the information of a Hamming distance based on the designed code, when several patterns of QPSK signal were injected into the comparator. The paper experimentally demonstrates the feasibility of the optical comparison operation for 8-bit QPSK-modulated RZ signal at 10 Gbaud.

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

INVITED SPEAKERS

Id-138

Silicon Photonics for Ultra-broadband Applications

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Abstract: The advent of silicon photonics has enabled revolutionary advances in applications spanning high bit-rate communications, integrated sensors, and on-chip spectroscopy. Driven by the low-loss transmission in single-mode fibers, many silicon photonic devices used in these applications are designed to utilize the communication band centered at the infrared wavelength of 1550 nm. Yet, recent developments in ultra-wideband photonics are expanding capabilities outside of the communication band, including optical systems operating over multiple octaves. Harmonic and supercontinuum generation at wavelengths from the visible range to several micrometers in mid-infrared have now been demonstrated in various silicon and silicon nitride platforms. However, efficiently routing such broadband signals requires integrated couplers with octave-wide optical bandwidths which typically cannot be achieved with conventional interferometric devices. In this talk, we present various integrated geometries for ultra-wideband coupling of optical signals onto a single waveguide by generalizing the concept of "spectrally-selective waveguides". We show various requirements on the group indices of adjacent waveguides in order to achieve spectral selection; and we determine the necessary criteria for achieving the desired cutoff wavelength in an optical high-pass/low-pass filter configuration. We provide examples of silicon-based filters with slowly varying transitions to obtain wide optical bandwidths and highly selective transmission responses. We experimentally demonstrate devices fabricated using complementary metal-oxide-semiconductor processes, with filter roll-offs over 2.5 dB/nm, and inherently flat-top and low-loss transmission bands. The presented devices mark an important step towards wideband integrated photonic circuits such as multi-octave interferometers, wideband wavelength division multiplexed networks, and integrated display systems.

Keywords: Silicon Photonics; Broadband Filters; Spectrally-selective Waveguides.

INVITED SPEAKERS

Id-142

Optimization of Terahertz Quantum Cascade Lasers by Suppressing a Carrier Leakage Channel via a High Energy State

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Abstract: Quantum cascade lasers (QCLs) are promising large output power semiconductor based THz sources with narrow bandwidths and wide operating frequency. However, for utilization of the real THz applications by QCLs, the performances of output power and operation temperature are both required at the same time. Here we consider a balance between operation temperature and the required output power near nitrogen temperature operation with relative compact cryogenic system. We analysis and design the temperature dependent operation of large output THz-QCLs active region by Non-Equilibrium Green's Function (NEGF) method and device fabrication. Simulations reveal a carrier leakage channel from upper laser level to the first high energy state in the emitting double-well of the next period. This leakage channel is due to unintentional alignment of the two states, which is distinct from the thermally activated leakage channels. By tuning the energy of this high energy state, such leakage current is clearly suppressed. The optimized THz QCL is much improved, with a peak power of 350 mW contrasting to 220 mW for the not-optimized structure.

Keywords: QCLs; THz.

INVITED SPEAKERS

Id-147

Preparation of Novel Solid-state Materials Immobilizing Dyes and Photochemical Behavior

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Abstract: Properties of dyes have been invetigated as a means of developing novel luminous systems, photoinduced electron and/or energy transfer systems, and so on. However, solution-state dyes are usually not sufficiently stable due to photobleaching. Therefore it would be advantageous to immobilize the dyes within solid-state materials. Layered materials provide attractive solid-state two-dimensional nanospcae for immobilizing the dyes. In this talk, I will focus on the immobilizing the dyes within the solid-state two-dimensional nanospace and their behaviors, e.g., emission, energy transfer, and so on. Cationic dyes can be incorporated into the interlayer space of smectites. Anionic dyes can also be incorporated into the interlayer space of layered double hydroxide. However it is difficult to incorporate neutral dyes into the interlayer spaces. In order to develop novel method for the preparation solid-state materials containing immobilized the neutral dyes we have utilized a layered inorganic-organic monolith. The organic moiety is located between inorganic layers being covalently bonded with the inorganic layers in the monolith. Neutral porphyrin derivatives have been successfully incorporated into the solid-state two-dimensional nanospace of the layered inorganic-organic monolith. The immobilized porphyrin derivatives exhibited emission. Further I will talk about energy transfer within the solid-state two-dimensional nanospace.
Keywords: Dyes; Emission; Energy Transfer; Layered Materials; Inorganic-Organic Hybrid.

INVITED SPEAKERS

Id-151

Development of Fiber-optic Sensors for Use in Harsh Environments

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Abstract: To modern information-measuring systems of high technology, in addition to high metrological characteristics, high reliability, absolute spark-explosion-fire safety, working capacity under conditions of mechanical factors, high and low temperatures, radiation, strong electromagnetic interference are required. The use of fiber-optic sensors (FOS), in contrast to traditional "electrical" sensors, maximizes the achievement of these requirements. Improvement of metrological characteristics of fiber optic sensors of physical quantities with an open optical channel (pressure and pressure difference, linear and angular micro-displacements, vibrodisplacement, acceleration, deformation, fluid media parameters, temperature, aerodynamic angles) for information-measuring systems of high technology based on new principles transformation of optical signals in a micro-optomechanical system of measuring converters.

Keywords: Fiber-optic Sensors; Information-measuring Systems; Measuring Converters.

INVITED SPEAKERS

Id-152

Applying Security-Aware Traffic Policing and Shaping Strategies with Dynamic Routing and Wavelength Assignment Attack Aware Algorithm in WDM Optical Networks

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Abstract: Optical Transport Equipment Market expected to reach the $16 Billion by 2022, projected DELL'ORO GROUP, an independent research firm in the US, founded since 1995 in their 2018 released "Optical Transport 5-Year Forecast Report". The same report projects a 95% contribution of WDM Systems in Optical Transport Revenue. The Vice President of the research Group foresees demand and use of optical equipments and WDM systems to continue rising as service providers continue to expand their fiber footprint by installing more optical transport capacity between their global data centers. In light of this, this paper presents a novel approach applying Security-Aware Traffic Policing and Shaping strategies with Dynamic Routing and Wavelength Assignment Attack Aware Algorithm in WDM Optical Networks.

Keywords: Attack-Aware RWA; WDM; Optical Networks; RWA; Security Aware Traffic Policing and Shaping.

INVITED SPEAKERS

Id-155

Advanced Optical Modulation Format Conversion for Short-reach and Long-haul Network Integration

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Abstract: Future optical access-metro integrated network (NW) is required to efficiently accommodate various types of fiber to the x (FTTx)-based service. In the current optical access and metro NW, the different types of modulation formats and detection schemes have been used such as intensity modulation/direct detection (IM/DD) and In-phase and quadrature (IQ) modulation/coherent detection, respectively. Therefore, a traffic delay due to optical-electrical-optical conversion occurs at the heterogeneous NW gateway node (HNGN) connecting the optical access and metro NW. All-optical modulation format conversion in the optical-domain converting from an intensity modulated signal to an IQ modulated signal using nonlinear optical effects such as cross phase modulation (XPM) has been kept attention toward future optical-based HNGN. An advantage of the optical modulation format conversion is that it seamlessly connects from an access NW to a metro NW while maintaining the packet format, modulation depth, and symbol rate without using a high-speed driver amplifier and IQ modulator. In this paper, we propose a novel modulation format conversion from PAM4 to QPSK using XPM and investigate its characteristics. We experimentally verified the desired signal performance in the 20 km transmission experiment after modulation format conversion. Moreover, we numerically clarified the optimum conditions of generating an ideal QPSK, and its SNR tolerance.

Keywords: Modulation; Nonlinear Optics; Optical Signal Processing.

INVITED SPEAKERS

Id-156

Laser Assisted Joining of Aluminum-Copper

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Abstract: The increasing industrial demand for components made of dissimilar materials is leading to an ever-growing interest in laser-assisted joining processes. Tailor-made components from dissimilar materials can help to reduce weight and minimize resource consumption without affecting important component properties such as strength or reliability. Aluminum and copper, for example, are of great importance for electrical applications such as accumulators or lightweight electrical drives. Rising raw material prices make aluminum increasingly attractive compared to copper, since aluminum combines comparatively good thermal and electrical properties with a lower price and a mass density of about one third of copper. A major limitation in the use of aluminum as a substitute for copper is the lack of reliable aluminum-copper joining processes. Complex interactions between these different materials and their different thermomechanical properties make thermal joining a challenge and can lead to joint failures already during the cooling phase. This paper deals with laser welding of aluminum-copper samples in an overlap configuration. The resulting joints were examined by optical microscopy, SEM and EDX analysis. Very tight intermetallic composite layers of Al-Cu could be achieved without cracks. Within the strength-relevant transition area of the joint only very few pores were present. The intermetallic compounds were investigated in which the very hard, copper-rich compound with a thickness of about 1 µm could be detected.

Keywords: Laser Welding; Aluminum; Copper; IMC.

INVITED SPEAKERS

Id-158

In-chip Photonics and Microstructures Enabled by 3D Nonlinear Laser Lithography

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Abstract: Silicon is the crown jewel of electronics, photovoltaics and silicon-photonics industries, however all these technologies are limited to the very surface of the material. In this talk, I will first review our efforts that allowed the fabrication of first fully buried 3D microstructures inside Silicon. Then, I will introduce the first in-chip photonic elements, functional devices created deep inside the wafer, created without damaging the wafer above or below these elements. Finally, I will comment on the realisation of laser-based, 3D sculpting of the wafer for various applications. I will finish by looking into the potential expansion of our approach to other semiconductors.

Keywords: Silicon; Laser Lithography; 3D; In-chip.

INVITED SPEAKERS

Id-159

IR Spectroscopy of Photoprocesses in Heterogeneous Systems

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Abstract: A review is presented on the photostimulated processes in heterogeneous systems studied by vibrational spectroscopy. Started in the early 40th in the works by acad. Terenin, the method was used to detect the products or the intermediates of photooxidation on solid photocatalysts. If the molecules are too stable and resist both photooxidation and ozonolysis, simultaneous action of ozone and UV irradiation reveals a synergetic effect, leading to their degradation. UV irradiation of supported V or Mo in reducing gases leads to selective creation of active cationic sites in certain oxidation state. After appearance of tunable pulse lasers for IR region studies of relaxation processes at the surfaces became available. By means of pump-probe method the characteristic times of energy relaxation were measured. Tunable lasers were also used for selective excitation of the vibrational modes of certain isotopomers in adsorbed isotopic mixtures in order to achieve isotope separation. The experiments, however, show that the selective desorption does not occur because of a quick energy transfer between the adsorbed species due to strong dipole coupling, which can be studied by means of isotopic dilution method. Some molecules exhibit linkage isomerism when the same molecule can be bound to the same cationic sites in different ways. So, CO in zeolites forms with the cations C- and O-bonded species. The two states have different energies, the less energetically favorable species can be considered as an excited state, whose energy could be used for activation of some reactions. Experiments on photoinduced isomerization are in progress. The work was supported by the Russian Foundation for Basic Research, Grant 17-03-01372.
Keywords: FTIR Spectroscopy; Adsorption; Photoprocesses; Surface.

INVITED SPEAKERS

Id-166

Luminescent Polymer Composites – A New Class of Active Media

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Abstract: The last few decades have witnessed a rapid development of polymer-based composite materials, deployed eagerly in all fields, where excellent mechanical properties combined with low weight, easiness of manufacturing and low cost are of concern. Aviation and automotive industry, civil engineering, biomedicine, are good examples of wide range of application areas of contemporary polymer composites. Although the majority of applications benefit mainly from extraordinary mechanical properties of composite materials, these may offer also very attractive luminescent features, specifically when doped with rare-earth compounds. The combination of optically transparent polymer host of excellent mechanical properties and optically active nanoparticles (nanocrystals or metal-organic complexes) may result in constituting a new class of optically active media – luminescent polymer composites – efficient, mechanically flexible and durable. This requires, however, solving at least two major problems – managing the technology of introducing the active components into polymer without significant worsening of its optical properties and, simultaneously, mitigating the parasitic interactions between light emitting centers and highly energetic phonons of polymer matrices. In this work there are summarized the results of several years of research on design and development of the PMMA-based composites activated with rare-earth ions introduced either as a M-O complexes or inorganic nanocrystals. Pros and cons of both technologies are discussed with respect of the main technological challenges and recent achievements. In general, both approaches enabled achieving an isolation of active ions from the influence of phonons of polymer matrix (although full shielding has been achieved only in the case of inorganic nanocrystals), the resulting materials have optical transparency practically unchanged, exhibiting the desired luminescent properties and enduring very well thermal processing, which enables drawing the active composite fibers. This work has been supported by the National Science Centre, Poland, grant number 2011/03/B/ST7/01917.
Keywords: Polymer Composite; Nanocrystals; M-O Complex; RE Ions.

INVITED SPEAKERS

Id-170

Synthesis, Characterization and Optical Properties of ZnO Nanostructures: From Nanoparticles to Nanorods

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Abstract: Well-crystallized ZnO nanoparticles of various sizes (5 - 20 nm) were synthesized by different chemical routes without surface modification. Also, ZnO nanorods were synthesized by growing the small size of nanoparticles to produced different lengths of nanorods (50- 150 nm). The morphology and structure of the nanoparticles and nanorods were characterized by transmission electron microscopy (TEM), X-ray diffraction (XRD), Raman spectroscopy, steady-state photoluminescence (PL) and time-resolved photoluminescence (PL). Strikingly, the intensity of the defect-related emission band is enhanced when the particle size is reduced. In a parallel manner, the energies of near band edge (NBE) UV emission and absorption onsets are blue shifted. The dynamical behavior of exciton confinement is reflected by very a short decay time of the NBE exciton, and by long-lived, multiexponential, intrinsic-defect emission in the green spectral range. This temporal investigation of PL gives strong indication that a quantum confinement effect exists in the electronic structure of ZnO nanoparticles well above the exciton Bohr radius. Furthermore, the PL spectrum of ZnO nanorods showed that the relative intensity of ultraviolet (UV) and (defects) green band depend on the length of ZnO nanorods. The peak of photoluminescence of UV band is strongly enhanced when the length of ZnO nanorods is reduced and the green emission decreases.

Keywords: ZnO Nanoparticles; ZnO Nanorods; Raman Spectroscopy; UV–Vis Spectroscopy; Photoluminescence Spectroscopy.

INVITED SPEAKERS

Id-171

Flexible Secure TWDM PON and Its Future Application

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Abstract: Internet traffic has increased manifold over the recent years due to the advent of different application specific services. This has created an unprecedented demand for high bandwidth specially at the last mile or the access part of the network. Fiber to the home (FTTH) technology provides an excellent solution to provision broadband access among the end users in an access network. Passive optical network (PON), as a FTTH solution, has emerged as the most suitable candidate, due to its minimal capital and operational expenditures involved. Hybrid WDM/TDM (TWDM) PON is an excellent access solution for sharing the available bandwidth with optimal resource utilization. In this talk we discuss a recently proposed novel TWDM architecture for optical access networks using arrayed waveguide grating, tunable transceivers and fast optical switches that simultaneously provides complete flexibility and security while keeping the distribution architecture completely passive. Unlike the other architectures in literature, the proposed architecture does not possess a security-flexibility trade-off and can support a longer reach with higher scalability. We further show that these architecture along with suitable media access control protocol (MAC) can be further applied for various application scenarios like open access, local distribution of contents, access metro integration and for introduction of edge/fog computation facility. In open access, we utilize the inherent security provided by the architecture to facilitate multiple service provider to coexist sharing the same distribution network while maintaining their isolation and network concurrency. In the local distribution, we modify the same architecture to facilitate supervised user to user direct connectivity. This utilizes the end users spare capacity and hence increases the network utilization by manifold. For access metro integration we use this local sharing capability to establish remote ONU to ONU connectivity without complicating the overall control process. The advantage is that the entire access metro data transmission remains optical and does not require any costly and energy hungry OEO conversion. Finally, edge computing is facilitated through a suitably designed MAC protocol that enables the fog scheduler to poll users when they are not busy with upstream/downstream transmission with the PON controller (optical line terminal).

Keywords: Optical Access Network; PON; TWDM PON.

INVITED SPEAKERS

Id-172

Direct Bandgap Silicon Clathrate for Future Solar Cells: Exploration and Bandgap Engineering Through First-principles

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Abstract: Through first-principles calculations, and by means of tensile and compressive biaxial strain through lattice mismatch technique, we have successfully engineered the bandgap of two types of guest-free silicon clathrates Si_{46} in the type-I and type-VIII systems. Initial equilibrium lattice parameters for type-I and type-VIII Si_{46} are obtained after structural optimization as a=10.22 Å and 10.12 Å respectively. The electronic structures and densities of states DOS were computed by means of GGA-PBE approximation in the frame of the DFT as implemented in the CASTEP package. At zero pressure fundamental bandgaps by GGA-PBE are 1.364 eV (1.359 eV) for type-I (type-VIII) Si_{46}. Under tensile strains of +2% and +4%, type-I and type-VIII clathrates become respectively direct-bandgap semiconductors, with optimal magnitudes within the visible range of the electromagnetic spectrum. Such findings play in the favor of further exploration and exploitation of silicon clathrates (that could be integrated in silicon based industries) to design thin film silicon based photovoltaic and photonic devices with higher efficiencies.

Keywords: Silicon; Clathrates; Bandgap Engineering; Biaxial Strain; Direct Bandgap.

INVITED SPEAKERS

Id-174

Ultra-fast Magnetism in Nanophotonic Structures

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Abstract: Magnetophotonic crystals are all-dielectric structures that provide optical resonances with high quality factors. Incorporation of a magnetic medium inside the microcavity leads to the significant enhancement of the Faraday effect. At the same time, the Faraday effect counter part (IFE) can be the origin of the magnetization precession excitation, when the structure is excited by femtosecond laser pulses. Optically excited magnetization dynamics and spin waves are of great interest for such fields as data processing and magnonics. Usually the IFE is observed in crystals and magnetic films on a substrate. Here we demonstrate the IFE induced by fs-laser pulses in the magnetic film inside the magnetophotonic crystal. Spectral dependence of the IFE on the laser pulse wavelength in the band gap of the magnetophotonic crystal has a sharp peak leading to a significant enhancement of the IFE. This phenomenon is explained by strong confinement of the electromagnetic energy and angular momentum within the magnetic film. Calculated near field distribution of the IFE effective magnetic field indicates its subwavelength localization within 30 nm along the film thickness. These excited volumes can be shifted along the sample depth via e.g. changing frequency of the laser pulses. The obtained results open a way for the new applications in the areas of ultrafast spintronics and quantum information processing.
The work was supported by Russian Science Foundation grant N 17-72-20260.

Keywords: Ultra-fast Magnetism; Inverse Faraday Effect; Magnetophotonic Crystals.

INVITED SPEAKERS

Id-175

Towards the Ultra-small Size Optical Nanopore for Single Molecule Analysis

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Abstract: The ultra-small size portable single molecule detection device by using an electrical detection technique has been recently manufactured by Oxford Nanopore Technology, which its relatively high error rate needs to be reduced significantly. It can be attributed to electric dipole layer formation inside the nanopore channel. Plasmonic sensing devices on ordered flow-through nanohole array with ~ 100 nm diameter for biomolecule sensing was fabricated, however, the optical nanopore device is yet to be fabricated**.** Considering the facts that the optical detection technique is being utilized for most biosensors including genome sequencing devices, optical detection nanopore array would be also an excellent candidate as a next generation bio sensor. Fabrication of Au nanopores with its diameter of ~ less than 10 nm has been reported under electron beam irradiation by using diffusion or drilling techniques. For scanning electron beam irradiations on the focused ion beam (FIB) drilled Au aperture with an energy ranging from 2 keV to 20 keV using field emission electron microscopy (FESEM), fast diffusion of Au and C atoms would occur, and pore formation will be observed on the diffused Au-C membrane, regardless of the ratio of Au film thickness to aperture diameter. However, for relatively high energy electron beam projection-type irradiation at ~100 keV or higher by using transmission electron microscopy (TEM), Au and C atoms diffuse inside the aperture area and forms the pore, only when the film thickness is greater than the aperture diameter. For pore formation under focused electron beam drilling on the nanoscale spot, extreme control of nano-positioning of ~ 1.5 nm electron beam probe diameter is required during processing. The focused electron beam currents upto ~500 pA on the ~ 1.5 nm^2 spot is required and electron beam density reaches upto ~10^9 electrons/nm^2. Fabrication of the nano-aperture surrounded by the periodic patterns on pyramidal probes to improve the low transmittance of light through the nano- aperture is also reported. The nanopores with its diameter ranging from 10 nm to 3 nm inside the FIB drilled aperture were fabricated by using various surface treatments including electron beam irradiations and ion beam irradiation. Formation of the Au nanoparticle on the diffused membrane during the electron beam processing was reported.

Keywords: Optical Nanopore; Electron Beam Irradiation; Au-C Diffusion; Ostwald Ripening; Spindoal Decomposition.

INVITED SPEAKERS

Id-177

Radiation Dosimetry Using Specialty Optical Fibers

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Abstract: Ionising radiation has demonstrated many applications, ranging from diagnostic imaging to radiotherapy. However, excessive exposure can lead to many detrimental affects. Regulatory bodies have imposed the need for radiation doses to be measured. Recently, they have been many interest in using optical fiber as radiation dosimeters. These interest have been fuelled by many advantages of optical fiber such as impervious to water, high spatial resolution and sensitivity. This talk will focus on two approaches, namely Thermoluminescence and Radio Luminescence. The fabrication, sample preparation, measurement and results will be presented and discussed.

Keywords: Specialty Optical Fiber; Radiation Dosimetry.

INVITED SPEAKERS

Id-178

The Nature of Defects and Traps in High-k Dielectrics with Photoluminescence Experiments

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Abstract: Silicon oxide SiO_2 and nitride Si_3N_4 are two key dielectrics in silicon microelectronics. Now these dielectrics are replacing by high-k dielectrics with high value of dielectric constant k, such as Si_3N_4 (k=7), Al_2O_3 (k=10), HfO_2, ZrO_2 (k=25). Ta_2O_5 (k=40). The leakage current in high k dielectrics results in excess power dissipation, heating in silicon devices. Leakage current in high-k dielectrics occurs throw electron and hole traps. The important scientific question is the nature (atomic and electronic structure) of defects and traps in high-k dielectrics HfO_2, ZrO_2, Ta_2O_5, Si_3N_4. The informative method for identification of defect and trap nature in dielectrics is photoluminescence. The photoluminescence stokes shift gives the thermal and optical trap energy. It was established that in HfO_2, ZrO_2, Ta_2O_5, Al_2O_3 the oxygen vacancies are defects responsible for luminescence and electron and hole transport.

Keywords: Optical materials and applications
Keywords: Defects; Traps; Photoluminescence.

INVITED SPEAKERS

Id-180

The Fluorescence Properties of Carbon Dots and Metal Doped Carbon Dots

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Abstract: Carbon dots (CDs) which are 5 nm size carbon particles, are known for their excellent fluorescence properties. There are many methods for their preparation. On the other hand the doping of the CDs with metal atoms (zero valent) is not that common. We have developed a general technique to synthesize M@CDs. The synthesis is conducted by melting metals whose melting point is lower than 430 ^{0} C. The metals that fit this synthetic method are Ga, In, Bi, Sn, Cd, Pb and Zn. The preparation of the M@CDs involves ultrasonic waves. Firstly, the metals are melted, the melt is overlayered by an organic solvent (PEG 400 or Silicon oil). A horn-type sonicator is placed in the organic layer and operates for 10-60 minutes. The temperature is held 25-50 degrees above the melting point. In addition to the precipitate that was obtained, the supernatant contains the M@CDs. For Ga water can be used for the overlayering liquid. We will present the emission spectra of the products, the Quantum yield, and their decay times. In addition we have hydrothermally reacted an aqueous solution of BSA (Bovine Serum Albumin) and obtained N@CDs. The quantum yield of these particles was 44%. In addition, we will present also a technique to dope metals with a high temperature melting point such as Ag, Au and Pt and their emission properties will be presented. Applications of some of the M@CDs as well of the N@CDs will be presented.

Keywords: Carbon-Dots; Metal Doped Carbon Dots; Sonochmistry.

INVITED SPEAKERS

Id-181

Design of Silica Optical Fibers with Selected Mode Staff Differential Mode Delay Management

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Abstract: Nowadays laser-based optical signal transmission technique over silica optical fibers with enlarged core diameter in comparison with standard telecommunication singlemode fibers is widely used in various applications of high bit rate networks as well as in fiber optic sensor systems. This technique combined with special launching conditions provides a few-mode regime, when laser excited optical emission is transmitted over large core optical fiber by not total mode staff but only limited number mode components. Since IEEE 802.3z standard was ratified on 1998 this technique started to be utilized for short-range in-premises multi-Gigabit networks. Nowadays it also becomes to be in demand for on-board cable systems and industrial network applications requiring 1 Gbps / 10 Gbps data transmission over fibers with extremely enlarged core diameter, while this technique is also considered as an alternative solution for the problem of nonlinear Shannon occurring for new-generation optical networks providing extra-high bit rates from hundreds Tbps up to Pbps and more. Here differential mode delay (DMD) is the main issue for networks based on multimode optical fibers operating in a few-mode regime, while fiber optic sensor applications based on a few-mode effects desire DMD improvement. This work presents an alternative method for design of special refractive index profiles of large core silica optical fibers, that provides selected or total mode staff DMD desired management, and some simulation results concerning with refractive index profile synthesis providing required DMD for described above applications.

Keywords: Large Core Optical Fibers; Few-mode Laser-based Data Transmission; Higher-order Modes; Differential Mode Delay; Mode Effective Area.

INVITED SPEAKERS

Id-189

Pneumatic Photonic Crystals: Properties and Application in Sensing and Metrology

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Abstract: A pneumatic photonic crystal i.e. a medium containing regularly distributed gas-filled voids divided by elastic walls is proposed as an optical indicator of pressure and temperature. The indicator includes layered elastic platform, optical fibers and switching valves, all enclosed into a chamber. We have investigated theoretically distribution of deformation and pressure inside a pneumatic photonic crystal, its bandgap structure and light reflection changes depending on external pressure and temperature. At chosen parameters and fixed temperature the multi-scale device may cover the pressure interval (0, 10) bar with nanobar accuracy. The optical devices considered offer an opportunity to organize precise simultaneous monitoring of pressure and temperature in quick processes in gas or liquid flow. Various applications of opto-pneumatic media in sensing and signal processing are reviewed. A method is proposed to determine the fundamental molar gas constant R with the relative standard uncertainty near 10^{-10} that is based on extra accurate volume controlling and high sensitive pressure measurements in the framework of scale echeloning procedure. An essential moment of the method is uniting of results for two measurement scales with increased relative standard uncertainty (10^{-5}) to obtain the higher precise level. A calibrated stable area of fixed temperature is used in vicinity of the triple point of water.

Keywords: Photonic Crystal; Optophotonic Media; Optical Sensors; All-optical Signal Processing.

INVITED SPEAKERS

Id-191

Effect of Bismuth-induced Control Phase of GaAs Nanowires on Optical Polarization

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Abstract: One dimensional semiconductor nanowires (NWs), such as III-V semiconductor alloy, have currently gained considerable research interest owing to its potential for future optoelectronic and photonic applications. Among the promising material systems for optoelectronic applications are GaAsBi alloy, which belong to the so called diluted bismuth semiconductor family. By adding of dilute concentration of bismuth (Bi) into GaAs, the bandgap energy can be precisely tuned down to optical window of 1.3 μm and 1.55 μm for fiber-optic communication. Furthermore, a strong increase of spin-orbit interaction is expected in GaAsBi, which may prove useful for spintronic devices utilizing low modulation electric field. Moreover, a higher Bi content in GaAsBi leads to strongly suppression of non-radiative Auger recombination loss and inter-valence band absorption, which is favorable for optimization of threshold current and quantum efficiency of near-infrared lasers. Here we employ the transmission electron microscope (TEM), polarized micro-Raman and photoluminescence (PL) spectra to explore the structural and optical properties in GaAs(Bi) NWs grown on GaAs(111)B substrates by Au-assisted molecular beam epitaxy (MBE). TEM measurements show that the introduction of bismuth can lead to the formation of zinc-blende GaAs nanowires, while the removal of bismuth changes the structure into a 4H polytypism before it turns back to the wurtzite phase eventually. We also found that the linear polarization of the photoluminescence emission can be engineered by tailoring the crystal structure of GaAs nanowires through Bi incorporation. The effect of bismuth-induced phase of GaAs nanowires on PL polarization will be presented in this talk. These finding are advantageous for their applications as a nanoscale source of polarized light.

Keywords: GaAsBi; Nanowires; Optical Polarization.

INVITED SPEAKERS

Id-192

Ultrathin Electron Layer Generation Based on Laser-driven Energy Modulation

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Abstract: Laser based manipulation enables to change the electron distribution in the phase-space. These modifications are advantageous for a couple of applications, for instance improving the longitudinal coherence and pulse shortening during generation of radiation in an undulator. Energy modulation can be generated by a periodically placed static magnetic field (i.e. modulator undulator) where laser field is present. They together – according to the Lorentz-force – modify the phase space distribution of the electron bunch. One part of the bunch is accelerated and other part is deaccelerated depending on the laser wavelength and phase. Subsequently, dispersive magnet series deflects the electrons to different paths according to their energy levels. This magnet series is called chicane. At the end of the chicane the density of the electrons are increased locally and forms a sequence of electron bunches which are separated by the laser wavelength. This process is called microbunching, and we call the nanometer scale ultrathin electron layers nanobunches. There are several electron manipulation techniques, which are differentiated by the combination of the three main components. For instance seeded FEL has four sub-types, where the two main sub-types are the High Gain Harmonic Generation (HGHG) and the Echo Enabled Harmonic Generation (EEHG). The main application area of these methods is femtosecond pulse generation in the extreme ultraviolet spectral range. Furthermore, several proposals were made, based on theoretical calculations, on generation even shorter, attosecond pulses by electron manipulation. In the recent years our Institute proposed three different setups, wherewith waveform-controlled attosecond pulse generation is possible, which are based on electron manipulation techniques: Carrier-Envelope-Phase Stable Single-Cycle Attosecond Pulse Generation in the Extreme-Ultraviolet Range which is based on linear accelerator; Laser-plasma accelerator-based single-cycle attosecond undulator source; Single-cycle attosecond pulses by Thomson backscattering of terahertz pulses. In my presentation I will speak about the used electron manipulation techniques and their results which were published.

Keywords: Free Electron Laser.

INVITED SPEAKERS

Id-193

Generation of Single-cycle CEP-stable Attosecond Pulses Based on Radiation of Ultrashort Electronbunches

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Abstract: Attosecond science is concerned with time-resolved measurement, control, and manipulation of electron dynamics in matter. Ultrafast electron dynamics determines how physical and chemical changes occur at a fundamental level. Usually the investigation of such processes requires ultrashort attosecond pulses, which can be reproduced with the same waveform. The most widespread and simplest generation method for attosecond pulse generation is the high-harmonic generation technique. Unfortunately, the waveform of the generated attosecond pulses by high harmonic technique is not predictable. It is also possible to generate attosecond pulses by radiation of relativistic electrons. However, controlling the pulse shape has not been demonstrated, yet. Recently, we proposed a technique to generate carrier-envelope phase stable, waveform-controlled single-cycle attosecond pulses using radiation of ultrashort electron bunches. We used a commercial software to perform the simulation of the bunching process on electron beam coming from a conventional electron source. A self-developed software was used to calculate the radiation of the bunched electrons. The energy of the radiation and the radiated waveform were calculated based on the Lienard-Wiechert potential. Supposing a few-cycle undulator as radiator undulator, according to our calculation, the waveform of the radiation copied the magnetic field distribution of the radiator undulator (along the propagation direction of the electron bunch) if the undulator parameter was below 0.8. Using helical undulator as radiator undulator circularly polarized attosecond pulses are generated. We suggested also an alternative solution to generate single-cycle carrier-envelope phase stable attosecond pulses using low energy electrons. In this case Thomson scattering of terahertz pulses on relativistic electron bunches create attosecond pulses with a few nJ energy.

Keywords: Free Electron Laser.

INVITED SPEAKERS

Id-197

Eu^{2+} Activated Oxonitridosilicate Phosphors for Highly Efficient White Diodes via the Modified Solid State Reaction Method

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Abstract: At present the novel class of oxonitridosilicate phosphors upon activation with RE ions has demonstrated its superior suitability for application in white light-emitting diodes. The most attractive green phosphor of $SrSi_2N_2O_2:Eu^{2+}$ is intensively studied but its practical application is limited because of synthesis sensitivity to the manufacturing parameters and the resultant luminescence properties. The present work deals with cooping on the Sr and Si site with Ca, Ba or Al respectively, various oxygen partial pressure during carbothermal synthesis of the phosphor, the resultant phase composition and optical characterization. It has been found that crystal symmetry and the second coordination sphere of the available sites for Eu^{2+} significantly alters the absorption and emission spectra of the phosphor. It has been shown that the final phase assemblage changed significantly after various nitrides to oxides ratio in the high-temperature synthesis showing the new non-reported earlier compound in the Sr-Si-O-N system with a highly defective structure. The detailed optical characterization confirmed green emission of Eu^{2+} in the all tested specimens but the highest quantum yield (QY) was observed in the specimens with a di-phase composition, where the triclinic $SrSi_2N_2O_2:Eu^{2+}$ was accompanied by the unknown phase.
Keywords: Oxonitridosilicate Phosphors Eu^{2+}.

INVITED SPEAKERS

Id-199

Gate Effect on Time Response and Responsivity in Single Walled Carbon Nanotube/Si Photodetectors

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Abstract: Although most part of the commercial available photodetectors are based on Si technology, new fields are becoming to be investigated pressed by the necessity to reduce costs and sizes of the devices. From this point of view, nanomaterials present characteristics which are unique expecially if one considers the possibility of their use in hybrid systems where Si remains one of the components. Carbon nanotubes (CNTs) with their nanometric size and their compatibility with Si, represent one of the most promising nanomaterials for Si technology integration. Thanks to their characteristics of optical transparency and electrical conductivity, CNT thin films are successfully considered as front windows for semiconducting based photodetectors with the double purpose of charge collection and light transmission, showing performances approaching the commercial level. Here we report on single walled (SW) CNT/Si photodetectors and the possibility to enhance their performances by operating on the electrical contacts and applying an external gate voltage. The as obtained samples measured in photovoltaic mode showed responsivity and detectivity of the order of 1 A/W and 10^{14} Jones respectively, noise levels of the order of 10^{-14}W·Hz$^{-1/2}$ and external quantum efficiency (EQE) of the order of 10% in the whole visible wavelength range. Moreover, using femtosecond laser pulses as light source, time response as short as few tens of nanoseconds were measured. The action of a gate voltage less than 20V steers the SWCNT/Si junctions towards the avalanche regime increasing the EQE up to 200% and reducing the response time to few nanoseconds paving the way to their use for weak signal detectors.
Keywords: Single Walled Carbon Nanotube; Gate Voltage.

INVITED SPEAKERS

Id-203

Making Wide-Bandgap Oxides "See" Light – A Prospective Approach for Low-Cost, Ultra-Low-Power Optical Sensing

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Abstract: Wide-bandgap oxides (e.g. silicon dioxide (SiO_2), hafnium dioxide (HfO_2)) have played a very important role in the advancement of semiconductor device technology. For instance, SiO_2 has served as the gate dielectric of the metal-oxide-semiconductor field-effect transistor for over four decades, only to be replaced by other high-k dielectrics in recent technology nodes. The past decade also witnesses an increasing effort in using SiO_2, HfO_2, etc. for resistive memory device applications. Although the large bandgap of these oxides has provided the thermal and electrical stability, it has also excluded them from being used as active components in general optical applications. Optical sensing or detection is a very important function in many applications (e.g. image sensors). The rise of the internet of things is expected to fuel an exponential growth of the demand for cheap, low-power optical sensors. The traditional way of realizing optical sensing is based on the positive photoconductivity effect, whereby photons of appropriate energy can promote the generation of excess electron-hole pairs in a semiconductor, thereby enhancing its electrical conductivity. Significant improvement in performance and reliability of photodetectors based on silicon and III-V semiconductors have been achieved over the years. However, it is difficult to integrate these traditional devices on transparent or flexible substrates used in flexible electronics systems. In the last several years, there has been an increasing effort to develop alternative optical sensors based on novel materials such as perovskites and two-dimensional dichalcogenides, and promising results have been achieved. However, the long-term stability of these materials remains a basic issue. For instance, perovskites are known to rapidly degrade in ambient condition and special encapsulation is needed to ensure stability. In this talk, I will share some results pertaining to our recent discovery of a negative photoconductivity effect in very thin wide-bandgap oxides such as SiO_2 and HfO_2 (thickness ~4 nm). Although these oxides are non-photo-responsive when they are in a pristine state with a relatively low defect density, they can be made photo-responsive after increasing the density of defects (believed to be oxygen vacancies) via a soft electrical breakdown step. The increased defect density gives rise to a higher leakage current through the nanoscale breakdown region, which is quenched when exposed to normal white light, giving it an optical sensing capability.

Keywords: Negative Photoconductivity; Optical Memory; Optical Sensors.

INVITED SPEAKERS

Id-205

Characteristics and Field Operation of Polarization-Insensitive Silicon Photonics 8×8 Optical Switch

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Abstract: High-throughput optical switches are key elements for future ultralow-energy low-latency optical network. Among various type of optical switches, switches based on silicon-photonics have advantages of low-energy, high-speed, high-density integration, and low cost. Recently, we developed a strictly non-blocking 8 × 8 optical switch using silicon-nanowire waveguide. The switch is currently in operation in the optical network deployed in Tokyo metropolitan area. In this paper, we present transmission characteristics of the silicon nanowire optical switch and its long-term stable operation in the field deployed optical network. We developed a silicon-photonics 8×8 switch with throughput over 48.2 Tb/s and energy efficiency of 0.37 pJ/bit. The robustness and reliability of the switch was confirmed in the long-term stable operation in the field deployed DOPN testbed.

Keywords: Silicon Photonics; Optical Switch; Optical Network.

INVITED SPEAKERS

Id-207

Laser Generation in Continuous Flow of Photoluminescent Carbon Quantum Dots for Fluorescence Cell Imaging

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Abstract: Carbon nanoparticles smaller than 10 nm and photoluminescent are defined as carbon quantum dots (CQDs). This nanoparticles have been applied in areas such as biomedicine. Pure samples with no byproducts are needed to avoid toxicity effects for in vivo and in vitro cell imaging. Due to this fact, laser fragmentation in liquids is an ideal synthesis technique where only a carbon precursor, a liquid to disperse it and laser irradiation are needed. After synthesizing carbon quantum dots for first time in a continuous flowing of the liquid configuration, an increase in the generation efficiency of CQDs with is shown). Compared to the standard methodology, this configuration increases particle size reduction efficiency in a 15%. Besides, the fluorescence quantum yield is also increased, 4.5% in the case of the flowing configuration and 0.5% for the standard. As an application, internalization of the CQDs inside three different cancer and healthy epithelial cells is achieved). The process is proved to be fast, is achieved in less than 10 minutes, and direct, only mixing of the CQDs with the cell sample is needed. To conclude, the fluorescence intensity is acquired during 5 hours, obtaining a constant response for more than 2 hours. The results clearly demonstrate the used methodology as excellent for synthesizing pure and fluorescent CQDs.

Keywords: Carbon Quantum Dots; Photoluminescence; Cell Imaging; Laser Fragmentation.

INVITED SPEAKERS

Id-214

III-nitride Emitting Devices Grown on (-201)-oriented β-Ga_2O_3 Substrate

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Abstract: Wide bandgap III-nitride semiconductors possess several material properties that make them attractive for potential application in developing devices that emit and detect light in the spectrum between UV and visible wavelengths, as well as high-power electronic devices. Vertical-injection GaN-based light-emitting diodes (VLEDs) are of particular importance in this context, as they are promising candidates for high-efficiency and high-power devices. In this work, we report on high-quality III-nitride films and VLED based on multiple quantum wells (QWs) with high optical efficiency that were grown on β-Ga_2O_3 substrates by MOCVD, with high internal quantum efficiency (~ 86%). We show that (-201)-oriented β-Ga_2O_3 has a much lower lattice mismatch with GaN (~ 4.6%) compared to the currently utilized substrates, such as sapphire (Al_2O_3) and Si. This low lattice mismatch reduces threading dislocation density relative to that grown on sapphire, while also improving optical efficiency. InGaN/GaN and GaN/AlGaN multiple quantum wells have been structurally and optically investigated by X-ray diffraction, transmission electron microscopy, photoluminescence and time-resolved spectroscopy. Carrier dynamics analysis shows that all our samples are dominated by radiative recombination, indicating high optical and structural quality. The findings show that high optical efficiency can be produced by growing III-nitrides directly on (-201)-oriented β-Ga_2O_3 without the need for advanced and expensive fabrication methods. In this work, we confirm that this substrate can be employed in the production of large-scale, cost-effective and high-efficiency UV and visible vertical emitting device arrays.

Keywords: GaN; Vertical LED; Ga_2O_3.

INVITED SPEAKERS

Id-217

Monolithic Metal-Semiconductor Nanowire Heterostructures for Electrical and Optical Applications

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Abstract: Due to physical limits and short channel effects a shift towards the adoption of new materials and novel design architectures is predicted to insure further improvement of modern integrated circuit technology with respect to integration densities, power dissipation and performance. Nanowires are predicted to be one of the most promising building blocks for future ultra-scaled high-speed nano- and opto-electronics. We will address the controlled formation of silicon, germanium and monolithic nanowire heterostructures. The main obstacles facing towards reliable synthesis of such hybrid systems are related to lateral strain relaxation, mitigating the limitations of material lattice compatibility and allow arbitrarily combined dissimilar materials unattainable in layered structures. Out of the wide range of nanowires, germanium combines a high carrier mobility, with a more than five times larger exciton Bohr radius compared to silicon. Hence, germanium is of particular interest especially for the development of high speed and novel quantum devices. A novel synthesis approach for semiconductor-metal nanowire heterostructures with abrupt interfaces will be presented and discussed. The synthesis employs vapor-liquid-solid nanowire growth and millisecond flash lamp annealing along with several standard techniques of semiconductor manufacturing like sputtering and plasma enhanced chemical vapor deposition. We recently demonstrated the formation of axial Al-Ge-Al nanowire heterostructures with atomically sharp interfaces and monocrystalline aluminum leads by using a thermally initiated exchange reaction. This enables the formation of an in line contacted Ge quantum dot without requiring precise lithographic alignment of the contacts, which is one of the most challenging issues of fabricating quantum dot based devices. The authors gratefully acknowledge financial support by the Austrian Science Fund (FWF), project no. P28175-N27. The authors further thank the Center for Micro- and Nanostructures for providing the cleanroom facilities as well as M. Stöger-Pollach from USTEM TU Wien for conducting TEM investigations.

Keywords: metal-semiconductor nanowire heterostructures, quantum dot, ballistic transport.

INVITED SPEAKERS

Id-218

Periodic Domain Structures Recorded by an Electron Beam for the Nonlinear Conversion of Laser Radiation in Optical Waveguides on Nonpolar Cuts of $LiNbO_3$

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Abstract: Microdomain patterns of specified design have attracted attention in view of their applicability for the nonlinear-optical frequency conversion on the basis of quasi-phase matching (QPM) principle, in particular in integrated schemes. The base material for optical integrated circuits of quantum photonics is $LiNbO_3$. We summarize our results on recording by an e-beam in the SEM planar microdomain structures on nonpolar cuts of $LiNbO_3$. Experiments were performed in $LiNbO_3$ crystals, in Ti in-diffused planar optical waveguides Ti:$LiNbO_3$, and in He-implanted planar optical waveguides He:$LiNbO_3$. In the SEM the local polarization reversal occurs due to space-charge fields induced by local e-beam irradiations. We investigated the regularity and feature of the domain formation under different irradiation conditions. Stable domain gratings with spatial period's 3 - 7 μm, up to several microns in thickness were recorded. The planar grating parameters (size, thickness and configuration) depended both on irradiation conditions (accelerating voltage, current, irradiation dose) and waveguide characteristics (structure distortions, Ti concentration, conductivity). The features of the e-beam technique applied direct to planar optical waveguides are reported. In Ti:$LiNbO_3$ waveguides the near-quasi-phase-matching characteristics of SHG in different domain gratings were analyzed. The obtained results show that it is possible to match the conditions of e-beam irradiations to the waveguide thickness in order to optimize the domain grating depth, uniformity and waveguide quasi-phase-matching SHG. The results are promising for development of the domain engineering by e-beam technique in optical waveguides. The work was supported by the RFBR projects № 16-29-11777 ofi-m; № 16-29-14046 ofi-m.

Keywords: E-beam; Periodic Domain Structures; Diffused Planar Waveguide; Lithium Niobate; SHG Microscopy.

INVITED SPEAKERS

Id-219

Design of on Optical Device Endoral 3D Contouring

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Abstract: The task of obtaining dental impression is a complicate one and it can be very uncomfortable to the patient. It is mainly based on the insertion, inside the mouth, of a formable material which is made to adhere to the teeth and, when hardened, removed from the oral cavity. In this way a negative cast of the dental elements is obtained. This is a completely manual process, mainly based on the ability of the dentist and many errors can occur that can alter the correct shape detection of the dental elements. In this work a device to perform the 3D contouring of dental elements is designed and discussed. The device is based upon optical methods so that any direct contact with the dental elements is avoided and the discomfort is diminished. The basic principle adopted to fulfill the task is based on the fringe projection approach. A known fringe pattern is projected on the dental surface and the projected pattern is modulated by the surface itself. Demodulating the signal allows obtaining the shape of the elements. Optical fibers are used in order to keep small the dimensions of the device so that it can be introduced in the endoral environment and an innovative approach to phase hierarchical unwrapping was developed to manage area where high slopes are present.

Keywords: Fiber Optics; Fringe Projection; Hierarchical Unwrapping; 3D Contouring.

INVITED SPEAKERS

Id-222

Simltaneous Nanoscale Measurement of Physical-Chemical Properties of Soft Materials by Novel AFM-Intermodulation Technique

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Abstract: The rapidly growing research and development industry in the field of biomaterials makes it essential to understand their properties and characterize these novel materials at the nanoscale since interactions and chemical changes of cells with their environment takes place at sub-10 nm range. These novel biomaterials have applications in various medical implantations such as joint replacements, artificial ligaments and tendons, bone plates, skin repair devices and so on. We aim to explore the elastic properties of these soft materials at the nano regime of things. In this study, young's modulus of Elastin-Like-Polypeptide (ELP) has been investigated which are bioengineered for different biological applications depending on the cell type and functionality. In addition to flat ELP samples, we also investigated the 1D and 2D nanowrinkled ELP material to understand if and how does the wrinkling procedure affect the elastic properties of ELP. A novel method has been developed in order to measure the elastic property at the nanoscale which is achieved by intermodulation Atomic Force Microscopy (AFM) while driving the tip at two frequencies. This results in generation of other frequencies from which the force curve can be reconstructed to be fitted with various force models in order to extract the elastic values. A very important consideration to be made is that the handling of force curves and data processing not only depends on the surface properties of the sample but also depends on the morphology of the samples and on the tip properties.

Keywords: Nonlinear Optics.

INVITED SPEAKERS

Id-223

Growth and Optical Properties of A3B5 Nanowires Grown by Molecular Beam Epitaxy on Silicon

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Abstract: A combination of nanowires (NWs) with quantum dots (QDs) are promising building blocks for future optoelectronic devices, in particular, single-photon emitters. The most studied epitaxially grown QDs are self assembled, i.e., grown by island nucleation in the Stranski-Krastanow growth mode. The size, shape, and density of self-assembled QDs can be controlled by changing of the growth parameters such as substrate temperature, growth rate and growth time, but in the end it is a self organized strain induced process and controlling the properties of the array independently is a challenging task. QDs in nanowires have, in contrast, shown great potential as a highly controllable system. Experimentally, different heteroepitaxial systems were examined. All they were grown by molecular beam epitaxy. For AlGaAs/GaAs material systems, different growth conditions were applied, but the strategy was the same: we have used Au-assisted growth of the NWs on Si(111) substrate, firstly we grew the AlGaAs base of the NW, secondarily, the GaAs nanoinsertion with lower bandgap (typically during 5-25 s), or QD, was formed and we end the structure with the core with the same material as the base. Optically, our growth method results in the formation of GaAs QD in a AlGaAs NW having very narrow spectral linewidth (< 10 ueV), single-photon emission in the wavelength range 750 – 820 nm in dependence on the QD growth time. Additionally, we report on the synthesis of InAsP insertions in InP nanowires grown on Si(111) substrates by Au-assisted MBE. We show that the total amount of Au deposited growth and relatively low substrate temperature allows us to control the nucleation on the NW lateral surface and provide a method to embed InAsP insertions into InP shells. The resulting heterostructures demonstrate strong room-temperature photoluminescence with a peak wavelength tunable from 1.0 to 1.4 μm by adjusting the growth conditions. This work was supported by Russian Science Foundation (Project No 14-12-00393).

Keywords: Nanowires; A3B5; Silicon; MBE; Quantum Dots.

INVITED SPEAKERS

Id-226

Tunable QW Laser and LEDs Devices

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Abstract: This research demonstrates several prototype optical devices for optical communications, displays and point of care testing. All devices are made of AlGaAs based quantum well material, which is a desirable material for all-optical devices and electro-optical devices. The devices are designed as monolithic selectively intermixed QW structures emitting controlled wavelengths in the infrared spectrum. The first device is a monolithic tunable laser consists of a beam-steering section and an optical amplifier gain section. The beam steering section consists of two parallel stripe separated by a 20μm wide gap. The optical amplifier gain section consists of three adjoining regions in which the quantum well is selectively intermixed by different extents. The gain section laser beam is confined and laterally steered by applying electrical currents to the parallel contact stripes. As the current ratios change, the beam is steered over the intermixed regions to produce a tunable laser over 27nm of wavelengths. The same technique is utilized to fabricate monolithic point of care testing devices and LEDs that are capable of producing light in different wavelengths. Monolithic multi-wavelength LED devices are designed to have multiple QW intermixed regions on a single substrate. Currents are applied to each intermixed region separately to emit light; currents can also be used in combination or individually to provide the option for the operator of performing color mixing by activating two or more intermixed regions simultaneously. The fabricated devices can be designed to have a single or multiple outputs and emit wavelengths of 805 nm, 787 nm and 772 nm.

Keywords: QW; LED; IFVD; Intermixing; Tunable Lasers.

INVITED SPEAKERS

Id-228

Luminescence from SRO-Si_3N_4 Nano-layered Systems for Electrophotonic Integration

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Abstract: The research on Si-based photonics gains relevance as it becomes more evident that this is one of the most promising ways to overcome limitations of electronics. Significant improvements in light guiding and light-based processing have been reported, but in most cases the systems rely on external, hybrid, or heterogeneous light generation. This evidences that the bottleneck on fully integrated Si-photonics is the light source, due to the intrinsic inability of silicon to emit light on regular conditions. The observed Photoluminescence in Si-based nanostructured materials and systems represents one promising way of developing CMOS compatible systems with seamless integration of electronics and photonics. The integration of electronics and photonics is the goal when using these, therefore it is extremely relevant to precisely identify the light emission mechanisms taking place in them, and how the spectra are affected by the different fabrication conditions and schemes, as these will be mostly dictated by CMOS restrictions. This work reports on the fabrication and luminescence of different Silicon enriched silicon oxide (SRO) and silicon nitride bi-layered nanostructures, which are the main components of integrated light emitters obtained by fully compatible CMOS techniques and facilities. The results indicate a combination of several recombination centers and quantum phenomena as the origin of the luminescence, and significant influence of transitional regions between layers of different materials, which on their turn depend on fabrication conditions. They also provided information regarding how the final emission spectra can be modified during fabrication to obtain the best suited light for specific applications.

Keywords: SRO; Silicon; Photoluminescence; Integrated Photonics.

INVITED SPEAKERS

Id-234

Luminescent Porous Si for Nanomedicine

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Abstract: Porous silicon (pSi) microparticles were synthetized by electrochemical etching of crystalline Si wafer in HF solution followed by sonication. We obtained pSi microparticles with an average size of 1-10 μm and an average pore dimension of few tens of nm with a photoluminescence centered at about 630 nm under 350 nm excitation. The optical and structural properties are stable for years in ethanol after a surface carboxyl-functionalization. However, to exploit pSi microparticles in nanomedicine, e.g. for bioimaging and targeting drug delivery, it is fundamental to preserve their photoluminescence and to avoid their degradation in biological media. In this comprehensive study (both material characterization and in-vitro tests), we investigated two different experimental procedures: (i) organic and (ii) inorganic coating. In the first case, the pSi surface was coated with a thick organic layer (PEG and chitosan). Long-term optical stability (more than 3 months) in biological buffer (i.e. PBS – phosphate buffered saline) was demonstrated and quantum yield and lifetime were not affected by the coating. Also, the microparticles structure was not modified as confirmed by TEM images. Additionally, thanks to the organic coating it is possible to change and tune the surface charge (i.e. the ζ-potential value): pSi-PEG were negatively charged, while pSi-chitosan positively charged microparticles. Preliminary drug loading and release experiments were performed with Cbi (cobinamide) as drug test. Cbi was not modified by the interaction with the pSi microparticles and was successfully loaded into the pores. A dependence of the release rate on the surface charge was observed: slower for more negatively charged surface. The second approach was explored to overcome the problem of pore volume decrease caused by the thick organic coating. We deposited an inorganic oxide (e.g. TiO_2 due to its no intrinsic toxicity) thin layer by ALD (Atomic Layer Deposition), which allows uniformity and tuning of the deposited layer thickness. Improved optical stability was obtained with respect to organic coatings (more than 6 months) and no significant morphological modifications were observed by TEM images. We performed in-vitro test to study the effect on human dendritic cells (DCs) and we observed no toxic effect up to concentration of 100 μg/mL. The pSi-TiO_2 microparticles were still photoluminescent after being uptaken by the cells, as demonstrated by two photons microscopy. The immune response was evaluated by ELISA assays.

Keywords: Nano-photonics; Plasmonics.

INVITED SPEAKERS

Id-235

Optical Fiber Based Microstructures

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Abstract: Over the last decade a variety of optical fibers based microstructures have been developed, owing to their significant contributions in a various applications including communications, medicine and astronomy. Their purpose has been the transmission or manipulation of light relying on the chemical and physical structure of the fabricated fibers. Optical fiber based microstructures can be classified under two different technologies. First refers to those microstructures or optical devices that can fabricated based on conventional optical fibers via some tapering process, such as optical microfiber resonator and interferometer structures. While the other technology refers to the new form of microstructure optical fibers that have internal shape and light guiding properties quite different from conventional optical fibers, such as shaped double clad fibers. In this talk, the two technologies will be highlighted in terms of fabrications and applications with presenting some results of recent demonstrations. A composite directional 2x2 microfiber coupler based generation a stable dual-output C-band multiwavelength fiber laser will be presented. Further, a new technique of polishing glass preforms using a CO_2 laser in order to shape the inner cladding of the optical fiber will be also presented. Constraints and considerations as well as the advantages of such technique will be highlighted with review of some fabricated fibers.

Keywords: Microstructures Optical Fibers; Microfibers; Double-clad Optical Fibers.

INVITED SPEAKERS

Id-238

Threat Detection and Classification with Phase-OTDR Based Distributed Acoustic Sensing Systems

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Abstract: Fiber-optic distributed acoustic sensing (DAS) based on the phase-OTDR technique offers a robust and cost-effective solution for monitoring long linear assets, such as oil/gas pipelines, powerlines, railroad tracks and boundaries of medium to large size facilities. Fiber-optic DAS can use telecommunication grade fiber optic cables as both the sensing and transmission medium, making it immune to electromagnetic radiation and jamming. As these cables are typically buried underground, DAS based monitoring solutions are robust against manual tampering as well. Furthermore, unlike active sensing solutions such as day-light or IR-cameras, DAS does not require additional power lines to be deployed along the asset. Phase-OTDR (or phase sensitive OTDR) is based on precise measurement of a physical phenomenon called Rayleigh scattering that is naturally observed in fiber optic cables. In its simplest form, Rayleigh scattering can be thought of as the partial backscattering of light traveling in the fiber optic cable due to molecular level imperfections that act as micro mirrors, also known as scattering centers. Mechanical waves in proximity of a fiber optic cable can physically interact with the cable and cause small but measurable alterations in the naturally observed levels of Rayleigh scattering. By sensing and interpreting these fluctuations in the backscattered light, physical activities such as digging or walking in proximity of a buried fiber optic cable can be detected, and with proper signal processing even be classified. In this talk, we present the basics of a distributed acoustic sensing based linear asset protection system along with novel signal processing and threat classification techniques. First, we present a comprehensive signal model for a better understanding of the observed physical phenomena in the phase-OTDR based distributed acoustic sensing systems. By using this signal model, we analyze the effects of common system parameters, such as leakage light power and laser center frequency drift, on the measured signal and investigate how these parameters affect the treat detection performance. We also discuss optical signal fading from a signal processing perspective and analyze the undesired effects of fading on threat detection performance. Using a detailed phase-OTDR signal model, we analyze the effects of internal system parameters and external vibration source characteristics on optical fading.

Keywords: Phase-OTDR; Distributed Acoustic Sensing; Extinction Ratio; Fading; Threat Detection.

INVITED SPEAKERS

Id-240

Arrayed Waveguide Gratings: Design and Applications

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Abstract: Arrayed Waveguide Grating (AWG) is a passive optical component, which have found applications in a wide range of WDM systems and medical applications. Low-index contrast AWGs (Silica-on-Silicon (SoS) based waveguide devices) feature many advantages such as low fiber coupling losses and low propagation loss. They are considered an attractive DWDM solution because they represent a compact means of offering higher channel count technology, have good performance characteristics, and can be more cost-effective per channel than other methods. High-index contrast AWGs (such as silicon, silicon nitride or polymer based waveguide devices) feature much smaller waveguide size compared to low index contrast AWGs. Such compact devices can easily be implemented on-chip and have already found applications in emerging applications such as optical sensors, devices for DNA diagnostics and optical spectrometers for infrared spectroscopy. In this work, we present the design, simulation and technological verification of both, the low-index contrast and high-index contrast AWGs. We discuss their advantages and drawbacks and show some possible applications. This work was carried out in the framework of the project COHESION, no. 848588, funded by the Austrian Research Promotion Agency (FFG); the projects PHOCOP (no. SK-AT-2017-0013) and NAMOPRISIN (no. SK-AT-2017-0005) from Slovak research and development agency of Ministry of Education, Science, Research and Sport of the Slovak Republic and SK 16/2018 and 15/2018 from OeAD-GmbH.

Keywords: Arrayed Waveguide Gratings; AWG; AWG Design; Silicon Nitride Waveguides; Medicinal Applications.

INVITED SPEAKERS

Id-249

Photonic Integrated Crcuits for Application in Telecommunication and Sensing Networks

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Abstract: Photonic integrated circuits (PICs) are considered one of the most attractive and promising solutions for modern optoelectronics, with the potential impact on the market similar to integrated electronics revolution. From two major technology platforms, based either on silicon or indium phosphide, the latter is much more attractive due to the possibility of realizing monolithically integrated laser light sources, amplifiers, modulators and detectors operating in the third telecom window. Nowadays two European InP foundries, SMART Photonics and Heinrich Hertz Institute, offer access to their generic platforms by means of organizing multi-project wafer runs, which provides an efficient and cost-optimized way of prototyping novel photonic devices. This offer is complemented by support in desinging and optimizing PIC-based solutios, provided presently by several European design houses, one of which is Eastern Europe Design Hub (EEDH) at Institute of Microelectronics and Optoelectronics of Warsaw University of Technology, Poland. In this work we demonstrate the capabilities of the InP technology with respect to applications in optical communication networks and optical sensing systems, which are at present the main drivers of integrated photonics market growth. To showcase the concept of photonic integration and demonstrate its potential we discuss selected examples of photonic integrated circuits - multichannel transmitters and receivers, interrogators of a fiber Bragg gratings based sensors, optical gyroscope systems and others. We present and discuss also the concept of hybrid integration of PICs with integrated electronic circuits. All presented and discussed circuits were designed by EEDH research team and realized using InP-based generic integration technology. This work was supported by the National Centre for Research and Development (project NIPPON grant agreement PBS3/A3/21/2015 and project OPTO-SPARE, grant agreement PBS3/B9/41/2015) and from the EU Horizon 2020 research and innovation programme under grant agreement No. 687777 (PICs4All).

Keywords: Photonic Integration; Indium Phosphide; Generic Integration Technology; Photonic Integrated Circuit, Fiber-optic Communication Systems.

INVITED SPEAKERS

Id-257

MBE Growth and Properties of III-V and Nitride Nanowires on Hybrid SiC/Si Substrates

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Abstract: The wide-gap nanoheterostructures based on GaN are of great interest for creating electronic and optoelectronic devices. Works in growing GaN layers on silicon have been very promising recently. However, the lattice misfit of such materials is 17%, which leads to the formation of defects of different nature. It is known that the optoelectronic GaN based devices can operate for a long time without degrading despite the high density linear defects. Nevertheless, to extend the lifetime of optoelectronic devices is necessary to increase the perfection of GaN structures. In this work, in order to reduce the number of dislocations a nanometer (about 50 nm) buffer layer of SiC was used. It is grown on Si by solid-phase epitaxy, which provides extremely low values of the density of misfit dislocations. Since the difference in the lattice parameters between GaN and SiC is only 3%, and also, instead of a planar layer, growth GaN nanowires (NWs), we can count on a radically reduce the density of structural defects in GaN. Growth experiments were carried out using Riber Compact12 MBE setup equipped with the effusion Ga cell and the nitrogen source. Growth time of GaN NWs was 16 hours. After the growth samples were studied by scanning electron microscopy (SEM) and low-temperature photoluminescence (PL) techniques. Comparison of photoluminescence spectra of grown GaN on hybrid and the most successful GaN NWs structures on silicon shows that the intensity of radiation from grown on SiC buffer layer GaN NWs is more than two times higher than the intensity from the best GaN structures on silicon. This fact leads to the conclusion that grown structures have fewer defects compared with GaN NWs on silicon substrate. This is caused by a smaller lattice constant mismatch between GaN and SiC compared with GaN and Si. Besides we have discovered a novel mechanism that allows Si to be incorporated into GaN NWs beyond the solubility limitThe work was financially supported by the Ministry of Education and Science of the Russian Federation under State assignment no. 16.24834.2017/4.6).

Keywords: Nanowires; MBE; Photolumenesence; Nanostructures.

INVITED SPEAKERS

Id-259

Application of Optical Fiber-grating Sensors for Air-leaks Independent Triggering in Non-invasive Mechanical Ventilation

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Abstract: In this talk, I shall present our recent results on applications of optical fibre gratings in medicine, in particular in pulmonology, cardiology and obstetrics, with a special emphasis on the former. Noninvasive mechanical ventilation is one of the most commonly applied techniques in the treatment of patients who cannot match the level of respiratory effort required to maintain a proper breathing cycle. Critical to successful ventilation are patient-ventilator synchronization and the volume of air provided to the patient. The mechanical ventilators involved are usually equipped with a facemask and a pneumatic (flow, pressure or volume) sensor detecting patient's own respiratory effort in order to assist spontaneous breathing. Unfortunately, non-optimal patient-ventilator interaction is common due to air leaks around mask. In an attempt to improve patient-ventilator interaction, we have developed a new method based on the measurement of chest-wall movement. The proposed solution uses a single long-period fibre grating sensor attached to patient's thorax and a simple and cost-effective monochromatic measurement scheme. On a set of healthy volunteers, we established the linear correlation between the change in curvature of the chest-wall during breathing and the volume of inhaled and exhaled air. In a separate clinical study, we demonstrated that chest-wall movement signal consistently advances airflow signal by 230±100ms, thus indicating that the proposed measurement technique may lead to a more confident triggering decision. We have further explored applications of the full dynamic range of an LPG sensor to noninvasive detection of cardiovascular pulsations and fetal movement in uterus, as well as distinction of all three signals measured by the same sensor simultaneously. The encouraging results perpetuate the future work on a multi-parameter single-sensor interrogation scheme without compromising its non-invasiveness, simplicity and low-cost.

Keywords: Fiber Grating Sensors; Mechanical Ventilation; Triggering.

INVITED SPEAKERS

Id-262

Bloch Surface Waves on One Dimensional Photonic Crystals: Fundamentals and Applications

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Abstract: Photonic crystals have been extensively studied because they enable a certain degree of control over light propagation. By exploiting interference phenomena occurring scale it is possible to confine the electromagnetic field at the surface of a truncated one-dimensional photonic crystal (1DPC), thus enabling the existence of surface electromagnetic modes also called Bloch Surface Waves (BSW). Similarly to Surface Plasmon Polaritons on metallic thin films, BSW can be reflected, refracted or diffracted by surface patterns, with the intrinsic advantage of much smaller losses. In this talk, I will overview recent advances about the interaction of spontaneous emitters with Bloch Surface Waves and present examples of related applications. More in detail, I will show that fluorescence coupled to BSW can be guided on the surface of 1DPC or beamed out of the surface along arbitrary directions, thus providing a versatile platform for sensing applications where an enhanced fluorescence signal is required.

Keywords: Bloch Surface Waves; Photonic Crystals; Sensing.

INVITED SPEAKERS

Id-264

Investigation of the Optical Properties of GeSn QWs for Laser Applications

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Abstract: The Si-based electronics industry has driven the digital revolution for unprecedented success. As a result, there have been tremendous efforts to broaden the reach of Si technology to build integrated photonics. Although great success has been made on Si-based waveguides, modulators, and photodetectors, a monolithic integrated light source on Si with high efficiency and reliability remains missing and is seen as the most challenging task to form a complete set of Si photonic components. A Si-based monolithic laser is strongly desired for the full integration of Si-photonics. Lasing from the direct bandgap group-IV GeSn alloy has opened a new avenue, different from the hybrid III−V-on-Si integration approach. We demonstrated optically pumped GeSn lasers on Si with broad wavelength coverage from 2 to 3 μm with Sn composition from 8% to 22.3%. The GeSn alloys were grown using newly developed approaches with an industry standard chemical vapor deposition reactor and low-cost commercially available precursors. The highest lasing temperature was measured at 180 K with the active layer thickness as thin as 260 nm. The unprecedented lasing performance is mainly due to the unique growth approaches, which offer high-quality epitaxial materials. Optically pumped GeSn lasers results lead to developing GeSn Quantum wells lasers that can operate at RT and lower threshold. Optical properties of GeSn QWs were investigated from 10 K to 300 K. A direct bandgap QW of GeSn was achieved with Sn composition 14%.

Keywords: GeSn; Lasers; PL; QWs.

INVITED SPEAKERS

Id-268

Advanced Optical Component Manufacturing Using CO_2 Laser Light

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Abstract: The use of CO_2 lasers in conjunction with advanced optics in a vertical configuration represents a paradigm shift in the fiber processing industry. Due to the short absorption length of 10,6 µm light in glass, a very localized heating in the component can be achieved. By controlling the shape and angle of the light higher quality and novel fiber components can be manufactured, opening up new opportunities.
Keywords: CO_2; Laser; Optical Fiber Processing.

INVITED SPEAKERS

Id-270

Unprecedented Effects of Aggregation on the Photoluminescence of Small Gold Clusters

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Abstract: Aggregation-induced optical responses are ubiquitously found for a variety of organic and inorganic compounds. Examples include the shifts of plasmon resonances and the enhancement (AIE, AIEE) / quenching (ACQ) of photoluminescence (PL) emissions. Here we report an unprecedented effect of aggregation on the photoluminescence (PL) of small gold clusters protected by octagold clusters, which display notable red shifts of the PL emissions upon aggregation as a result of switching the dominant radiative mode. Ligand-coordinated small gold cluster compounds with defined compositions and structures have currently attracted considerable attention because of the unique optical/electronic properties associated with their molecule-like features. During our efforts to explore novel gold clusters using diphosphine ligands, we have found several clusters with unique geometric structures and optical properties, and shown that some of them exhibit unique photoluminescence activities. The cluster we used here has a core+exo-type octagold framework comprising a bitetrahedral Au_6 core with two additional gold atoms, which is ligated by four 1,3-bis(diphenylphosphino)propane (dppp) ligands and two anionic chloride or acetylide ligands (L) ($[Au_8(dppp)_4L_2]^{2+}$). In good solvents in which cluster molecules exhibited a visible emission at ~600 nm, but upon aggregation in poor solvents they displayed a new emission at ~700 nm with the original emission at ~600 nm retained. Lifetime measurements revealed that the PL emissions at ~600 and ~700 nm had fluorescence and phosphorescence characters, respectively. Studies coupled with the PL excitation spectra demonstrate that the phosphorescence-type emission is originated from exciton-coupled cluster assemblies, which have exceptionally high emission activity. Accordingly, in the solid states, the clusters exhibited solely phosphorescence-type emissions, whose quantum efficiencies were higher by two orders of magnitude than those of the corresponding monomeric forms in solution. This work provides the first example of the critical perturbation effects of cluster aggregation on their optical properties, which may be used in the design of cluster-based materials with unique functions and properties.

Keywords: Photoluminescence; Aggregation; Gold; Cluster.

INVITED SPEAKERS

Id-271

Arrays of Resonant Nanopillars as Multiplexed Optical Transducers for High Sensitivity Biosensing

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Abstract: Resonant nanopillars (R-NPs) are now used as optical transducers in label-free biosensors. They are composed of pairs of Bragg reflectors of silicon nitride and silicon oxide (Si_3N_4/SiO_2) and a central cavity of silicon oxide (SiO_2) arranged on a quartz substrate. A resonant nanopillar has an optical response consisting of a spectral band gap that prevents the light transmission (photonic gap) except in a specific range of the band, where the light is transmitted (resonance), due to the central cavity. The light is guided by each R-NP, and due to their nanometric character, part of the light travels outside of the nanopillar, observing thus, what is on the surface. R-NPs, being grouped in cells or arrays arranged in different zones of the same chip, once immobilized with the bioreceptor, are called BICELLs (Bio Photonic Sensing Cells). This distribution, gives R-NPs the possibility of being used as sensors with high multiplexing capacity, to be able to detect different biomolecules in the same chip. In fact we have demonstrated that the R-NPs have a good performance to detect the immobilization of the bioreceptors and the subsequent specific recognition of the analyte in real-time and in fluidic conditions, or in discrete measurements in dry conditions where they have revealed a sensitivity one order of magnitude higher than in fluidic conditions. In addition other materials to fabricate R-NPs are being studied so as to increase the sensitivity of the transducer and thus, improve the Limit of Detection of the biosensor. R-NPs have shown performances in the range of those from other transducers such as photonic crystals or slot waveguide resonators. Moreover their easy vertical optical interrogation and low cost bring them closer, to the long-awaited real Poin of Care Systems.

Keywords: Optical Biosensor; Multiplexed; Optical Interrogation; Label-free.

INVITED SPEAKERS

Id-272

Visible Light Communication Based Vehicular Communications

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Abstract: Autonomous vehicle platoon is an enhancement of autonomous behavior, where vehicles are organized into groups of close proximity through wireless communication. Platoon members mostly communicate with each other via the current dominant vehicular radio frequency (RF) technology, IEEE 802.11p. However, this technology leads security vulnerabilities under various attacks from adversaries. Visible Light Communication (VLC) has the potential to alleviate these vulnerabilities by exploiting the directivity and impermeability of light. Utilizing only VLC in vehicle platoon, on the other hand, may degrade platoon stability since VLC is sensitive to environmental effects. We analyse VLC channel characteristics in vehicular environment and propose an IEEE 802.11p and VLC based hybrid security protocol for platoon communication.

Keywords: Visible Light Communication; Vehicular Communications.

INVITED SPEAKERS

Id-273

Nonlinear Optical Conductivities in the Independent Electron Approximation

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Abstract: Optical nonlinearities play a central role in many optical devices and applications. The description of these nonlinearities is often provided by the framework of nonlinear conductivities (susceptibilities), with their different frequency components describing different effects. A method of computing these conductivies for crystals was provided in the early nineties, within the density matrix formalism. This perturbative treatment can be implemented in various ways, depending on the gauge choice that is used to define the perturbation. The subtle issue of the equivalence and implementation of the two more commonly adopted gauge choices, length and velocity gauge, has only recently been clarified. In this talk, these formal developments will be adressed, with a discussion of how and when to use each gauge.

Keywords: Nonlinear Conductivity; Density Matrix; Graphene.

INVITED SPEAKERS

Id-274

Chiral Quantum Dots

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Abstract: Chirality is one of the most fascinating occurrences in the natural world which plays an important role in chemistry, biology and materials science. In the past decade it has been shown that quantum dots (QDs), fluorescent semiconductor nanoparticles (NPs) with unique optical properties, can demonstrate chirality due to chiral ligands bound on their surface. These chiral fluorescent NPs could find potential applications in biomedical research, therapy and diagnostics. Consequently, it is very important to investigate the interaction of chiral NPs with living cells. The main aim of our work is to develop new chiral QD based materials of different shapes and investigate their in vitro biological behaviour. It was found that QDs stabilised with opposite ligand enantiomers, had identical PL and UV-Vis spectra and mirror imaged CD spectra, but displayed different biological activity. Further research on the investigation of biological properties of chiral nanomaterials is in progress.

Keywords: Quantum Dots; Chirality; Chiral Qouantum Dots; Nanomaterials.

INVITED SPEAKERS

Id-

Photonic Integrated Circuit Based on Silicon-on-Insulator

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Abstract: Small footprint photonic integrated interferometer based on silicon-on-insulator platform is reported. A passive interferometer comprising small footprint 4 × 4 and 2 × 2 multi-mode interference (MMI) couplers is designed and tested. An efficient use of the small design area is accomplished by positioning the input and output ports of the passive interferometer along the same side of the chip with a separation of 127μm between each other (pitch size). A passive-active interferometer terminated with Ge photodiodes has also been designed and tested.

Keywords: Photonic Integrated Circuit.

REGULAR SESSIONS

Id-043

Optical Sensing in Biological Tissue Based on Resonant Microcavities

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Abstract: In this paper, we present a new technique that allows mapping the refractive index of an organic tissue and detection of local temperature variations through immunofluorescent techniques. Here, mice brain slices stained against Tyrosine Hidroxylase (TH) enzyme and revealed with a Cy2 immunofluorescent secondary antibody were introduced in a Fabry-Perot (FP) microcavity, acting as a photonic structure. To prevent a quick degradation of the sample a drop of glycerol was added to the tissue. This cavity is formed by two parallel fused silica plates covered with dichroic Bragg Reflectors (BR) with a separation of 60 microns. The BRs were obtained by a multilayer deposition of Nb_2O_5/SiO_2 thin films. They were designed to reach high reflection in the green region, while showing great transparency in the blue or in the infrared (IR) spectral, facilitating the use of organic dyes that tent to show green emission. In a first test, coronal Cy2 immunofluorescent brain tissue slices were excited outside of the cavity with a 473 nm laser and a broad band corresponding to the Cy2 emission was observed. When the tissue was introduced in the FP microcavity, a drastic change in the emission was observed as the broad Cy2 band started showing a series of superimposed narrow peaks. These peaks correspond to the FP cavity modes, which resonate in the direction perpendicular to the cavity surface. This phenomenon was observed for brain tissue slices with thickness lower than 100 µm, as for 100 µm and greater thickness the light was not capable of resonate between the BR. Different thickness from 100 µm to 75 µm where tested. This research was supported by Spanish Ministry of Economy and Competitiveness (Agencia Estatal deInvestigación, AEI) and EU-FEDER, (MAT2016-79866-R), (MAT2016-75586-C4-4-P).

Keywords: Optical Sensing; Resonant Microcavities.

REGULAR SESSIONS

Id-046

Optical Response and Luminescence Properties of Sm^{3+}-doped Sodium-Fluoro-Phosphate Glasses for Reddish-Orange Lighting Applications

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Abstract: Sodium fluoro-phosphate (NNS) glasses doped with different concentrations of Sm^{3+} ions have been prepared using conventional melt quenching technique and characterised for their lasing potentialities using spectroscopic techniques such as optical absorption, emission and emission decay measurements. Absorption spectrum from near infrared to visible was obtained and the Judd–Ofelt (J-O) intensity parameters (Ω_2, Ω_4, and Ω_6) were determined. Spontaneous emission probabilities of some relevant transitions, branching ratio, and radiative lifetimes of several excited states of Sm^{3+} have been predicted using intensity J-O parameters. The luminescence intensity decreases with the increase in Sm^{3+} ion concentration beyond 0.5 mol.% and the same was discussed through various energy transfer mechanism which takes place between Sm^{3+} ions. The lasing parameters like peak stimulated emission cross-section (σ_e^p), branching ratios (β_R), measured branching ratios (β_{exp}) and radiative lifetime (τ_{rad}) for the excited $^4G_{5/2}$ luminescent level have been calculated, discussed and reported. The measured lifetime (τ_{meas}) of the $^4G_{5/2}$ excited level is found to be single exponential up to 0.5 mol.% and after that it changes into non-exponential for higher concentration and the non-exponential behavior arises due to the energy transfer between the Sm^{3+} ions through various cross-relaxation channels. The CIE color chromaticity coordinates have also been calculated to characterize the emission of the prepared glasses. From the emission characteristic parameters of $^4G_{5/2}$ level, it is concluded that the NNS glasses could be useful for photonic devices like visible lasers, fluorescent display devices and optical amplifiers.

Keywords: Sm^{3+} Ion; Sodium Fluoro-Phosphate Glass; Absorption; Judd–Ofelt Analysis; Fluorescence Properties.

REGULAR SESSIONS

Id-068

Ultrafast All-Optical Feed-Forward Delay Line Buffer Based on Two-Photon Absorption and the Quadratic Stark Effect in an Unbiased SOA

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Abstract: In this work, we have inserted, into an unbiased multi-quantum well semiconductor optical amplifier (SOA), a powerful control beam with photon energy slightly smaller than that of the band-gap of its active region. As the SOA was unbiased, the refractive index of its active region was the highest possible and the control beam was strongly confined inside the small cross section of the amplifier waveguide core, which generated a high optical intensity. These circumstances allowed that the two-photon absorption (TPA) and the quadratic Stark effect (QSE) were excited and experimentally observed. At the same time, the heavy-hole 1s excitonic resonance, of the semiconductor of the waveguide core, was bleached and blue shifted by the control beam photons. It is worth mentioning that the lack of biasing in the SOA prevented that effects such as the screening of the Coulomb interaction by an e-h plasma, the bandfilling and the Burstein-Moss could reduce the number of possible nonionized exciton states and mask the QSE. For the available SOA, the modification of the heavy-hole 1s excitonic resonance, the TPA and the QSE induced an appreciable birefringence inside the amplifier waveguide, which significantly modified the polarization-state of a probe beam. Based on these effects, we have experimentally demonstrated the operation of an all-optical feed-forward delay line buffer using an unbiased SOA. Specifically, the buffer operation was successfully demonstrated with a data packet synthesized from an 80 Gb/s optical pulse comb gated with a 5 Gb/s nonreturn-to-zero sequence. Since the employed SOA was not electrically powered, amplified spontaneous emission was not generated and there were not current-injected carriers that could distort the pulses of the packet payload (pattern effect free). Particularly, it was found that an error-free operation at power penalties below 1 and 1.5 dB can be achieved with an extinction rate of about 13 dB for the buffer configured to not delay and to delay the packet payload, respectively. The buffer was able to isolate and to delay, about 729 ns, the packet payload from the header, which was separated from it by 20 ns.

Keywords: All Optical Buffers; Quadratic Stark Effect; Semiconductor Optical Amplifiers; Two-photon Absorption.

REGULAR SESSIONS

Id-097

Room Temperature Sol-gel Strategy for Fabrication of High Performance Metal-oxide Thin Films as ETL in Flexible Planar Heterojunction Perovskite Solar Cells

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Abstract: Flexible perovskite solar cells have drawn broad interests in optics and photonics society, owing to their great performance and facile adaption with abundant materials and cost-effective process, such as solution deposition. In a typical perovskite SC the active layer, an organo-metal lead halide component, harvests the light full range spectra and generates photoactive split hole-electron pairs, which are conducted to the opposite electrodes, using n and p-type carrier transporting layers. According to these mechanism a generic perovskite solar device should have a tandem architecture, which accommodates various materials in each compartment, and adopts either a n-i-p or a p-i-n alignment. So far, the n-i-p platforms employing a mesoporous or a compact metal oxide thin film as n-junction, have been certified as the most efficient (up to 22% power conversion efficiency) PSCs. However, to prepare a uniform and highly functional metal oxide thin film requires sever manufacturing conditions, i.e solution processing followed by a high-temperature annealing, chemical vapor deposition in a high temperature gas medium and atomic layer deposition in vacuum atmosphere. All these cases obviously impose excessive costs to the technology and more importantly hamper the roll-to-roll and up-scale manufacturing of flexible and wearable devices on plastics, papers and textiles. It is therefore of paramount importance to design and develop a low temperature and low-cost strategy, enabling preparation of high-quality metal oxides, with compelling electrical and optical properties, on polymers (polyethylene terephthalate: PET/ poly(ethylene 2,6-naphthalate: PEN) or textiles. Authors introduce a low temperature, cost-effective and highly reproducible technology, so-called ultrasonic assisted sol-spinning. A short-time vibration on an ultrasonic transducer (at 40 kHz/ 10 W), followed by UV-treatment, allows evenly deposition of a compact, pin-hole free, highly conductive and transparent metal-oxide layer on PET, without thermal annealing. While, a conventional sol-gel process requires a post-heating process at 200-800°C.

Keywords: Sol-gel; Solution Processing; Thin Film; Metal Oxide.

REGULAR SESSIONS

Id-103

Detection of Extended Spectrum β Lactamases Enzymes Producing Bacteria Escherichia Coli Using Infrared Microscopy in Tandem with Machine Learning Algorithms

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Abstract: The spreading of multidrug resistant bacteria has become as a global concern. One of the most important and emergency multidrug resistance bacteria is the extended spectrum β lactamases (ESBL+) producing bacteria. Due to wide spread and constant evolution of ESBL−producing bacteria, they become increasingly resistant to most of commonly used antibiotics, leading to an increase in the mortality associated with their infections. Fast detection of ESBL producing bacteria and their susceptibility to appropriate antibiotics can certainly reduce the spread of these bacteria and their consequent complications. Routinely methods for the detection of ESBL−producing bacteria are time consuming and need at least 48 hours to obtain the results. In this study we evaluated the potential of infrared microscopy, combined with multivariate analysis for rapid detection of ESBL−producing bacteria Escherichia coli (E. coli) isolated from urine tract infection (UTI) samples. Our results were conducted on 874 samples of Uropathogenic E.coli UPEC including 277 ESBL+ and 597 ESBL− samples. All samples were obtained from bacterial colonies after 24 h culture from midstream patients' urine. Our results revealed that it was possible to detect ESBL- producing bacteria, with success rates as high as 80% for the tested samples in time span of few minutes after the first culture.

Keywords: EBSL; E. coli; FTIR; Susceptibility; UPEC.

REGULAR SESSIONS

Id-149

Comparative Evaluation of Depth of Penetration of Root Canal Irrigant After Using Manual, Passive Ultra-sonic and Diode Laser Assisted Irrigant Activation Technique

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Abstract: Reduction of microbial load and prevention of re-infection are ultimate goals in root canal treatment. There are evidences of microbial colonies even after thorough chemo-mechanical debridement. Therefore irrigant activation within well shaped canal plays a critical role in disinfecting the root canal system. To compare and to evaluate the depth of penetration of irrigant after using manual, passive ultra-sonic and Diode laser assisted irrigant activation technique. Thirty three single rooted human mandibular premolars are selected [n=33]. Teeth are decoronated and working length is standardized for 12mm. Root canals are shaped till Protaper Universal F3. Saline is used as irrigant in between every successful instrumentation. After completion of chemo-mechanical preparation, root canals are filled with Rhodamine B labeled Sodium hypochlorite [5.25%]. Teeth samples are divided into 3 experimental groups. Group – 1 [n=11], Manual irrigant activation is done for 30 seconds with 15 size K-file in gentle up and down motion. Group – 2 [n=11], Ultra-sonic irrigant activation done using passive ultra-sonic endo tips for 30 seconds. Group – 3 [n=11], Laser activation done using Diode laser for 30 seconds with 200 micron tips. Transverse sections are made at 2mm, 5mm and 8mm from the root apex and observed under Confocal Laser Scanning Microscopy. Maximum depth of penetration of irrigant are recorded and statistically analyzed.

Keywords: Irrigant Astivation; Passive Ultra-sonics; Diode Laser; Rhodamine B Labeled Sodium Hypochlorite; Confocal Laser Scanning Microscopy.

REGULAR SESSIONS

Id-200

Optical-Microresonator- Array-Sensor (OMAS)

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Abstract: Geometrical optics is used to discuss the essential properties of spherical optical microresonators. Resonators with a surface layer are included in the presentation. The different modes of a spherical resonator with a surface layer are identified and the resonance conditions for the different modes are formulated. The properties of the modes are discusses with respect to sensor applications. The concept of an array of resonators in place of a single resonator is presented. It is shown that with this concept no tunable laser is necessary. The array is illuminated by a fixed narrow band laser beam with affixes frequency. The experimental realization of this concept is demonstrated and some practical applications are shown.

Keywords: Sensor; Microresonator; Sensor Array; Geometrical Optics.

REGULAR SESSIONS

Id-229

The Results of WFG FS-Lasik Procedure in Treatment of Myopia and Myopic Astigmatism

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Abstract: To present the results of wavefront guided femtosecond-assisted laser in situ keratomileusis (WFG FS-LASIK) procedure in treatment of myopia and myopic astigmatism. One hundred seventy four eyes of 87 patients with myopia and/or myopic astigmatism who had undergone WFG FS-LASIK procedure are examined retrospectively. Postoperative spherical, cylinderical and spherical equivalent values were significantly lower than those of preoperative values (P=0.000) and postoperative uncorrected distance visual acuity (UDVA) and corrected distance visual acuity (CDVA) levels were significantly greater than those of preoperative values (P=0.000). WFG FS-LASIK is an efficient, safe and predictable procedure for correction of myopia and myopic astigmatism.

Keywords: WFG FS-LASIK; Spherical Value; Cylenderical Value; Visual Acuity.

POSTER SESSIONS

Id-025

Gold Nanoparticles Supported on Two Different Metal Oxides to Form Ferromagnetic Nanostructures

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Abstract: Nano-sized materials have particularly attracted attention due to their optical, electrical, magnetic and thermal properties that differ substantially from those of the corresponding solid material. In This work, we study gold nanoparticles supported on titanium oxide and cerium oxide, prepared by impregnation with ionic exchange. In the first stage, the conditions of fixing of the gold precursor on the oxide support are optimized. In the second stage, the samples are calcined at various temperatures (T=250, 350, 500°C). Several experimental techniques are used for the characterization of the samples at the various stages of their elaboration (MEB, DRX, FTIR).A change of morphology of the oxides supports grains was observed by Scanning Electron Microscope. The X-rays diffraction made it possible to evidence the formations of nanoparticles of gold sized 3 nm in the case of catalysts Au/TiO_2 calcined at 250°C, and the formation of nanoparticles $Au_{51}Ce_{14}$ of near size 7 nm in the case of Au/CeO_2 calcined at 250°C. At superior temperature,its size increases following the phenomenon of coalescence. The spectrometry FTIR allowed to observe peaks of vibration of links Ti-O, Ti-OH, Ti-O-Ti, Ce-O,and Au-O.

Keywords: Optical Properties; Ferromagnetic Nanostructures; Ionic Exchange; Calcination.

POSTER SESSIONS

Id-026

Numerical Simulation of A High Responsivity Ultraviolet Photodetector

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Abstract: Ultraviolet photodetectors (UV PDs) are important devices that can be used in various scientific, commercial and military applications. In this work, a numerical simulation study of nitride-based "p^+-n-n^+" front illuminated UV PD, designed with an aluminum composition achieving a true solar blindness, has been reported using the commercially available Atlas package from Silvaco international. It has been found that the proposed structure is sensitive to the UV rays in the wavelength range investigated (0.155 µm-0.37 µm), where the spectral response reaches its maximum of 0.156 AW^{-1} then declines sharply with a good performance of solar-blind at 0.31 µm, room temperature and zero-bias voltage. Furthermore, it was also found by simulating the evolution of the current density according to different wavelengths of the incident radiation that the designed structure is able to act as a wavelength selector device.

Keywords: AlGaN, Ultraviolet, Solar blind, Photodetector, Spectral response.

POSTER SESSIONS

Id-047

First-principles Investigation on Structural, Electronic and Optical Properties of Amorphous Silica with Interstitial Defects

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Abstract: The structural, electronic and optical properties of an amorphous SiO_2 (a-SiO_2) model were investigated by using first-principles calculation. Previous theoretical works used several SiO_2 crystalline approximation structure as a reference to model amorphous silica structure. However only electronic properties, without the optical properties, were presented. Here, both the electronic and optical properties, which matched closely to the real vitreous a-SiO_2 properties have been successfully generated. Using the Rietveld refinement method, small sample of amorphous quartz glass was generated and optimized using density functional theory by CASTEP computer code. The structure of generated amorphous silica was validated with previous theoretical and experimental works. It demonstrates that the calculated structural, electronic and optical properties of small sample of a-SiO_2 have similar properties with a larger sample as well as match closely to previous works from others. The interstitial oxygen-excess defect structure traps electrons in the localized state of a-SiO2 glass. The electron trapping in defect energy level reduces as more number of excess oxygen atoms were accumulated in the a-SiO2 glass structure. An experimental investigation using 388-nm wavelength laser source launched into a-silica glass demonstrates the presence of the defect states. The 3.27 eV defect-state energy level complements with the theoretical calculations, which gives a better insight to describe the mechanism of defect states formation. Light emission from an un-doped glass will be highly sought-after, where tailoring specific defect-state energy level provides the possibility for wavelength selectibilty for any particular applications.

Keywords: Amorphous Silica; Glass; Density Functional Theory; CASTEP.

POSTER SESSIONS

Id-069

The Synthesis and Optical Properties of Red Functional Dyes for Inkjet Printing Process

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Abstract: The researches on inkjet printing method are active nowadays, thanks to the full development of digital printing technology. A variety of photonic materials were formulated as functional inks used for the inkjet printing process. The inkjet printing process can be applied for digital textile printing or organic light-emitting device fabrication. However, all these approaches use pigments, therefore, they have the limitation of solubility. On the other hand, dye-based functional inks can have higher transmittance and contrast ratio due to lower light scattering since dyes can be dissolved in a media and exist in molecular phase. In this study, we designed and synthesized five water-soluble red functional dyes that have superior optical properties. Some of them exhibited very high color strength and color purity. We also found the suitable ink formulation recipes in order to apply the synthesized dyes for high-speed ink-jet printing process. The five red dyes were modified from perylene precursors, respectively. The perylene dyes have high tinctorial strength and superior light / heat stability. In order to improve the low water solubility of perylene dyes, sulfonic acid groups were introduced at the bay positions of perylene moiety. In addition, the different functional groups were introduced at the bay or terminal positions of the perylene moiety for improving the light fastness and the optical properties of the dyes. The molecular properties of the prepared dyes were analyzed and the ink-jet printing process was conducted after appropriate ink formulation.

Keywords: Dye; Inkjet Printing; Optical Property; Synthesis.

POSTER SESSIONS

Id-085

Hybrid Thulium-doped and Thulium/Holmium-doped Fiber Laser Cavity for Generation of Dual-wavelength Two-micron Lasers

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Abstract: A dual-emission laser operating in the two-micron region is successfully demonstrated using a simple hybrid Thulium-doped Fiber and Thulium/Holmium-doped fiber (TDF-THDF) laser configuration. The cavity is composed of two gain fibers to eliminate the limit by the homogenous gain broadening of a single rare-earth-doped optical gain medium. The TDF-THDF laser output peaks at 1877.2 nm (peak 1) and at 1982.8 nm (peak 2) which also maintains its respective wavelength lines with no observable mode-hopping while running within a one-hour long operation. Its output power also maintains an average output power of 1.06 mW with less than 0.02 mW drift. By incorporating a Mach-Zehnder filter on the THDF part of the cavity, the wavelength of laser peak 2 can be tuned up to 40 nm. The combination of the TDF and THDF is supported by a circulator which also acts to rectify the lasing direction. The laser configuration has the potential to be used a dual wavelength laser source for applications such as sensing and LiDAR.

Keywords: Thulium-doped Fiber; Thulium/Holmium-doped Fiber; Two-micron Laser; Dual-wavelength.

POSTER SESSIONS

Id-107

Porous Silicon Nanoparticle Produced Laser Ablation Method for Biomedical Applications

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Abstract: Nowadays, porous silicon nanoparticles (SiNPs) are receiving growing attention in biomedical researchers. Due to biocompatibility and biodegradability properties, SiNPs could be used for delivery of therapeutic agents. SiNPs are also used for drug delivery, biosafety and therapeutic applications. Characteristic and high-pure nanoparticles are used for the applications. Therefore, needs to new production techniques such as laser ablation for the applications. In this study, the porous silicon was formed by anodic etching of silicon in aqueous HF solution. Porous silicon nanoparticles (SiNPs) were also produced by pulsed laser ablation method in various liquids such as ethyl alcohol, acetone and distilled water. The SiNPs were analyzed and characterized by UV-VIS spectrometer and Atomic Force Microscope (AFM).

Keywords: Porous Silicon Nanoparticles; Laser Ablation.

POSTER SESSIONS

Id-123

Plasmonic Effects of Silver Nanoparticles Embedded in Low-Loss Optical Surrounding Media

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Abstract: In this work, we consider the photovoltaic properties of a sol-gel fabricated composite material based on the AZO (ZnO:Al) matrix with embedded silver nanoparticles (AgNPs). The photoconductivity enhancement in the UV region is found for the composite material in comparison to pure AZO films; the photoconductivity in the visible region with the increase in near-IR is also observed. To explain experimental results we discuss two mechanisms of photocurrent generation: (i) the generation of hot electrons assisted by plasmon oscillations in AgNPs and (ii) local electromagnetic field enhancement upon excitation of localized plasmon resonance. The comparison of the simulation (COMSOL Multiphysics) results with experimental data allows developing a model indicating that the observed localized plasmon resonance in the near-IR region is caused by the core-shell AgNP/AZO structure. The excitation of plasmon resonance leads to a lowering of the Schottky barrier height at AgNP/AZO interface to 1.2 eV. The analysis of the dependencies for dark current and photocurrent through the composite material on temperature gives the activation energies 0.2 eV and 0.4 eV. The difference in the values of activation energies indicates the existence of two conduction channels: the first is associated with the electrons transition from the doping level; the second is due to the overcome of Schottky barrier. Thus, the investigated composite material demonstrates an effective transformation of radiation into photocurrent in UV, visible and the near-IR regions that is promising for transparent photovoltaics. We acknowledge the support from RF Target Program 2017-14-576-0003, agreement № 14.575.21.0127, ID RFMEFI57517X0127.

Keywords: AZO (ZnO:Al); Silver Nanoparticles (AgNP); Composite Material; Photoconductivity; Plasmon Resonance.

POSTER SESSIONS

Id-124

Defining the Local Matter and the Non-Local Field Using the Planck Distribution

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Abstract: Planck's equation of thermal radiation once solved an important problem and has since served as an inspiration for many new ideas when applied in various specific contexts. Here, Planck's equation is re-written in a form that provides information specifically about the interplay between radiating matter and the electromagnetic field. Terms that are either relevant to the local momentum transfer in the matter or to the field are identified. The emission from the matter and the absorption from the field turned local constitute two mutually exclusive events whose probabilities are complementary. Recognizing that the momentum transfer is one-dimensional leads to the identification of perpendicular axes that are non-local from the particle's point of view. These harbor the field. A geometrical construct obtained by Lorentz-transforming the inverse of the 1:st spatial component of the four-velocity at two discrete time-coordinates is shown to exhibit these properties comprising a 1-D local and a non-local observer. Momentum transfer and divergence are inherent in the geometry, which retains the time dilatation of relativity theory whereas relativistic length contraction is confined to the non-local frame of observation. These results, corroborating and extending previous work (Cerven, VI:th Wigner Symp, 1999) show how the choice of geometrical framework may deepen the understanding of emission-absorption.

Keywords: Planck's Equation; Non-local Electromagnetic Field; Geometry; Emission; Absorption.

POSTER SESSIONS

Id-137

Experimental and Mathematical Model for Determination of the Temperature Distribution of Optical Elements during Interaction with Laser Irradiation

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Abstract: The heating of optical elements is one of the main factors limiting the power of laser setups. An inhomogeneous change in the temperature of crystals and glasses can lead to a change in their optical properties, both reversible (phase matching detuning, thermal lens, etc.) and irreversible (optical damage). Thus the temperature distribution is an important parameter of the optical system which must be controlled. In this abstract, as a model experiment, the optical ceramic disk (50 mm diameter, 5 mm thickness) from a magnesium fluoride was heated by 50 W CW laser radiation at 1064 nm. The temperature kinetics was simultaneously measured at 3 different points on the sample surface. Small piezoelectric crystals (0.5 * 0.13 * 2 mm^3) from lithium niobate were used as sensors. Their temperature was determined by the eigenmodes frequency shift which was measured by radiofrequency resonance spectroscopy. The measured temperature distribution on the sample surface was used to solve the inverse heat transfer problem by determining optical absorption and heat exchange coefficients. This problem was solved by minimizing the residual functional with the gradient descent method. The calculated optical absorption coefficient was 1.2 m^{-1}. Thus the work shows the applicability of the radiofrequency resonance spectroscopy method to determine the temperature distribution and the optical absorption coefficient of samples of different materials and shapes.

Keywords: Optical Absorption Coefficient; Radiofrequency Spectroscopy.

POSTER SESSIONS

Id-139

High-speed Fiber-coupled InGaAs/InP Photodetector for C- and L- optical Wavelength Transmission Bands

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Abstract: Photodetectors exhibiting wide dynamic range and broad bandwidth for detection of high-frequency-modulated signals are required in microwave analog photonic links, remote antennas and measurement systems. We proposed a photodetector based on InGaAs/InP top-illuminated p-i-n photodiode with 18 um active area diameter as a receiving part of analog photonic link. An epitaxial heterostructure was consisted of an i-type $In_{0.53}Ga_{0.47}As$ absorbing layer of 800 nm thickness, p- and n-type $In_{0.53}Ga_{0.47}As$ absorbing layers of 100 nm thickness, window layer, gradient layers and p- and n-type contact layers. The fiber-coupled photodetector demonstrated maximum responsivity of 0.65 A/W at 1550 nm and was highly sensitive at wavelengths 1200 – 1700 nm. We obtained wide bandwidth and low dark current due to precisely calculated heterostructure layers thicknesses and minimization of contact resistance. Photodiode chip was designed as planar mesa-structure and its fabrication included the following operations: metallization of ohmic Ti/Au and AuGe/Ni/Au contacts to InGaAs contact layers of p- and n-type conductivity respectively, plasma-chemical mesa BCl_3/Ar etching, mesa passivation and deposition of Ti/Au metallization. The photodetector provided 20 GHz electrical bandwidth, matched coaxial RF output, 20 ps raise and fall time with 1.5 V reverse operating voltage and had 40 dB dynamic range with 70 nA dark current and 5 mW maximum optical input power. Achieved parameters allow to use the photodetector in measurement systems and high-speed fiber-optics communication systems. This work was supported by Ministry of Science and Education of Russia, agreement No 14.578.21.0239 of September 26, 2017, unique ID RFMEFI57817X0239.

Keywords: Microwave Photonics; High-speed Photodetector; InGaAs/InP p-i-n Photodiode.

POSTER SESSIONS

Id-140

Investigation of Heat Transfer Conditions of Nonlinear Optical Crystals during the Laser Irradiation in Vacuum

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Abstract: Due to continuous rise in laser irradiation power used in laser technology, the requirements for the quality of optical components increase. Absorption of radiation leads to components' heating that in turn, changes the optical properties of the material. In case of high intensities, it can lead to degradation and destruction of the material. Measurement of the absorption spectrum of optical material helps to estimate maximum intensity of light that the material is able to withstand. It also helps to estimate the material's optical quality. Measurements of absorption coefficient and heat transfer coefficient were carried out using piezoelectric resonance spectroscopy under different air pressure. The test sample was a nonlinear optical crystal of lithium triborate. The pressure was varied from atmospheric pressure to medium vacuum. The dependence of heat transfer coefficient on air pressure appeared to be not monotonous. The derived value of absorption coefficient was $3.9 \cdot 10^{-4}$ cm^{-1}. Numerical evaluations of dependence of the poezoelectric eigenfrequencies and their change due to heating on pressure variation for the sample were made. The dependencies were proved to be linear. These results are important for the possible improvement of the technology of the absorption coefficient measurement and evaluation of the crystal quality.

Keywords: Absorption Coefficient; Lithium Triborate; Crystals; Vacuum; Heat Transfer Coefficient.

POSTER SESSIONS

Id-144

Investigation of Active Fiber Heating under the Condition of Laser Radiation Generation in Different Heat Sinks

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Abstract: High-power laser generation in optical silica glass fiber doped by the lanthanide atoms leads to the high temperature of the core of active fiber that limits maximum laser output power because of thermal degradation of the protective polymer coating, thermal lenses and other effects. Therefore, there is a continuous search for new effective ways to reduce the active fiber heating and enlarge output laser power. In this paper, measurements of active fiber heating under different heat sink conditions were conducted. Investigated fibers in conditions of high-power laser generation were placed into different conditions of heat dissipation such as convective air cooling and using of external cooling materials like water and ice. Most effective cooling was realized in the rectangular metal plate with grooves, where active fiber was placed. These grooves were filled with a thermally conductive compound like water or solder with low melting temperature. Active core temperature was evaluated by means of measurement of fiber surface temperature and numerical modeling of fiber heating based on solution of heat conduction equation. Also effectiveness of different heat dissipation systems was estimated through thermal resistance between fiber surface and heat sink. Lowest resistance was $42 \cdot 10^{-5}$ m^2K/W in case of grooves filled with solder, that was 30 times lower than convective air cooling.

Keywords: Fiber Laser; Thermal Effects; Cooling Designs; Thermal Measurements; Thermal Contact Resistance.

POSTER SESSIONS

Id-145

Radio-frequency Impedance Spectroscopy of the Active Fiber under Condition of Laser Generation

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Abstract: Output power of the fiber lasers has already reached 10 kW and 100 kW in CW single-mode and multi-mode generation regime respectively. One of the main reasons that limits them is fiber heating, which generally caused by quantum defect, the difference between energies of pump and generated photons. The heating of the active medium significantly affects the efficiency of lasing generation. Therefore, many methods of active fiber temperature measurement are being developed. In this paper, we introduce a novel method of measuring the temperature of active Yb/Er-doped fiber under conditions of laser generation. We have used the radio-frequency impedance spectroscopy technique, which provides a determination of the temperature of piezoelectric mini resonators used as sensors. The resonators were made of lithium niobate crystal ($LiNbO_3$) in form of parallelepipeds 7x1.5x1 mm with grooves along them. Active fiber segments were placed into the grooves at certain distances from pump radiation input in order to obtain longitudinal temperature distribution. In conditions of laser generation active fiber and, consequently, the crystal sensors were heated, what led to the proportional shift of its piezoelectric resonant frequencies, which were measured by means of impedance spectroscopy. The longitudinal and transversal temperature distribution in active fiber was calculated using experimentally obtained data and mathematical model of fiber heating based on the solution of the stationary heat equation. The heating of active fiber from 302 K in the case of one side pumping with pump power 20 W varied from 20 K to 3 K along the length of the fiber laser.

Keywords: Fiber Laser; Temperature Measurements; Temperature Effects; Radio Frequency; Sensors.

POSTER SESSIONS

Id-148

Measurement of the High-power Laser Radiation Beam Profile using the Matrix of the Copper-coated Passive Optical Fibers

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Abstract: In most practical applications of laser sources it is necessary to know the radiation beam quality as well as its intensity profile. Nowadays, the optical power of industrial CW fiber lasers exceeds 10 kW and 100 kW levels in the single-mode and multimode regimes respectively. In order to measure the beam profile of high-power laser radiation using the conventional semiconductor sensors it is necessary to employ the multistage attenuation systems, which can deteriorate the initial beam quality. In this paper, we introduce a novel approach for the measurement of the intensity profile of high-power laser radiation, which does not require any preliminary attenuation. It is based on the application of the matrix made of multimode passive optical fibers coated with copper. Optical radiation transmitted through an optical fiber experiences Rayleigh scattering. Scattered radiation is completely absorbed inside the copper layer leading to its heating and, therefore, to its proportional electrical resistance change. The matrix sensor consisting of 19 copper-coated optical fibers, designed as a regular cable with circular cross-section, was assembled. The investigated laser radiation is directed into the polished end faces of the matrix fiber elements. The intensity profile of the incident beam is evaluated by measuring for each fiber the copper coating resistance change. Intensity profiles of the single-mode and multimode fiber laser beams were successfully measured using proposed fiber matrix sensor. In our experiments the incident radiation intensity exceeded 2 kW/cm^2. The introduced technique can be applied for the determination of the beam quality factors (M^2).

Keywords: Copper; Fiber Lasers; Coating; Fiber Optics Sensors; Rayleigh Scattering.

POSTER SESSIONS

Id-154

Impedance Spectroscopy of Nonlinear-optical Crystals Interacting with High Power Laser Radiation

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Abstract: Nowadays the output power of CW single-mode fiber lasers operating at one micron wavelength exceeds 10 kW level. Infrared radiation can be converted into visible and ultraviolet regions using nonlinear-optical crystals. Efficiency of such processes is governed by corresponding phase matching conditions. Lithium triborate (LBO) is one of the most promising nonlinear-optical crystals used for the frequency conversion of high-power laser radiation due to its low optical absorption coefficient. However, in case of high power laser radiation even low absorption leads to nonuniform heating of crystal and violation of the phase matching conditions. Determination of optical absorption coefficients of nonlinear-optical crystals as well as measurement and control of its temperature during laser irradiation is an important task. Piezoelectric properties of nonlinear-optical crystals enable to use piezoelectric resonance laser calorimetry technique, based on impedance spectroscopy, for measuring their optical absorption coefficient. Piezoelectric resonance frequencies of crystal are highly temperature dependent. Therefore, when the crystal is heated by laser radiation its temperature kinetics can be directly obtained by measuring the kinetics of the preliminary temperature calibrated piezoelectric resonance frequencies. Optical absorption coefficient determines by finding the correspondence between the solution of the nonstationary heat conduction equation and temperature kinetics. Dependence of the optical absorption coefficient of LBO crystal on the incident power of the single-mode laser radiation at λ=1070 nm was measured in 15 W - 450 W range. Average value of the LBO optical absorption coefficient was obtained to be $6.5 \cdot 10^{-5}$ cm^{-1}. The measurement error is below 10% level.

Keywords: High Power Single-mode Fiber Laser; Lithium Triborate Crystal; Optical Absorption; Impedance Spectroscopy.

POSTER SESSIONS

Id-190

Unidirectional Optical Interconnects Based on Gap Plasmon Resonators

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Abstract: Grating couplers are the most versatile mechanism to couple light efficiently into waveguides featuring submicronic cross-sections. Most often, grating couplers are used in a tilted illumination configuration in such a way that the power scattered by the grating is dominantly sustained by a single diffraction order leading to unidirectional excitation of the waveguide. In practical applications, tilted illumination of the gratings is not always possible in particular for fully integrated opto-electronic PCBs with a light source and an optical layer implanted on each side of the board. In this case, the incoming light hits the gratings couplers at normal incidence and specific strategies mostly based on reflectors are needed to achieve unidirectional excitation of the guided mode. In this work, a novel unidirectional optical interconnect concept based on the use of gap plasmon polariton (GPR) grating couplers sustained by Metal-Insulator-Metal (MIM) resonators is introduced. Unlike traditional challenging subwavelength coupling schemes based on plasmonics and Si-Photonics, we consider non-symmetric GPR featuring highly directional scattering efficiency. The plasmonic gratings have been modelled numerically employing a Fourier Modal Method and the results have been confirmed by FEM simulations.

Keywords: Plasmonics; Gap Plasmon Resonators; Optical Interconnects.

POSTER SESSIONS

Id-221

On the Structural, Elastic, Electronic and Optical Properties of CdS/ZnS Super Lattice under High Pressure

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Abstract: In this work, we study the structural, elastic, electronic and optical properties of the super lattices CdS/ZnS under hydrostatic pressure using the pseudo-potential plane wave method (PP-PW) scheme in the fram of generalized gradient approximation (GGA). Structural and elastic results are given for lattice constant (a,c), bulk modulus B their pressure dependence and elastic constants C_{ij}. The band structure calculation together with the density of states shows that this compound has a direct energy band gap ($\Gamma \rightarrow \Gamma$). We have calculated the frequency dependent complex dielectric function $\varepsilon(w)$ and its zero frequency limit $\varepsilon_1(0)$. We have found that the values of $\varepsilon_1(0)$ increases with decreasing the energy gap for radiation up to 25 eV.

Keywords: CdS/ZnS; PP-PW Method; Elastic Constants; Electronic Properties; Optical Properties.

POSTER SESSIONS

Id-232

On the Impact of Digital Back Propagation Nonlinearity Compensation in Non-Repeatered Transmission WDM Systems

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Abstract: We have theoretically evaluated transmission property and BER performance of 120Gbps digital coherent signals, with and without nonlinear compensation. For single channel, there is 2 dB development by using DBP nonlinear compensation method. And for DWDM cases, DBP has more effective influence on SPM than XPM and FWM.

Keywords: Digital Back Propagation; Non-repeatered Transmission System.

POSTER SESSIONS

Id-236

Photon Energy Up-conversion of Er^{3+}

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Abstract: Excitation of Er^{3+} ions in $KY_{1-x}Er_xF_4$ crystals using 532 nm or 488 nm laser radiation produces photoluminescence (PL) band around 410 nm, in addition to the usual Stokes-shifted PL bands. The time-dependence of the PL shows that this up-converted PL is arising from the energy transfer between nearby Er^{3+} ions. This up-converted PL also shows an interesting thermal behavior where the PL intensity increases with increasing temperature. This thermal behavior indicates that phonons are involved in the energy transfer process. The energy mismatch between the two electronic transitions in the energy transfer process is compensated for by the energy of the phonons participating in the process. There is also a secondary energy up-conversion observed in this Er^{3+} -doped crystal: when excited by 532 nm laser, a PL band around 520 nm is observed. The origin of this secondary up-conversion is different from the previous one. The thermal equilibrium between two nearby excited states is responsible for it, as revealed by the incident power and temperature dependence.

Keywords: Up-conversion; $Er3^{+}$; Energy Transfer.

POSTER SESSIONS

Id-250

Polish Active Optical Fibers for Applications in Laser Systems

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Abstract: In 1961 Elias Snitzer introduced the concept of the laser with rare-earth doped optical fiber as an active medium. This, together with the following Snitzer's idea of double-clad active fiber, has started the era of fiber laser technology and resulted in dynamic development of a new class of coherent radiation sources offering excellent properties – laser action at single spatial mode (M^2 parameter close to unity) combined with enormously high output powers (of order of kWs). These unique advantages result from this specific geometry of active medium, which offers not only easiness of obtaining single transverse mode operation but also excellent heat dissipation and, due to waveguide effect, a possibility of using the active media of almost any length while maintaining a compact size of the entire device. In recent years, fiber laser-based systems have dominated the market of solid-state lasers, finding numerous applications in industrial systems for materials' processing (cutting, welding, hardening, etc.), medical systems and laser weapon systems as well. It should be emphasized here, that although there is a number of fiber lasers manufacturers, only a few centers dispose of technological competencies that allow the production of active fibers of appropriate properties. This work will summarize the results of several years of our efforts on mastering the technology of manufacturing active optical fibers applicable to laser systems. The fundamentals of the technology will be presented together with the results of the spectroscopic characterization of developed fibers and first laser experiments with Polish active fibers doped with ytterbium and thulium ions, developed in the Laboratory of Fiber Optic Technology at the Faculty of Chemistry of Maria Curie-Skłodowska University, Lublin, Poland. Both spectroscopic and laser properties of developed preforms and active fibers will be compared with properties of samples available from commercial suppliers. This work was partially supported by the project 1-6/1/PS/2014 by the National Center for Research and Development, Poland.

Keywords: Fibers; Lasers; Ytterbium; Thulium.

POSTER SESSIONS

Id-251

Low-temperature FTIR Spectroscopy of Adsorbed CO for Characterization of Copper Species in Mordenites

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Abstract: Low-temperature infrared (IR) spectroscopy of adsorbed molecules is widely used to identify surface species. Copper-exchanged zeolites are highly promising catalysts for removal of nitrogen oxides (de-NOx) and other processes. To improve their properties it is necessary to understand the state of copper sites. The content and specific forms of copper species are highly affected by preparation method. Recently it has been shown that microwave assisted copper ion-exchange treatment of sodium mordenite leads to diversification of copper species stabilized inside the mordenitepores. By means of ESR and FTIR spectroscopy one can detect Cu^{2+}, Cu^{+} and $[Cu–O–Cu]^{2+}$ species. Figure 1 shows the spectra of CO adsorbed on a sample of Cu mordenite prepared by microwave treatment and evacuated at 450°C at different conditions. Spectrum of an oxidized sample heated and cooled in oxygen in the presence of CO at 77K exhibits a pair of bands near 2160 and 2140 cm^{-1}, accompanied with perturbation of OH groups at 3624 cm^{-1}. The perturbation disappears after removal of gaseous CO, leaving the bands of CO at 2180 and 2148 cm^{-1}. After further lowering of CO coverage the only band at 2160 cm^{-1} remains. Subsequent heating the sample in vacuum results in new bands of adsorbed CO between 2220 and 2200 cm^{-1}, which do not arise if a fresh sample is evacuated in the absence of oxygen. The method of isotopic dilution with ^{12}CO-^{13}CO mixtures enables us to distinguish bands of single adsorbed molecules from those of binary CO species at the same surface Cu sites. The work was supported by the Russian Foundation for Basic Research in cooperation with the Ministry of science, technology and environment of the Republic of Cuba, grant # 18-53-34004.

Keywords: FTIR Spectroscopy; Adsorption; Surface; Zeolites.

POSTER SESSIONS

Id-263

The Front-end Upgrade of Subpetawatt Laser System Pearl

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Abstract: We completed the upgrade of the front-end of laser system PEARL (PEtawatt pARametric Laser), based on the OPCPA (optical parametric chirped pulse amplification) method. Before upgrading the laser system we injected the stretched radiation of the Cr:Forsterite master oscillator with central wavelength of 1250 nm into the first cascade of parametric amplification. As a result of three-wave interaction in nonlinear crystal DKDP (pump wavelength is 527 nm) the collimated 910-nm radiation was generated. Then it was amplified in subsequent parametric cascades and compressed in Treacy four-grating compressor. Specially for upgrading of PEARL front-end the Ti:Sapphire femtosecond oscillator with central wavelength of 910 nm was created, its radiation was injected in the first cascade of amplification. The replacement of the femtosecond master oscillator required creating a new stretcher, dispersion-matched to the existing compressor. We performed the analysis of various schemes of stretchers and created stretcher based on Offner triplet with spherical mirrors. Using the same wavelength radiation in compressor and stretcher allows us to easy match these devices without pulses amplification. Output pulse duration less than 43 fs was reached.

Keywords: OPCPA; Ti:Sapphire; Stretcher; Femtosecond Pulse; Pearl.

ALL SUBMISSIONS & TOPICS

Topic	Submission
Biophotonics	Id 5 - New Biophotonic Materials from Persistent Luminescent Particles Containing Bioactive Glasses
	Id 7 - Medical Application of SERS Cellular Imaging
	Id 40 - Diffuse Optic Tomography Techniques for Biomedical Imaging
	Id 77 - Switching with Light: A Palette of Opportunities with Photochromic Materials
	Id 92 - Targeted Imaging and Drug Delivery for Prostate Cancer Cells using Upconversion Nanoparticles Functionalized with Phosphate Micelles
	Id 103 - Detection of Extended Spectrum β Lactamases Enzymes Producing Bacteria Escherichia Coli Using İnfrared Microscopy in Tandem with Machine Learning Algorithms
	Id 112 - Luminescence Bioassays of Different Complexity: Bacterial Cells, Enzyme Reactions, and Fluorescent Proteins
	Id 133 - Effect of Low-Power Laser Irradiation Time on Human Blood Cells

	Id 149 - Comparative Evaluation of Depth of Penetration of Root Canal Irrigant after Using Manual, Passive Ultra-sonic and Diode Laser Assisted Irrigant Activation Technique
Green Photonics, Energy, and Related Technologies	Id 35 - Green Emitting Phosphor Coupled TiO_2 Nanotubes as Effective and Efficient Photocatalyst for Pollutant Elimination
	Id 56 - Development of a Self-sustainable PV - Energy Supply System for Domestic Consumption
	Id 113 - Can Quantum Dot Sensitized Solar Cells be a Potential Contender of Energy Crisis?
High Power Laser Technology, Ultrafast Optics and Applications	Id 120 - The Use Laser Welding and the Keyhole Effect for Increase of Thermal Efficiency of the Solar Absorber
	Id 156 - Laser Assisted Joining of Aluminum-Copper
	Id 192 - Ultrathin Electron Layer Generation Based on Laser-driven Energy Modulation
	Id 193 - Generation of Single-cycle CEP-stable Attosecond Pulses Based on Radiation of Ultrashort Electronbunches
	Id 268 - Advanced Optical Component Manufacturing Using CO_2 Laser Light
	Id 23 - Multichannel Si Photonic Crystal Filters with Fine-Tuning Capability of Individual Channels for Sensing and Optical Interconnect Applications

Silicon Photonics	
	Id 30 - Silicon Photonic Interconnect for High Performance Multicore Processors and Hardware Accelerators
	Id 65 - New Functionalization of 2D Photonic Macroporous Silicon Structures under the High-pressure Oxidation
	Id 66 - Electro-optical Effects in 2D Photonic Macroporous Silicon Structures with Nanocoatings
	Id 95 - Advanced Silicon Nitride Platforms for Photonic Integrated Circuits
	Id 138 - Silicon Photonics for Ultra-broadband Applications
	Id 158 - In-chip Photonics and Microstructures Enabled by 3D Nonlinear Laser Lithography
	Id 172 - Direct Bandgap Silicon Clathrate for Future Solar Cells: Exploration and Bandgap Engineering through First-Principles
	Id 205 - Characteristics and Field Operation of Polarization-Insensitive Silicon Photonics 8×8 Optical Switch
	Id 223 - Growth and Optical Properties of A3B5 Nanowires Grown by Molecular Beam Epitaxy on Silicon
	Id 240 - Arrayed Waveguide Gratings: Design and Applications

Light-matter Interactions at the Quantum Limit: Atoms, Molecules and Photons	Id 25 - Gold Nanoparticles Supported on Two Different Metal Oxides to Form Ferromagnetic Nanostructures
	Id 59 - Enhanced Optical Properties of Neodymium Doped Tellurite Glass for Advanced Laser Glass
	Id 105 - Influence of Arcing in Air on Electron Work Function for Silver-Metal Oxide(Ag-MeO) Electrical Contacts
	Id 124 - Defining the Local Matter and the Non-Local Field Using the Planck Distribution
	Id 159 - IR Spectroscopy of Photoprocesses in Heterogeneous Systems
Nano-photonics and Plasmonics	Id 36 - Application of Ag Nanoparticles Grown by Dewetting Process to SERS and Solar Cells
	Id 91 - GaN Directional Micro LEDs Based on Evanescent Wave Coupling
	Id 106 - Effects of Spatial Dispersion in Symmetric and Asymmetric Semiconductor Quantum Wells
	Id 107 - Porous Silicon Nanoparticle Produced Laser Ablation Method for Biomedical Applications
	Id 110 - Zero-index Mediums Using Two Dimensional All-Dielectric Photonic

	Id 123 - Plasmonic Effects of Silver Nanoparticles Embedded in Low-Loss Optical Surrounding Media
	Id 132 - Structural Rearrangements in Mononucleosomes Induced by Potassium and Sodium Ions: Single Particle FRET Analysis
	Id 174 - Ultra-fast Magnetism in Nanophotonic Structures
	Id 175 - Towards the Optical Nanopore for Single Molecule Analysis
	Id 180 - The Fluorescence Properties of Carbon Dots and Metal Doped Carbon Dots
	Id 190 - Unidirectional Optical Interconnects Based on Gap Plasmon Resonators
	Id 207 - Laser Generation in Continuous Flow of Photoluminescent Carbon Quantum Dots for Fluorescence Cell Imaging
	Id 217 - Monolithic Metal-semiconductor Nanowire Heterostructures for Electrical and Optical Applications
	Id 234 - Luminescent Porous Si for Nanomedicine
	Id 274 - Chiral Quantum Dots
	Id 38 - Optical Parametric Oscillators Based on Novel Mid-infrared Nonlinear Materials

Nonlinear Optics	Id 68 - Ultrafast All-Optical Feed-forward Delay Line Buffer Based on Two-Photon Absorption and the Quadratic Stark Effect in an Unbiased SOA
	Id 218 - Periodic Domain Structures Recorded by an Electron Beam for the Nonlinear Conversion of Laser Radiation in Optical Waveguides on Nonpolar Cuts of $LiNbO_3$
	Id 222 - Simultaneous Nanoscale Measurement of Physical-chemical Properties of Soft Materials by Novel AFM-intermodulation Technique
	Id 273 - Nonlinear Optical Conductivities in the Independent Electron Approximation
Optical and Quantum Communications	Id 22 - Atmospheric Effects of Depolarization in Free Space Communication: How to Overcome It
	Id 75 - Visible Light Communication in Industry 4.0
	Id 86 - Performance of Quantum Key Distribution
	Id 136 - Optical Comparator for PSK-modulated Signals by Using Serially-Cascaded Delay Line Interferometer
	Id 48 - Thermal Sensitivity of Phase and Propagation Delay in Hollow-core Fibres

Optical Fibers	Id 129 - InfraRed Fiber Optics for Photonics Applications in 2-16 μm Range
	Id 144 - Investigation of Active Fiber Heating under the Condition of Laser Radiation Generation in Different Heat Sinks
	Id 145 - Radio-frequency Impedance Spectroscopy of the Active Fiber under Condition of Laser Generation
	Id 148 - Measurement of the High-power Laser Radiation Beam Profile Using the Matrix of the Copper-coated Passive Optical Fibers
	Id 181 - Design of Silica Optical Fibers with Selected Mode Staff Differential Mode Delay Management
	Id 235 - Optical Fiber Based Microstructures
	Id 15 - Ultrafast Laser Plasma Doping- A Novel Approach to Photonic Materials and Devices Engineering
	Id 46 - Optical Response and Luminescence Properties of Sm^{3+}-doped Sodium-Fluoro-Phosphate Glasses for Reddish-Orange Lighting Applications
	Id 52 - Visible Light Responsive Wide Band-Gap Oxides: Potential Application in Photocatalysis
	Id 61 - Doped Sol–gel Silica Glasses for Radiation Dosimetry in Harsh Environment

Optical Materials and Applications	
	Id 62 - PbS Quantum Dots and Nanocomposites for Solution Processed Broaband Photodetectors
	Id 64 - From Fundamental Spectroscopy of MOFs to Lighting Applications
	Id 67 - In vivo and Ex vivo Scoring of Liver Fibrosis by Diffuse Reflectance and Fluorescence Spectroscopy: A Happy Cross-Communication Story between Engineers and Physicians
	Id 69 - The Synthesis and Optical Properties of Red Functional Dyes for Inkjet Printing Process
	Id 74 - Efficient Persistent Room Temperature Phosphorescence in Amorphous Polymers under Ambient Conditions
	Id 82 - Volume Holographic Gratings in Photopolymeric Materials Doped with Quantum Dots for Distributed Feedback Lasers
	Id 97 - Room temperature Sol-gel Strategy for Fabrication of High Performance Metal-oxide Thin Films as ETL in Flexible Planar Heterojunction Perovskite Solar Cells
	Id 130 - Highly Ordered and Stable Inorganic-organic Hybrid Quantum Structures Based on II-VI Compounds
	Id 137 - Experimental and Mathematical Model for Determination of the Temperature Distribution of Optical Elements during Interaction with Laser Irradiation

	Id 140 - Investigation of Heat Transfer Conditions of Nonlinear Optical Crystals during the Laser Irradiation in Vacuum
	Id 147 - Preparation of Novel Solid-state Materials Immobilizing Dyes and Their Photochemical Behavior
	Id 154 - Impedance Spectroscopy of Nonlinear-optical Crystals Interacting with High Power Laser Radiation
	Id 166 - Luminescent Polymer Composites – A New Class of Active Media
	Id 178 - The Nature of Defects and Traps in High-k dielectrics with Photoluminescence Experiments
	Id 189 - Pneumatic Photonic Crystals: Properties and Application in Sensing and Metrology
	Id 197 - Eu^{2+} Activated Oxonitridosilicate Phosphors for Highly Efficient White Diodes via the Modified Solid State Reaction Method
	Id 228 - Luminescence from SRO-Si_3N_4 Nano-layered Systems for Electrophotonic Integration
	Id 229 - The Results of WFG FS- Lasik Procedure in Treatment of Myopia and Myopic Astigmatism
	Id 257 - MBE Growth and Properties of III-V and Nitride Nanowires on Hybrid SiC/Si Substrates

	Id 270 - Unprecedented Effects of Aggregation on the Photoluminescence of Small Gold Clusters
Optical Sensors	Id 18 - Fluorescent Optical Microresonators for Optofluidic Sensor Applications
	Id 26 - Numerical Simulation of a High Responsivity Ultraviolet Photodetector
	Id 43 - Optical Sensing in Biological Tissue Based on Resonant Microcavities
	Id 50 - The Two Polarization Planes of Light and Its Use at the Fiber Optic Sensors
	Id 55 - Experimental Limitations of Rare-earth-doped Luminescent Nanosensors
	Id 78 - Mid-infrared Photonics: LEDs and Photodiodes for Sensing Applications
	Id 81 - Plasma Actuator Stability Monitoring Using Fiber Bragg Grating Sensor
	Id 84 - Graphene-coated Tip Fiber Optic Chemical Sensor for Nitrate Sensing Application
	Id 89 - Precision Measurements of Physical Values Based on Fiber-optical Sensors with Impulsive Modulation of Optical Stream Intensity

	Id 151 - Development of Fiber-optic Sensors for Use in Harsh Environments
	Id 177 - Radiation Dosimetry Using Specialty Optical Fibers
	Id 200 – Optical Microresonator Array Sensor (OMAS)
	Id 203 - Making Wide-Bandgap Oxides “See” Light – A Prospective Approach for Low-Cost, Ultra-Low-Power Optical Sensing
	Id 210 - Resonant Optical Devices on Chip for Bio/chemical Sensing
	Id 219 - Design of on Optical Device for Endoral 3D Contouring
	Id 238 - Threat Detection and Classification with Phase-OTDR Based Distributed Acoustic Sensing Systems
	Id 259 - Application of Optical Fiber-grating Sensors for Air-Leaks Independent Triggering in Non-invasive Mechanical Ventilation
	Id 262 - Bloch Surface Waves on One Dimensional Photonic Crystals: Fundamentals and Applications
	Id 271 - Arrays of Resonant Nanopillars as Multiplexed Optical Transducers for High Sensitivity Biosensing
	Id 85 - Hybrid Thulium-doped and Thulium/Holmium-doped Fiber Laser Cavity for Generation of Dual-wavelength Two-micron Lasers

Photonic Networks and Devices	Id 142 - Optimization of Terahertz Quantum Cascade Lasers by Suppressing a Carrier Leakage Channel via a High Energy State
	Id 171 - Flexible Secure TWDM PON and its Future Application
	Id 226 - Tunable QW Laser and LEDs Devices
	Id 249 - Photonic Integrated Circuits for Application in Telecommunication and Sensing Networks
Photonic Theory Design and Simulations	Id 47 - First-Principles Investigation on Structural, Electronic and Optical Properties of Amorphous Silica with Interstitial Defects
Optical Characterization	Id 98 - Photoluminescence of ZnO Micro Structured Thin Films Prepared by the Spray Pyrolysis Method
	Id 170 - Synthesis, Characterization and Optical Properties of ZnO Nanostructures: From Nanoparticles to Nanorods
	Id 191 - Effect of Bismuth-induced Control Phase of GaAs Nanowires on Optical Polarization
	Id 214 - III-nitride Emitting Devices Grown on (-201)-oriented β-Ga_2O_3 Substrate
	Id 264 - Investigation of the Optical Properties of GeSn QWs for Laser Applications

Photodetectors	Id 139 - High-speed Fiber-coupled InGaAs/InP Photodetector for C- and L- optical Wavelength Transmission Bands
	Id 199 - Gate effect on Time Response and Responsivity in Single Walled Carbon Nanotube/Si Photodetectors
Optical Communications	Id 126 - Application of Angle Diversity Technique to Optical Wireless Communication Systems for Smartphones
	Id 131 - Application of an Opto-electronic Oscillator in Radio Access Networks
	Id 152 - Applying Security-aware Traffic Policing and Shaping Strategies with Dynamic Routing and Wavelength Assignment Attack Aware Algorithm in WDM Optical Networks
	Id 155 - Advanced Optical Modulation Format Conversion for Short-reach and Long-haul Network Integration
	Id 272 - Visible Light Communication based Vehicular Communications