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BOOK OF ABSTRACTS

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FROM ADVANCED METHODS OF PREFORM FABRICATION TO SPECIALTY COATED FIBERS – MATERIAL AND TECHNOLOGY?

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Type of presentation: Plenary presentation

Abstract:

The presentation will focus on the recently developed "Reactive Sintering of Powdered Silica – REPUSIL" and gas phase doping of rare earths as alternatives to standard MCVD technologies in particular for laser applications. However, even the technologies are new; they face old problems (e.g. glass defects and their absorptions) and follow similar rules (e.g. incremental influence of glass dopants on the refractive index). A summary on potentials and limits of the described fabrication technique for active as well as passive glass preforms and fibers will be given.

The performance of an optical fiber is strongly characterized by its outer layer which is usually an optical coating. For the great variety of polymers there are a couple of techniques for the application of standard and specialty coatings on the fiber.

FORCES OF LIGHT: FROM SOLAR SAILS TO NANOPARTICLE COOLING

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Type of presentation: Plenary presentation

Abstract:

The talk briefly introduces the origin of force of light and their history from Johannes Kepler´s time to the most recent effort of optical cooling of nanoparticles. We will start with radiation pressure and its usage for propelling of satellites using solar sails and proceed to spatial shaping of the laser beam intensity and phase to obtain much complex manipulation with objects at the micro-level. A brief review of different examples and applications will be demonstrated, for example holographic optical tweezers, measurement of tiny pN forces, optical rotors, sorting of objects by light sieves, pulling and pushing of objects by optical "tractor" beams, various forms of self-arrangements of microparticles into so-called optically-bound matter and cooling down the mechanical motion of nanoparticles.

LATEST ADVANCES IN BIOPHOTONICS

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Type of presentation: Plenary presentation

Abstract:

Biophotonics is the science that uses light to image, detect and manipulate biological objects, ranging from macroscopic (animals, organs), via microscopic (cells) to nanoscopic (molecules) ones. In recent years, a number of new imaging approaches have been developed, including time-resolved and/or non-linear methods. Such multimodal optical imaging, particularly when applied to unstained tissues, is showing to be a very promising. In recent years, Nanobiophotonics became the new interdisciplinary field linking Biophotonics to nanotechnologies. Latest advances in Biophotonics thus involve biomedical and biotechnological applications, including detection of suspected tissue, diagnostics and therapy of diseases, but also improvement of industrial processes. Supported by LASERLAB-EUROPE IV 7FP grant n°654148, APVV-14-0716, APVV-14-0858.

ADVANCED INJECTION SEEDER FOR VARIOUS APPLICATIONS - FORM LIDARS TO SUPERCONTINUUM SOURCES

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Topic: 1. Laser in industry

Type of presentation: Oral Presentation

Abstract:

A Master Oscillator Power Amplifier configuration has been commonly applied in high power laser systems. This setup uses a low power injection seeder (as a master oscillator) and one or several amplifying stage to provide suitable gain. Input pulse parameters determine pulse width, repetition rate and central wavelength of the whole laser system, which are key parameters for many applications. The paper describes an injection seeder driver (prototype) for a directly modulated semiconductor laser diode. The device provides adjustable pulse duration and repetition frequency to shape an output signal. A temperature controller stabilizes a laser diode spectrum. Additionally, to avoid a back oscillation, redundant power supply holds a generation until next stages shut down. Low EMI design and ESD protection guarantee stable operation even in a noisy environment. The controller is connected to the PC via USB and parameters of the pulse are digitally controlled through a graphical interface. The injection seeder controller can be used with a majority of commercially available laser diodes. In the experimental setup a telecommunication DFB laser with 4 GHz bandwidth was used. It allows achieving subnanosecond pulses generated at the repetition rate ranging from 1 kHz to 50 MHz. An injection seeder controller with a proper laser diode can be used in many scientific, industrial or medical applications. It may be a master oscillator for high power lasers, supercontinuum sources or optical parametric oscillators. Adjustable pulse parameters allow tuning up the whole laser system finding applications in LIDAR systems, holography and many others.

A PRACTICAL MODEL OF THIN DISK REGENERATIVE AMPLIFIER BASED ON ANALYTICAL EXPRESSION OF ASE LIFETIME

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Topic: 1. Laser in industry

Type of presentation: Oral Presentation

Abstract:

In recent years, ultrashort pulse laser systems operating at high repetition rates and delivering high energy are essential in various scientific and industrial applications. It´s well-known that the major loss in these high gain laser systems is caused by Amplified Spontaneous Emission (ASE). There has been considerable interest in developing analytical and numerical models for analyzing ASE and evaluating its influence in high gain laser systems. In this paper, a practical model of thin disk regenerative amplifier has been developed based on analytical approach, in which Drew A. Copeland had evaluated the loss rate of the upper state laser level due to ASE and derived the analytical expression of the effective life time of the upper state laser level by taking the Lorentzian stimulated emission lineshape and total internal reflection into account. By adopting the analytical expression of effective life time in the rate equations, we´ve developed a less numerically intensive model for not only predicting but also analyzing the performance of a thin disk regenerative amplifier. With this model, optimized combination of various parameters can be obtained for avoiding saturation, avoiding period-doubling bifurcation or first pulse suppression prior to experiments. The effective lifetime due to ASE is also analyzed against various parameters. The simulated results fit well with experimental results. By fitting the numerical model with more experimental results, we can improve the parameters, such as reflective factor which is used to determine the weight of boundary reflection within the influence of ASE. This practical and analytical model will be used to find out the scaling limits imposed by ASE of the thin disk regenerative amplifier being developed in HiLASE Centre.

A NOVEL METHOD FOR FABRICATION OF SIZE CONTROLLED METALLIC NANOPARTICLES BY LASER ABLATION

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Topic: 1. Laser in industry

Type of presentation: Oral Presentation

Abstract:

Time resolved experimental investigation of laser produced plasma-induced shockwaves have been carried out in the presence of confining walls placed along the axial and lateral directions using a Mach Zehnder interferometer in air ambient. Copper was used as target material. The primary and the reflected shock waves and their effects on the evolution of medium density and the plasma density (in the plume region) have been studied. The reflected shock wave has been seen to be affecting the shape and density of the plasma plume in the confined geometry. The same experiments were performed with water and isopropyl alcohol as the ambient liquids and the produced nanoparticles were characterised for size and size distribution. Significant differences in the size and size distribution is seen in case of the nanoparticles produced from the ablation of the targets with and without confining boundary. The change in the size and size distribution has been attributed to the presence of confining boundary and the way it affects the thermalisation time of the plasma plume. The experiments also show the effect of medium density on the mean size of the copper nanoparticles produced.

CRYOGENIC COOLED TM:SBN TUNABLE LASER

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Topic: 1. Laser in industry

Type of presentation: Poster

Abstract:

The goal of our work is present the temperature dependence of spectroscopic and laser properties of new active medium Tm:SBN (Strontium-Barium Niobate, SrxBa1â??xNb2O6, x = 0.61). The tested sample of Tm:SBN (2 wt. % of Tm2O3) which is appropriate for generation of laser radiation 1.88 Îzm had plan-parallel polished faces without anti-reflection (thickness 6.65 mm). During spectroscopy and laser experiments the Tm:SBN was attached to temperature controlled copper holder and it was placed in vacuum chamber. The transmission and emission spectra of Tm:SBN together with the fluorescence decay time were measured in dependence on temperature in range 80 - 350 K. The fluorescence decay time was measured to be 3.5 ms and 2.8 ms at 80 and 350 K, respectively. The longitudinal excitation of Tm:SBN was carried out by a fibre-coupled laser diode (pulse duration 10 ms, repetition rate 10 Hz, pump wavelength 793 nm). Laser resonator was hemispherical, 146 mm in length with flat pumping mirror (HR @1.8 - 2.1 Îzm) and spherical output coupler (r = 150 mm, R = 97.5 % @1.8 - 2.1Îzm). The Tm:SBN laser properties were investigated at temperature range 80 - 300 K. The highest slope efficiency with respect to absorbed pumped power was 3 % at 80 K temperature. The maximum output peak amplitude power was 0.12 W at 80 K, i.e. 3.2 times higher than it was measured at 200 K. Tunability of laser at 80 K in range 1854-1962 nm was obtained using SiO2 birefringent filter. At temperature 300 K, laser tunability in range 1859-1970 nm was reached. From our investigation it is seen that new Tm:SBN crystal can be useful laser material in the region of 2 Îzm.

LASER BEAM DISTRIBUTION SYSTEM FOR THE HILASE CENTER

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Topic: 1. Laser in industry

Type of presentation: Poster

Abstract:

We report recent progress in design and testing of the distribution system for delivering of high-power lasers developed within the HiLASE project of the IOP in the Czech Republic. Laser Beam Distribution System is a technical system allowing safe and precise distribution of different laser beams all around the laboratory building to several experimental stations. Unique nature of HiLASE lasers requires new approach, which makes design of the distribution system a state-of-the-art challenge.

Q-SWITCHED ND:YAG/V:YAG MICROCHIP 1338 NM LASER FOR LASER-INDUCED BREAKDOWN SPECTROSCOPY

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Topic: 1. Laser in industry

Type of presentation: Poster

Abstract:

Q-switched microchip laser emitting radiation at wavelength 1338 nm was tested as a radiation source for laser-induced breakdown spectroscopy (LIBS). This laser used sandwich crystal which combined in one piece the cooling part (undoped YAG crystal 4 mm long), the active laser part (Nd:YAG crystal 12 mm long), and the saturable absorber (V:YAG crystal 0.7 mm long). The diameter of this crystal was 5 mm. The microchip resonator consisted of dielectric mirrors directly deposited on the monolith crystal surfaces. The pump mirror (HT @ 808 nm, HR @ 1.3 um) was placed on the undoped YAG part. The output coupler (R=90 %@ 1338 nm) was placed on the V:YAG part. The fibre-coupled 808 nm pumping laser diode was operating in pulsed regime (rep. rate 250 Hz, pulse width 300 us, pulse energy 6 mJ). Using this pumping, stable and high reproducible Q-switched pulses were generated at wavelength 1338 nm. Pulse length was 6.2 ns (FWHM) and the mean output power was 33 mW. The single pulse energy and peak power was 0.13 uJ and 21 kW, respectively. Laser was operating in fundamental TEM00 mode. The laser radiation was focused on a tested sample using single plano-convex lens (focal length 75 mm). The focal spot radius was 40 um. The corresponding peak-power density was 0.83 GW/cm2. The laser-induced break-down was successfully reached and corresponding laser-induced plasma spectra were recorded for set of metals (Cu, Ag, Au, Pb, Sn, Zn, Al, Fe, Ni, Cr, Cd) and alloys (dural, vanadium-steal, stainless-steel, brass, bronze, etc.). To record the spectra, StellarNet BLACK-Comet concave grating CCD-based spectrometer was used without any special collimation optics. Thanks to used laser wavelength far from the detector sensitivity, no special filtering was needed to overcome the CCD dazzling. The constructed laser could significantly improve repletion-rate of up-to-date LIBS devices.

HIGH-EFFICIENT ND:YAG MICROCHIP LASER FOR OPTICAL SURFACE SCANNING

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Topic: 1. Laser in industry

Type of presentation: Poster

Abstract:

A CW operating, compact, high-power, high-efficient diode pumped 1064 nm laser, based on Nd:YAG active medium, was developed for optical surface scanning and mapping applications. To enhance the output beam quality, laser stability, and compactness, a microchip configuration was used. In this arrangement the resonator mirrors were deposited directly on to the laser crystal faces. The Nd-doping concentration was 1 at.%Nd/Y. The Nd:YAG crystal was 5 mm long. The laser resonator without pumping radiation recuperation was investigated - the output coupler was transparent for pumping radiation. For the generated laser radiation the output coupler reflectivity was 95 % @ 1064 nm. The diameter of the samples was 5 mm. For the laser pumping two arrangements were investigated. Firstly, a fibre coupled laser diode operating at wavelength 808 nm was used in CW mode. The 400 mm fiber was delivering up to 14 W of pump power amplitude to the microchip laser. The maximum CW output power of 7.2 W @ 1064 nm in close to TEM00 beam was obtained for incident pumping power 13.7 W @ 808 nm. The differential efficiency in respect to the incident pump power reached 56 %. Secondly, a single-emitter, 1 W laser diode operating at 808 nm was used for Nd:YAG microchip pumping. The pumping radiation was directly coupled into the microchip laser using free-space lens optics. Slope efficiency up to 70 % was obtained in stable, high-quality, 1064 nm laser beam with CW power up to 350 mW. The system was successfully used for scanning of super-gaussian laser mirrors reflectivity profile.

FIBRE OPTIC GYROSCOPE WITH SINGLE-MODE FIBRE AND LOOP-BACK PHASE SHIFT COMPENSATION

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Topic: 2. Metrology and sensors

Type of presentation: Oral Presentation

Abstract:

An all-fibre optical sensor of angular velocity (gyroscope) based on the Sagnac interferometer using a loop-back compensation is presented. The sensing loop consists of 760 metres of an ordinary single-mode fibre, which makes this setup cost-effective. To preserve principles of beams reciprocity, randomly induced changes of polarization in the fibre must be reduced. Therefore, the light within fibre is unpolarized, which is achieved by a fibre Lyot depolarizer and a superfluorescent fibre source. The source consisting of an erbium-doped fibre pumped by a laser diode produces the unpolarized light with low time coherence, which is required for suppression of backreflections in the fibre. Unlike common approaches to the unpolarized fibre-optic gyroscope with a single-mode fibre, whose output is naturally nonlinear, we use a loop-back compensation of a rotation-induced phase shift to achieve a linear response. This technique normally requires a fast electro-optical modulator, which is compatible only with more expensive polarization-maintaining fibre. We present here a novel phase modulation scheme suitable for a modulation with a piezoelectric fibre stretcher, which can be used with any kind of optical fibre. The proposed modulation scheme utilizes only harmonic signals and can therefore avoid undesired resonance frequencies of the modulator. As a result, the range of the gyroscope's linearity is greatly increased and a sensitivity to source power changes is suppressed. We describe the gyroscope setup with proposed modulation method and the signal processing technique in details, including mathematic explanation as well as experimental results showing a comparison to the common open-loop setup.

CAMERA-BASED MICRO INTERFEROMETER FOR DISTANCE SENSING

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Topic: 2. Metrology and sensors

Type of presentation: Oral Presentation

Abstract:

Interference of light provides a high precision, non-contact and fast method for measurement method for distances. However, capacitive, resistive or inductive methods dominate in the field of compact sensors. The reason is, that the interferometric system has to be precise adjusted and needs a high mechanical stability. We developed a new concept for a very small interferometric sensing setup. Therefore we combine a miniaturized laser unit, a low cost pixel detector and machine vision routines to realize a demonstrator for a Michelson type micro interferometer. Furthermore we develop a concept which allows the automatable production without individual adjustment. We demonstrate a low cost sensor smaller 1cm3 including all electronics and demonstrate distance sensing up to 30 cm and resolution in nm range.

POINT DISTINGUISH USING MULTIPLE PARTIAL REFLECTOR.

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Topic: 2. Metrology and sensors

Type of presentation: Poster

Abstract:

Recently, fiber optic sensors have been used in various fields. Conventional fiber optic sensors require passive fiber optic sensors with a separate light source from the optical fiber and require a sensitive optical detector because the intensity of the measurement signal is weaker as the measurement distance from the light source increases. In this paper, we propose a new type of quasi - distributed fiber laser sensor using active mode locking to solve the problems of the conventional passive optical fiber sensor. We fabricated an active mode locking laser cavity using partial reflector. When the modulation frequency is applied to the semiconductor optical amplifier corresponding to the resonator length, the active mode coupling laser is oscillated. The modulation frequency of the active mode locking laser is inversely proportional to the length of the laser cavity. The modulation frequency of the active mode locking laser is inversely proportional to the length of the laser cavity. Therefore, when the length of the cavity is changed by applying strain to the optical fiber at the front portion of the partial reflection portion, the modulation frequency also changes. At this time, cavity length change was measured by modulation frequency change, and it was shown that cavity length change and modulation frequency change coincided. Therefore, it is proved that the external environment change can be known through the modulation frequency change.

SYNTHETIC APERTURE COMMON-PATH SPIRAL DIGITAL HOLOGRAPHIC MICROSCOPY

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Topic: 2. Metrology and sensors

Type of presentation: Poster

Abstract:

This work presents a common-path synthetic aperture digital holographic microscopy using spiral phase plate to improve phase stability and spatial resolution. The influence of lateral shift and defocus in spiral phase plane were considered at different illumination angles. Experimental results show that the lateral resolution and SNR can be enhanced by the proposed method.

INVESTIGATION OF REFRACTIVE INDEX INCREMENT OF DIFFERENT PROTEINS BY KRETSCHMANN ELLIPSOMETRY

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Topic: 2. Metrology and sensors

Type of presentation: Poster

Abstract:

We measured the adsorption of different protein monolayers on the surface of a 40 nm thin gold layer by in situ spectroscopic Kretschmann ellipsometry. During the in situ investigations we used a home-made semi-cylindrical Kretschmann-Raether flow cell, so we could use the surface plasmon resonance (SPR) phenomenon to increase the sensitivity of the measurement by measuring the interface from the substrate. The optical properties of the gold layer were investigated ex situ, so we could make an optical model to describe the process in more details. The signal of the baseline was acquired while measuring the buffer solution, and then we used a protein solution to study the adsorption of the molecules. In these measurements we investigated the refractive index increment of three different kinds of protein (e.g. bovine fibrinogen, flagellar filament and bovine serum albumin). This is an important quantity when one would like to determine the surface mass density of a protein layer on a solid surface. Our goal is to determine its value for each protein and investigate how it changes in another buffer solution. Using a spectroscopic ellipsometer gave us the opportunity to build a complex optical model and use it to study the adsorbed protein layer quantitatively. We created an optical model successfully that described the structure, so we registered in situ information about the adsorbed protein. The protein adsorption was modeled also with random sequential adsorption (RSA) and then the numerical results were compared with the measurements.

RESOLUTION ENHANCEMENT OF DIGITAL HOLOGRAPHIC MICROSCOPY USING ANGULAR-POLARIZATION MULTIPLEXING

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Topic: 2. Metrology and sensors

Type of presentation: Poster

Abstract:

Digital holographic imaging for micro-optical elements and biological objects has been widely investigated in recent years because of its advantages in performing quantitative wavefront analysis and full-field measurement instead of piece-wide mechanical scanning and massive treatment. Compared with a normal aperture, synthetic aperture imaging can provide spatial resolution enhancement in digital holographic microscopy (DHM). In the study, we present an angular and polarization multiplexing technique for synthetic aperture (SA) imaging in a DHM system by using a pair of phase-type spatial light modulators (SLMs) to achieve resolution enhancement through a single hologram acquisition. Liquid crystal on silicon (LCoS) panels have been adopted as phase-type SLMs, which possess the characteristics of polarization rotation and electrically controlled birefringence within the liquid crystal layer, and they are potential candidates in the proposed SA system. Furthermore, the LCoS method miniaturizes the optical setup and its alignment in the SA approach. In experiments, we used LCoS panels to control the phase retardation in order to change the deflection angle and polarization state of propagating waves and implemented angular-polarization multiplexing simultaneously for reconfigurable SA imaging in DHM to enhance the reconstructed image resolution.

OPTICAL FIBER STRAIN SENSOR USING ACTIVE MODE LOCKING FBG LASER CAVITY

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Topic: 2. Metrology and sensors

Type of presentation: Poster

Abstract:

Conventional FBG interrogation systems utilize an optical spectrometer and broadband light source to read the center wavelength of the reflected signal from FBGs. These systems have several limitations: the maximum number of FBGs that can be implemented is limited by the spectral bandwidth of the light source. The low signal-to-noise ratio (SNR) can result from weak reflections because of the narrow bandwidth of the FBGs, and, the interrogation speed is limited by slow measurement with optical spectrometer. We proposed an active mode-locking (AML) FBG laser sensor to overcome problems of conventional FBG interrogation system. The system is based on measurement of mode-locked frequencies which depend on the position and Bragg wavelength of each FBG. The initial mode-locked frequency of each FBG is determined by the cavity lengths defined by the position of each FBG, and each mode-locked frequency is shifted with the change of Bragg wavelength of each FBG. The shift in mode-locked frequency resulted from an applied strain on the FBG can be improved by the amplified length change due to the dispersion of CFBG. In strain response measurement, the proposed FBG sensor system was characterized with the high sensitivity and high linearity at measurement speed up to 5 kHz. The AML FBG laser sensor based on CFBG would be highly useful for dynamic interrogation of many FBGs in various region.

STEPS TOWARDS ANALYTICAL RECONSTRUCTION OF TWO DIFFERENT PULSES FROM DOUBLE SPECTROGRAMS ALONE

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Topic: 2. Metrology and sensors

Type of presentation: Poster

Abstract:

The full characterization of the electric-fields of femtosecond pulses is a basic requirement for methodologies such as ultrafast spectroscopy, femtochemical analytics and nonlinear wave mixing experiments, amongst others, which involve ultrashort signal analysis. In this work, we present a simple, fast, non-interferometric method for the simultaneous characterization of two independent pulses from double spectrogram measurements. The method we present has been developed with a view towards the direct mathematical reconstruction of pulses from spectrogram information, meaning that the issues of solution uniqueness and stagnations, which may occur when iterative phase retrieval algorithms are used, can be approached. The experimental setup of this work is a modified version of a pulse retrieval method called "very advanced method for phase and intensity retrieval of e-fields" (VAMPIRE). In the new setup we measure two different spectrograms which are basically FROG spectrograms. However, the important feature is a particular dispersive element, in our case a thin BaF2 plate, which provides a small amount of near quadratic spectral dispersion over a spectral range from 200 to 1200 nm. With this setup Wigner-Ville function projections can be used in order to extract phase information corresponding to the fields which produce the spectrograms. We report a simplified spectrographic pulse reconstruction method which can be operated in either scanning or single shot operating modes. The results demonstrate the achievement of the characterization of two different pulses from dual spectrograms using a direct mathematical approach which is not based on commonly used iterative reconstruction algorithms. This approach leads to faster retrieval times and the removal of stagnations. *Acknowledgments: This research was supported by CONICYT-FONDECYT Regular 1130580 and CONICYT-PIA ACT1409.*

SOME POSSIBILITIES IN DIGITAL HOLOGRAPHIC VIBROMETRY FOR NON-HARMONIC VIBRATION MEASUREMENT

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Topic: 2. Metrology and sensors

Type of presentation: Poster

Abstract:

This paper presents two basic methods of digital holographic vibrometry (time average digital holography and stroboscopic digital holography) for measurement of non-harmonic vibrations. Non-harmonic vibrations are very difficult to measure by time average digital holography due to overlapping modes generated by different harmonic components of the vibration spectral domain. However, frequency shifting of the reference arm can help to isolate the individual modes and measure them separately. The principle of the both methods is described in the paper and further their application on non-harmonic vibration is shown.

THE ZNO NANOWIRE-BASED GAS SENSOR WITH ULTRAVIOLET-LEDS

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Topic: 2. Metrology and sensors

Type of presentation: Poster

Abstract:

One dimension (1D) nanostructures such as nanowire, nanorods, nanofibers and nanotube have been widely utilizes for applications in gas sensing due to their morphology and geometry. Semiconducting metal-oxides are SnO2, ZnO and TiO2 have been proved to be stable as a gas sensing material. There are highly sensitive sensor materials because of low cost, low dimensions, low operating temperature, and rapid response. However, the sensitivity of gas sensor was limited at the room temperature (RT) because most gas sensors were only operated at above 200 °C for sensing various gas. Therefore, in this study we fabricated the 1D structure gas sensor using ZnO nanowire grown by three step growth of VLS method and used the ultraviolet LEDs of 365nm as sensing energy instead of thermal energy for measurement at RT . The ZnO nanowire with VLS method was grown by using zinc nitride and HMT (Hexamethylenetetramine) in the experiment. In order to formation of ZnO nanowire, first step is that an alumina crucible containing ZnO powder was placed at the other temperature side of the furnace. Next, ZnO nanowire on glass were scratched by scalpel. On a glass substrate, electrodes of Pt on Ti were created by electron beam. Finally, ZnO nanowire spray on electrode. The nanostructure and crystal structure of ZnO nanowire was observed by SEM (Scanning Electron Microscopy) and XRD (X-ray diffraction). The sensors were exposed to VOCs gas for 10 min. and dynamic changes of resistance of the ZnO nanowire during 3 cycles of gas in and gas out of exhausting gas with concentration of 5, 25 and 50 ppm. We have observed the difference sensitivity between reference gas sensing and turn on UV-LED gas sensing. The sensitivity of ZnO nanowire sensor was improved by photonic energy of UV-LED.

QUALITY ASSESSMENT OF GLASS JEWELLERY STONES

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Topic: 2. Metrology and sensors

Type of presentation: Poster

Abstract:

In the production of machine cut jewelry stones is necessary to ensure repeatable and accurate measurement of the stone's quality. One possible way, how to reach satisfactory results, is to use the camera-based system and appropriate methods of image post-processing. This paper deals with the methods for the identification, feature detection, and sorting of glass jewelry stones. Since the glass stones are tiny, the task of identification is quite challenging. We compared Hough transform and template matching technique. Our analysis shows that, however, template matching algorithm has significantly smaller execute time, it may produce some false positive detections, having a negative effect on the time needed to evaluate quality all detected objects. Our method employs the model representing stone features, namely facets and culet (flat face on the bottom). To detect edges of facets and stone griddle, we compared commonly using Hough transform and method of line segment detection based on weighted mean shift procedures on a 2D slice sampling strategy (LSWMS). We conclude LSWMS detector is more advantageous because it achieves a better trade-off between accuracy and speed. To detect culet, we compare radial symmetry transform and method of crossing edges. In this case, radial symmetry transform is more efficient. Then, for assessment of the degree of damage, we propose to use distance transform, widely used for unsupervised surface defect detection. It can be used both to identify samples with significant damage or samples with damage of single facet if the stone model is employed.

LARGE DISPLACEMENT AND DEFORMATION MEASUREMENT BY FREQUENCY SCANNING DIGITAL HOLOGRAPHY

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Topic: 2. Metrology and sensors

Type of presentation: Poster

Abstract:

Recently a novel method called frequency scanning digital holography was developed by authors. This paper presents how the method can be used for measurement of large displacements or deformations without ambiguity problem. Deformation or displacement values can be retrieved absolutely and independently in every single pixel and thus no unwrapping technique has to be applied in the phase map. Principle of this contactless method is introduced and experimentally verified.

ASSESSING RESOLUTION IN LIVE CELL STRUCTURED ILLUMINATION MICROSCOPY

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Topic: 3. Life science and Biophotonics

Type of presentation: Oral Presentation

Abstract:

Structured Illumination Microscopy (SIM) is a powerful super-resolution technique, which is able to enhance the resolution of optical microscope beyond the Abbe diffraction limit. In the last decade, numerous SIM methods that achieve the resolution border of 100 nm in the lateral dimension have been developed. The SIM setups with new high-speed cameras and illumination pattern generators allow rapid acquisition of the live specimen. Therefore, SIM is widely used for investigation of the live structures in molecular and live cell biology. Quantitative evaluation of resolution enhancement in a real sample is essential to describe the efficiency of super-resolution microscopy technique. However, measuring the resolution of a live cell sample is a challenging task. Based on our experimental findings, the Fourier ring correlation (FRC) method does not seem to be well suited for measuring the resolution of SIM live cell video sequences. Therefore, the assessing resolution methods based on Fourier spectrum analysis are often used. We introduce a measure based on circular average power spectral density (PSDca) estimated from a single SIM image (one video frame). PSDca describes the distribution of the power of a signal with respect to its spatial frequency. Spatial resolution corresponds to the cut-off frequency in Fourier space. In order to estimate the cut-off frequency from a noisy signal, we use a spectral subtraction method for noise suppression. In the future, this resolution assessment approach might prove useful also for single-molecule localization microscopy (SMLM) live cell imaging.

OPTICAL PROPAGATION ANALYSIS IN PHOTOBIOREACTOR MEASUREMENTS ON CYANOBACTERIA

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Topic: 3. Life science and Biophotonics

Type of presentation: Oral Presentation

Abstract:

Biotechnology applications are nowadays increasing in many areas, from agriculture to biochemistry, or even biomedicine. Microorganisms could be beneficial as they can supply fuel, drugs, food or even oxygen, among other products. Knowledge on biological processes is becoming essential in order to be able to adequately estimate and control the production of these elements. Cyanobacteria are a particular type of microorganisms that present the capability of producing oxygen and biomass, from CO2 and light irradiation. Therefore, they could be fundamental for human subsistence in adverse environments, as basic needs of breathing and food would be guaranteed. Their behavior is of utmost relevance for maximizing relevant elements production. Cyanobacteria cultivation, as other microorganisms, is carried out in bioreactors. These devices are specifically designed to favor microorganisms growth, by supplying and controlling the elements they need. In the particular case of cyanobacteria, light irradiation is fundamental for their growth, and the devices are then called photobioreactors. The adequate design of photobioreactors greatly influences elements production throughput. This design includes optical illumination and optical measurement of cyanobacteria growth. In this work an analysis of optical measurement of cyanobacteria growth in a photobioreactor is made. As cyanobacteria are inhomogenous elements, the influence of light scattering is significant. Several types of cyanobacteria are considered, as long as several spatial profiles and irradiances of the incident light. Depending on cyanobacteria optical properties, optical distribution of transmitted light can be estimated. These results allow an appropriate consideration, in the optical design, of the relationship between detected light and cyanobacteria growth. As a consequence, the most adequate conditions of elements production from cyanobacteria could be estimated.

CORRELATED FLUORESCENCE-ATOMIC FORCE MICROSCOPY STUDIES OF THE CLATHRIN MEDIATED ENDOCYTOSIS IN SKMEL CELLS

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Topic: 3. Life science and Biophotonics

Type of presentation: Oral Presentation

Abstract:

Clathrin-mediated endocytosis is one of the central pathways for cargo transport into cells, and plays a major role in the maintenance of cellular functions, such as intercellular signaling, nutrient intake, and turnover of plasma membrane in cells. The clathrin-mediated endocytosis process involves invagination and formation of clathrin-coated vesicles. However, the biophysical mechanisms of vesicle formation are still debated. Currently, there are two competing models describing the membrane bending during the formation of clathrin cages: the first involves the deposition of all clathrin molecules to the plasma membrane, forming a flat lattice prior to membrane bending to form clathrin vesicles, whereas in the second model, membrane bending happens simultaneously as the clathrin arrives to the site to form a clathrin-coated cage. We investigate clathrin vesicle formation mechanisms through the utilization of tapping-mode atomic force microscopy for high resolution topographical imaging in neutral buffer solution of unroofed cells exposing the inner membrane, combined with fluorescence imaging to definitively label intracellular constituents with specific fluorescent fusion proteins (actin filaments labeled with green phalloidin and clathrin coated vesicles with the fusion protein Tq2) in SKMEL (Human Melanoma) cells. Results from our work are compared against dynamical polarized total internal fluorescence (TIRF), super-resolution photo-activated localization microscopy (PALM) and transmission electron microscopy (TEM) to draw conclusions regarding the prominent model of vesicle formation in clathrin-mediated endocytosis.

REAL-TIME PHOTOACOUSTIC IMAGING USING HIGH-SPEED RED REGION LASER

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Topic: 3. Life science and Biophotonics

Type of presentation: Poster

Abstract:

Photoacoustic (PA) imaging is a promising biological imaging system that provides high contrast imaging with a noninvasive method. In principle, PA signals (so called ultrasound waves) are generated by the thermoelastic expansion when a short-pulsed laser is absorbed at a specific region of biological tissues. Since the wavelength of light source determines what to detect and the imaging repetition rate is related to imaging speed, the role of light source is very important in PA imaging. In conventional light source, optical parametric oscillators (OPOs) and dye lasers are mainly used in functional PA imaging, which is required to multi-wavelength. However, they are high-priced system and low repetition rate under 1 kHz. For high repetition rate, fiber microchip lasers have been recently reported with hundred kilohertz of repetition rate but the wavelength was fixed at 532 nm or 1064 nm. In addition, Supercontinuum source has been also introduced to extend the tunable wavelength range with tens kilohertz, however, broad power distribution causes low energy per band. To overcome these light sources, stimulated Raman scattering (SRS) source has been reported for recent several years. Until today, the green color SRS source has been demonstrated by PA image. In this study, we demonstrate red region laser based on SRS effect by obtaining the real-time images. Due to the fiber laser, it was possible for repetition rate to increase hundred kilohertz, which enable to obtain real-time C-scan images. In order to demonstrate performance of high-speed red region laser, phantoms were imaged with 300 kHz of A-scan acquisition rate. In the future, we will apply this technique to biomedical applications by sensing the specific target using bio-conjugated nanoparticles or dyes.

WAVELENGTH-COMB-SWEPT LASER BASED ON AOTF

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Topic: 3. Life science and Biophotonics

Type of presentation: Poster

Abstract:

Wavelength swept lasers have been developed for application of imaging (SS-OCT). The performance of the wavelength swept laser can be determined by various factors, which spectral bandwidth, linewidth (coherence length), swept repetition rate, and wavenumber (k) linearity. In the case of SS-OCT, narrowed spectral linewidth is very important for longer depth measurement. So the wavelength comb swept laser was developed for longer depth measurement. The wavelength comb swept laser has a fixed narrowband comb filter inside the cavity of conventional wavelength swept lasers. The narrow spectral linewidth of the wavelength comb swept laser decreases the sensitivity roll-off in longer depth range, enabling measuring over a longer depth range. Most of the wavelength swept lasers use the filter which wavelength sweeping is achieved by mechanical moving part. These mechanical moving parts have the disadvantage of non-wavenumber linearity. Since the linearized wavenumber (k) sweeping of swept laser is essential in signal process of SS-OCT, it is very important for swept lasers to have improved linearity of wavenumber (k) in SS-OCT. To meet the longer depth measurement and higher k-linearity wavelength comb swept laser for longer depth measurement is demonstrated. Wavelength comb swept laser with narrow spectral linewidth is generated by combination of AOTF and etalon filter.

A STUDY OF PHOTOTHERMAL EFFECT AND MULTI-PHOTON FLUORESCENCE FOR A CANCER CELL TARGETING AGENT

Soo Kyung Chun, Hyun Soo Jung , Junyoung Kwon, Hyun Ah Lee, Jaebeom Lee, Dae Youn Hwang, and Chang-Seok Kim

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Topic: 3. Life science and Biophotonics

Type of presentation: Poster

Abstract:

Near-infrared photothermal therapy (NIR PTT) is one of the new solutions for avoiding the severe side effects associated with conventional cancer therapies. It has received attention due to provide a highly localized and low power/energy cancer therapy with minor undesired side effects to normal tissues. NIR-PTT is based on the laser heating of nanoparticles. In this work, folic acid (FA), a targeting molecule to cancer cells, was conjugated to GOs via covalent amide bond. Because of high affinity for folate receptors (FRs), FA can be a promising candidate for cancer-cell targeting. Folic acid-conjugated graphene oxides (FA-GOs) can be apply to the cancer targeted photothermal therapy due to their strong absorbance at the 800nm wavelength region. On the other hand, it is also reported that graphene oxides (GOs) themselves have a three-photon induced strong photoluminescence at the 1200nm wavelength region. Therefore, FA-GOs can be applied to for a three-photon microscopy (3PM). The 3PM is promising tool for cancer detection and imaging owing to the deep imaging depth, low background signal, eliminated autofluorescence of sample, reduced photobleaching, and reduced phototoxicity. In this work we propose the dual functional agent, FA-GOs, for photothermal therapy and multi-photon imaging. Our research revealed the NIR photothermal heating and three-photon induced fluorescence from FA-GOs by using a custom-built multi-photon microscopy. To demonstrate the capacity of FA-GOs for dual-function agent for NIR PTT and imaging, we used human breast cancer cell lines (MCF7) and normal human mammary epithelial cell line (MCF-10A). We performed raster-scanning at laser wavelength of 800nm and 1200nm. Our results suggest that the FA-GOs can be used dual-function agent for localized heating for NIR PTT and optical contrast agent for 3PM.

NEAR-INFRARED INTENSITY-MODULATED WAVELENGTH-SWEPT LASER FOR DIFFUSE OPTICAL SPECTROSCOPY

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Topic: 3. Life science and Biophotonics

Type of presentation: Poster

Abstract:

Diffuse optical spectroscopy is non-invasive imaging modality which can obtain absorption and scattering properties of human tissue. Because human tissue contains several molecules and absorption spectrum of each molecule, more than two wavelength information are required. Another significant optical property of human tissue is scattering coefficient. Frequency domain diffuse optical spectroscopy is the most widely used technique which use intensity-modulated light around 100 MHz level. It is quietly difficult to construct light source which can offers both wide spectral bandwidth and intensity-modulated output. For this reason, most light source for frequency domain diffuse optical spectroscopy adopt a set of laser diodes to satisfy both wide spectral bandwidth and intensity-modulated output. Unfortunately, a set of laser diodes based system can provide only a few discrete number of wavelength information. Different from laser diode based system, white light spectrometer based system has wide spectral output that optical properties of tissue can be obtained more precisely but relatively low signal-to-noise ratio (SNR) is weakness of white light spectrometer based system. In this research, we have developed a novel light sources which can satisfy both wide spectral capacity and intensity-modulated output light, simultaneously. To obtain near-infrared output spectrum, semiconductor optical amplifier (SOA) was incorporated into the fiber ring cavity configuration. By using radio frequency (RF) signal, intensity of the output light is modulated with a few tens of MHz level.

DUAL-WAVELENGTH LASER USING STIMULATED RAMAN SCATTERING FOR PHOTOACOUSTIC EFFECT.

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Topic: 3. Life science and Biophotonics

Type of presentation: Poster

Abstract:

Photoacoustic imaging is a technique for detecting ultrasonic signal occurred from optical absorption properties of biological tissues. Contrast of Photoacoustic imaging is determined by the degree of optical absorption properties of biological tissues and imaging speed of PAI depends on the pulse repetition rate of laser light. In general, dye laser and optical parametric oscillator is used to generate specific wavelength. However, these lasers of pulse repetition rate were limited with 10 Hz ~ kHz. Unlike dye laser or optical parametric oscillator, Fiber laser is suitable for high speed photoacoustic imaging because it is possible to have high pulse repetition rate. However, fiber laser has a fixed wavelength and is hard for various samples imaging. So, we used stimulated Raman scattering effect to produce various wavelengths at a fixed 532 nm wavelength. In this work, we present a dual-wavelength laser using stimulated Raman scattering effect which have high pulse repetition rate for functional photoacoustic imaging. We have developed stimulated Raman scattering laser capable of pulse-to-pulse switching between two difference wavelength. Each wavelength has high pulse repetition rate. Pulse energy has enough to photoacoustic effect. This laser is suitable for high speed functional photoacoustic imaging by using stimulated Raman scattering.

THE STUDY ON IN-VIVO BIOMEDICAL APPLICATIONS OF FLUORESCENCE LIFETIME SIGNAL DETECTION

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Topic: 3. Life science and Biophotonics

Type of presentation: Poster

Abstract:

We studied the In-vivo biomedical applications using fluorescence lifetime technique. We desinged the experimental setup for providing the multi-plexing functions, such as confocal endomicroscopic imaging and fluorescence lifetime measurement. We used the commercially available confocal endomicroscope (Cellvizio, Mauna Kea Technologies, Paris, France) and fluorescence lifetime spectrometer (FluoTime 300, PicoQuant, Berlin, Germany), which were linked to the same optical mini-probe. We tried to approach the proposed technique to a cancer detection in gastro-intestinal tract. For the study, we subcutaneously injected AsPC-1 activated human pancreatic cancer cells into a living mouse, followed by intravenous injection of sodium fluorescein. Generally, fluorescence lifetime of sodium fluorescein depended on the local pH. Since pH value differed between abnormal and normal tissues, they could be dicriminated by measuring the fluorescence lifetime of pH-sensitive sodium fluorescein. We morphologically confirmed abnormal and normal tissues using confocal endomicroscopic imaging, and then we measured fluorescence lifetime of injected sodium fluorescein. We found the different fluorescence lifetime information of two tissues and the proposed method can be possible to access the cancer detection in the near future.

THIN FILMS STRUCTURAL PROPERTIES: RESULTS OF THE FULL-ATOMISTIC SUPERCOMPUTER SIMULATION

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Topic: 4. Simulation of photonic devices

Type of presentation: Oral Presentation

Abstract:

Multilayer thin film optical coatings are key elements of many photonic devices. Structural and optical properties of thin film coatings depend on their fabrication conditions. Quite often the investigation of these properties presents a challenge for experimental techniques. Fortunately, due to the progress in high-performance computing supercomputer simulations can be used for investigating thin films structural properties. In the present work the full-atomistic molecular dynamic simulation approach is reported and the dependencies of thin film density, refractive index, concentrations and types of defects on fabrication conditions are studied

EVALUATION OF ENERGY TRANSFER COEFFICIENTS IN TM-DOPED FIBERS FOR FIBER LASERS

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Topic: 4. Simulation of photonic devices

Type of presentation: Poster

Abstract:

Thulium doped fibers are nowadays used for optical fiber lasers and are attractive high-power laser sources operating in the region around 2 um [1,2,3]. Evaluation of energy transfer coefficients between various energy levels of Tm ions in optical fibers are required for the reliable theoretical prediction of active fiber performance in fiber laser devices [4,5]. In this work we report on the determination of the energy transfer coefficients from the measurements of the fluorescence decays of the 3F4 and 3H4 energy levels of Tm ions. Optical fiber preforms were prepared by solution-doping of Tm(3+) ions with Al(3+) ions or alumina nanoparticles. Prepared optical fibers were also characterized by means of Tm concentration profiles, refractive index profiles, optical spectral attenuations and luminescence spectra. *The research was supported by European Union, project COST MP1401 "Advanced fibre laser and coherent source as tools for society, manufacturing and lifescience" and by the Ministry of Education, Youth and Sports of the Czech Republic, project COST CZ LD15122 "Novel materials and components for advanced fiber lasers" (COFILA).* *References [1] P. Peterka, P. Honzatko, M. Becker, et al., "Monolithic Tm-doped fiber laser at 1951 nm with deep-UV femtosecond-induced FBG pair," IEEE Photonics Technol. Lett. 25(16):1623-1625 (2013). [2] J. Cajzl, P., Peterka, P. Honzátko, et al., "Characterization of fluorescence lifetime of Tm-doped fibers with increased quantum conversion efficiency", Proceeding of SPIE 9450, 945017-1-18 (2015). [3] M. Písarík, P. Peterka, J. Aubrecht, et al., "Thulium-doped fibre broadband source for spectral region near 2 micrometers", Opto-Electronics Review, 24 (4), 223-231 (2016). doi: 10.1515/oere-2016-0022 [4] M. Eichhorn, "Numerical Modeling of Tm-Doped Double-Clad Fluoride Fiber Amplifiers", IEEE Journal of Quantum Electronics, 41 (12), 1574-1581 (2005). [5] S.D. Jackson, T.A. King, "Theoretical Modeling of Tm-Doped Silica Fiber Lasers", Journal of Lightwave Technology, 17 (5), 948-956 (1999).*

DESIGN AND OPTIMIZATION OF THE SILVER NANOGRATING STRUCTURE UTILIZING SURFACE PLASMON-POLARITON FOR INCREASE OF SERS SENSOR RESPONSE

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Topic: 4. Simulation of photonic devices

Type of presentation: Poster

Abstract:

Raman spectroscopy represents an essential instrument of analytical chemistry used for analysis of chemical compounds, pollutants, biological samples and chemical elements in trace quantities. To this end, the achieved Raman signals have to be enhanced to the detectable level. One of the methods uses the surface enhanced Raman spectroscopy by which the response signal is intensified via optimized surface structures. These structures guide and preserve the surface plasmon-polariton (SPP) which further interacts with the analyte resulting in the enhancement of the original signal. This paper reports on the design of the SERS structures that was optimized through computation and simulation to obtain the best enhancement of the SPP response on these structures. The structure of the silver nano-grating was designed, fabricated, optimized and measured. Enhancement factor and increase in the absorption capabilities associated with SPP were evaluated. The Rigorous coupled wave analysis (RCWA) and Finite-difference time-domain (FTDT) computational/simulation methods were utilized. The comparison between the computation simulation outputs and the measured outputs of the fabricated samples was performed. To further increase the SERS response assessed by enhancement factor, the Au/Ag nanoparticles of computationally optimized parameters were experimentally added on the surface of the SERS sensor.

OPTICAL RRH WORKING IN AN ALL-OPTICAL FRONTHAUL NETWORK

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Topic: 4. Simulation of photonic devices

Type of presentation: Poster

Abstract:

The growing demand for the development of fast and reconfigurable fronthaul networks for mobile systems requires new directions in the design of radio-photonic devices and systems. The fronthaul network can be implemented using microwave radio-links or fiber optic links in FTTA architecture. Fiber optic networks undoubtedly provide much greater potential, but in order to enable efficient optical resource scaling, they should be based on the SDN format. Fronthaul networks for next-generation mobile systems will have the task of transmitting a very large number of digital or analog streams. Their task will be to combine a cloud of the BBU/RFU devices processing the radio signals, with the Remote Radio Heads (RRHs). The work presents the concept of Optical RRH (O-RRH), which supports the massive-MIMO features, and the optical side will be directly connected to a flexible all-optical network based on DWDM system. Properly designed O-RRH will be able to send/receive radio signals to/from BBU/RFU. Contemporary signals transmitted in the optical fronthaul network are digital and occur in the CPRI/ORI/OBSAI formats. D-RoF (Digitized Radio-over-Fiber) technology is used for this purpose. The proposed O-RRH design also enables it to work with BBU/RFU via the A-RoF (Analogue Radio-over-Fiber) interface. It can be assumed that the increase in demand for very wideband signals in the fronthaul network will be so significant, that it will be necessary to introduce analogue techniques for transmitting radio signals in an all-optical network. O-RRH, as an active optical path termination, or as an active optical network node, is only a single element of the massive-MIMO distributed antenna system (DAS). It is, the optical fronthaul network that uses O-RRH, allows to create an effective A-DAS, which is part of the development of O-eNB as distributed base station in NG-MNs.

ANALYSIS AND OBSERVERS SURVEY FOR REDUCTION OF SEA GLINT REFLECTION

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Topic: 4. Simulation of photonic devices

Type of presentation: Poster

Abstract:

When observing sea waves, a collection of glints caused by reflected light from the wave water may appear. These sea glint reflections fluctuates faster than the eye can discern. At marine environment the location and timing of these glints depend on many environmental variables.

Glints may produce severe saturation in some areas of detection and observation photography, which generates blinding glares and increased fatigue, what eventually increases marine target detection difficulty. At times, certain objects can "hide behind" these glints making them very hard to detect.

We have examined reduction of the glints in the Red-Sea by adding external linear polarizers to the observation camera. Experiments carried out an analysis in a qualitative and quantitative manner, using image processing and comparing with theory. A survey with observers was performed to examine effectiveness of the solution.

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We have examined reduction of the glints in the Red-Sea by adding external linear polarizers to the observation camera. Experiments carried out an analysis in a qualitative and quantitative manner, using image processing and comparing with theory. A survey with observers was performed to examine effectiveness of the solution.

FIBER FACET GRATINGS FOR HIGH POWER FIBER LASERS

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Topic: 5. Diffractive optical devices

Type of presentation: Oral Presentation

Abstract:

We numerically investigated the properties of diffraction gratings designed for fabrication on the facet of an optical fiber. The gratings are intended to be used in high-power fiber lasers as mirrors with a low or high reflectivity. The modal reflectance of low reflectivity polarizing grating has a value close to 3% for TE mode while it is significantly suppressed for TM mode [1]. Such a grating can be fabricated on laser output fiber facet. The polarizing grating with high modal reflectance is designed as a leaky mode resonant diffraction grating. The grating is etched in a thin layer of high index dielectric which is sputtered on fiber facet. We used Ta2O5 as a material for such a layer. Reflection of TE polarization is close to 1 and reflection of TM polarization is nearly suppressed. Rigorous coupled wave analysis was used for fast optimization of grating parameters while Aperiodic rigorous coupled wave analysis, Fourier modal method and finite difference time domain method were compared and used to compute modal reflectance of designed gratings. Optimized gratings were fabricated using focused ion beam milling. The low reflecting polarizing grating mirror was tested in thulium-doped high power laser. Preliminary measurements were performed with high reflecting polarizing grating mirrors. We gratefully acknowledge funding of this work by the Czech Science Foundation under Grant No GA15-07908S. [1] M. Vanek, J. Vanis, Y. Baravets, F. Todorov, J. Ctyroky, and P. Honzatko, "High-power fiber laser with a polarizing diffraction grating milled on the facet of an optical fiber," Opt. Express 24, 30225-30233 (2016)

THEORETICAL MODEL OF A POLARIZATION DIFFRACTIVE ELEMENTS FOR THE LIGHT BEAMS CONVERSION HOLOGRAPHIC FORMATION IN PDLCS

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Topic: 5. Diffractive optical devices

Type of presentation: Poster

Abstract:

In this work a theoretical model of the holographic formation of the polarization diffractive optical elements for the transformation of Gaussian light beams into Bessel-like ones in polymer-dispersed liquid crystals (PDLC) is developed. The model is based on solving the equations of photo-induced Fredericks transition processes for polarization diffractive elements formation by orthogonally polarized light beams with inhomogeneous amplitude and phase profiles. The results of numerical simulation of the material´s dielectric tensor changing due to the structure´s formation process are presented for various recording beams´ polarization states. In addition, the amplitude and phase distributions of the diffraction field are calculated for the recorded hologram reading stage. Based on the results of numerical simulation, the ability to form the diffractive optical elements for light beams transformation by the polarization holography methods is shown.

MONOLITHIC THULIUM-DOPED FIBER LASERS

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Topic: 6. Waveguide photonics

Type of presentation: Oral Presentation

Abstract:

Thulium-doped optical fibers are promising materials for fiber laser systems that are tunable in the wide spectral range and operate in the eyesafe wavelength near 2000 nm [1]. Various applications such as chemical sensing, material processing, and telecommunications have a great need for laser sources operating in this region [2]. Thulium-doped fiber lasers (TDFLs) are also the efficient source used to pump of holmium-doped fibers. Laser cavities usually consist of active fiber and pair of Bragg gratings (FBG). In our contribution, we have focused on comparison of two as follows laser systems. First, monolithic TDFL refers to compact laser cavities with Bragg gratings inscribed directly into the active fiber [3,4]. Second system under study is TDFL with FBG pair in passive fiber. All tested fibers fabricated in house were prepared by drawing from preforms manufactured by modified chemical vapor deposition method and solution-doping of thulium ions with aluminum ions or alumina nanoparticles. Finally, we have characterized laser systems in Fabry-Perot configuration with respect to output power, slope efficiency, and laser threshold. The research has been supported by Technology Agency of the Czech Republic (TA ČR), project TH01010997 "Thulium fiber lasers for industrial and medical applications". References [1] P. F. Moulton, G. A. Rines E. V. Slobodtchikov, K. F. Wall, G. Frith, B. Samson, and A. L. G. Carter, "Tm-Doped Fiber Lasers: Fundamentals and Power Scaling," IEEE Journal of selected topics in quantum electronics, vol. 15, no. 1,(2009). [2] M. Písařík, P. Peterka, J. Aubrecht, J. Cajzl, A. Benda, D. Mareš, F. Todorov, O. Podrazký, P. Honzátko, and I. Kašík, "Thulium-doped fibre broadband source for spectral region near 2 Micrometers," Opto-Electronics Review, 24(4), 223-231. (2016). [3] P. Peterka, P. Honzatko, M. Becker, F. Todorov, M. Pisarik, O. Podrazky, and I. Kasik, "Monolithic Tm-doped fiber laser at 1951 nm with deep-UV femtosecond-induced FBG pair," IEEE Photonics Technol. Lett. 25(16):1623-1625, (2013). [4] M. Becker, et al., "Towards a monolithic fiber laser with deep UV femtosecond-induced fiber Bragg gratings," Opt. Commun., vol. 284, no. 24, pp. 5770-5773, (2011).

ARSENIC SULFIDE LAYERS FOR DIELECTRIC REFLECTION MIRRORS PREPARED FROM SOLUTIONS

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Topic: 6. Waveguide photonics

Type of presentation: Oral Presentation

Abstract:

It is well known that chalcogenide materials exhibit high refractive indices, transparency in the mid-IR spectral region, nonlinear refractive indices, etc. They have been employed as bulks, fibers, or films in photonic devices such as light amplifiers, optical regenerators, broadband radiation sources, etc. Chalcogenide films can be prepared by physical methods. However, solution-based techniques in which such films are applied from solutions of chalcogenides in amines are more useful for coating complex 3D shapes. This paper presents results on the solution-based fabrication and characterization of single arsenic sulfide layers and multilayer stacks containing As2S3 layers which are coated on planar and fiber-optic substrates and have been tested as dielectric mirrors. Input As2S3 solutions for the layer fabrications were prepared by dissolving As2S3 powder in n-propylamine in concentrations of 0.33-0.50 mol/l. These solutions were applied on glass slides by dip-coating method and obtained layers were thermally treated in vacuum at temperatures up to 180 °C. Similar procedure was used for As2S3 layers in multilayer stacks. Such stacks were fabricated by repeating the application of one polymeric layer (e.g. silicone or acrylate polymer) and one As2S3 layer onto glass slides or silica fibers (a diameter of 0.4 mm) by using the dip-coating method. The curing process of the applied layers was carefully controlled in order to apply up to three pairs of such layers. Single layers were characterized by optical microscopy, AFM and by measuring their transmission spectra in a range of 200-2500 nm. Thicknesses and refractive indices were estimated from the spectra. Transmission and reflection spectra of planar multilayer stacks were measured, too. Multilayer stacks on silica fibers were characterized by measuring their spectral transmittance. Multiple reflection bands have been determined from optical measurements on the multilayer stacks. *This research was supported by the Czech Science Foundation (contract 16-10019S).*

MULTIMODE OPTICAL POLYMER PLANAR WAVEGUIDES FOR OPTICAL INTERCONNECTIONS

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Topic: 6. Waveguide photonics

Type of presentation: Oral Presentation

Abstract:

We report about properties of the optical multimode polymer waveguides. The waveguides were fabricated by using spin coating, following by photolithography process and wet etching. Epocere polymer were used for waveguide core layer and Epoclad polymer was used for cladding layer. The waveguides were fabricated onto silicon and different foil substrates. We also study possibilities fabrication processes for optical planar large core waveguides compatible with plastic optical fiber with dimension 750 and 1000 Îzm. For this purpose, we used for creating U-groove for core layer CNC machining or 3D printing technology. Optically clear adhesives were used as core waveguide layer.

DESIGN, FABRICATION AND CHARACTERIZATION OF SIOX/SION/SIO2/SI STRUCTURES FOR PASSIVE OPTICAL WAVEGUIDES REALIZATION

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Topic: 6. Waveguide photonics

Type of presentation: Oral Presentation

Abstract:

SiON is a suitable material for the implementation of photonic integrated circuits with a middle refractive index contrast for the visible and near infrared region. The refractive index of SiON deposited layers can be set in parameters over a wide range of technological processes from 1.45 (SiO2) to 2.00 (Si3N4). This great flexibility of refractive index selection increases the attractiveness of this material for the preparation of photonic integrated circuits for applications in information and communication systems and optical sensing because it allows the construction of planar waveguides with a favorable compromise between compactness, comparable dimensions to telecommunication optical fibers and possible variations for technological production processes. The paper presents the design, fabrication and characterization of SiON/SiO2/Si structures for passive optical waveguides realization with designed refractive index contrast 0.13. This refractive index contrast allows fabrication of strip SiOx/SiON/SiO2/Si waveguides with waveguide band losses bellow 0.01dB / cm at 150um waveguide radius. SiON and SiOx layers were fabricated by plasma-enhanced chemical vapor deposition techniques. The plasma-enhanced chemical vapor deposition technological parameters were tuned for designed refractive index contract 0.13 and designed waveguide thickness 2.5 d-m. After deposition SiON layers were annealed at temperature from 550 Â°C to 1100 for optical losses reducing caused by vibrational overtones of the N-H and Si-H bonds. The reduction of optical losses for different annealing parameter were evaluated. The refractive index of fabricated SiON layers were measured by optical elipsometry and optical losses by Fourier transform infrared spectroscopy.

CHANNEL WAVEGUIDES AND PHASE DIFRATION GRATINGS OPTICALLY FORMED IN PHOTOREFRACTIVE SURFACE LAYERS OF LITHIUM NIOBATE

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Topic: 6. Waveguide photonics

Type of presentation: Oral Presentation

Abstract:

Lithium niobate (LiNbO3) doped with some impurities like iron (Fe), copper (Cu) and their combinations is promising material to the needs of modern photonics. It allows formation of optically reconfigured phase photonic elements by laser light of low intensity. The main aim of this work is investigation of channel waveguides with spatially modulated parameters and phase diffraction gratings formed in photorefractive surface layer of LiNbO3 samples by visible light. The solid state YAG:Nd3+ and the semiconductor lasers with light wavelengths Ît=532 nm and Ît=450 nm are used as light sources in our experiments. Channel waveguides are formed by point-by-point exposure of the sample surface with focused light beam. The light power is ranged from 5 to 20 mW for the beam diameters 5 â?? 12 Îzm on half maximum intensity. The distance between exposured points in different experiments is varied between 10 â?? 60 Îzm. Characteristics of waveguide and diffraction elements are studied both the light diffraction method during their optical probing in directions normal to the exposed surface, and parallel to the sample surface. The diffraction elements are induced using the amplitude mask. The spatial periods of formed gratings in different experiments are varied from 8 to 40 Îzm. The temporal characteristics of grating formation are studied by the light intensity depletion within the zero order intensity maximum in the diffraction far field. Experimental results are demonstrated formation of channel waveguides and phase diffraction gratings along different directions with respect to the crystal optical axis, including those with spatial modulation of their parameters. This study was carried out with the financial support of Ministry of Education and Science of Russia (the project on request 3.1110.2017/PCh).

PHASE NOISE MEASUREMENTS OF SINGLE-FREQUENCY WIDELY TUNABLE YTTERBIUM FIBER LASER

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Topic: 6. Waveguide photonics

Type of presentation: Oral Presentation

Abstract:

We developed a single frequency ytterbium fiber laser widely tunable in a spectral range of 1023-1098 nm. The laser tunability is given by a narrow band grating filter while the single frequency regime is achieved by using a fiber ring resonator filter (FRRF). The key parameter for wide tunability is low resonator loss in the whole tuning range. The finesse and transmission loss of the FRRF is critically dependent on fiber couplers. We achieved a peak transmission of about 0.6 and the finesse in between 25 and 50 in the whole tuning range of the laser by careful selection of fiber couplers. The length of the main resonator is controlled by piezo-stretcher to keep it in resonance with the FRRF. The error signal is derived from signal that is not coupled into the FRRF. We examined the phase noise of the laser by a delayed self-heterodyne method (DSHM). We determined the laser line-width to be of about 10 kHz. The wavelength stability of the laser is assessed using the Mach-Zehnder interferometer.

GAIN DETERMINATION OF OPTICAL ACTIVE DOPED PLANAR WAVEGUIDES

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Topic: 6. Waveguide photonics

Type of presentation: Poster

Abstract:

The paper summarizes the results of measurement of the gain transmission characteristics of the new ion exchange Ag+ - Na+ optical Er3+ and Yb3+ doped active planar waveguide realized on a silica based glass substrates. The results were used for optimization of the precursors concentration in the glass. The gain measurements were performed by the time domain method using pulse generator, as well as broadband measurement method using supercontinuum optical source in the wavelength domain. Both methods were compared and the results were graphically processed. It has been demonstrated that pulse method results in a very accurate measurement of the gain characteristics depending on the pumping power, but only for one wavelength. In the case of radiation, spectral characteristics measurement was exactly determined the maximum gain wavelength bandwidth of the active waveguide. In this case, the spectral characteristics of the pumped and unpumped waveguides were compared. This paper also discusses calculations of the optical waveguides gain. The gain parameters of the reported silica-based glasses can be compared with the phosphate-based ones typically used for optical active devices application.

MEASUREMENT OF ATTENUATION COEFFICIENT OF CORE AND CLADDING MODES IN BRAGG FIBER

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Topic: 6. Waveguide photonics

Type of presentation: Poster

Abstract:

In this contribution a new method for determination of transmission characteristics and mechanism of optical radiation propagation in Bragg fibers is described. The investigated Bragg fibers are designed for high-power laser radiation delivery. Attenuation coefficient and coupling efficiency are usually measured using simple cut-back method for optimum mode matching of the incident radiation to the fiber mode. Our current approach is based on cut-back technique but we also investigate the dependence of the mentioned parameters on radial position of the excitation mode from the fiber axis. In addition, using the imaging of the output face of the measured fiber on a CCD camera, the spatial profile of the propagated beam can be obtained. For this reason this method is suitable for delivered laser mode control. The investigated Bragg fiber consisted of the 26um diameter silica core surrounded by three pairs of circular Bragg layers. Each pair is composed of one layer with a high and one layer with a low refractive index and is characterized by a refractive-index contrast up to ~0.03. The 1064nm laser beam was focused by a telescope onto the fiber input face. The beam radius in the focal plane was 5um. The Bragg fiber output face was imaged by a 1:6 optical telescope on the CCD camera. The transmitted power and spatial beam profile were simultaneously registered for various offset from the fiber axis. After the fiber shortening, the measurement was repeated and the cut-back was performed. The lowest attenuation coefficient of 0.17dB/m corresponded to a core mode of delivered laser radiation. In general, the attenuation was higher with a shift from the radial axis of the fiber symmetry. In the case of cladding mode excitation, the curve shows a local minimum. This phenomenon was consistent with the refractive index profile of the tested Bragg fiber.

OPTICAL PROPERTIES OF NA2O-TIO2-SIO2 GLASS FILMS PREPARED BY THE SOL-GEL METHOD

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Topic: 6. Waveguide photonics

Type of presentation: Poster

Abstract:

Films based on TiO2-SiO2 systems fabricated by sol-gel method have been investigated for the preparation of planar waveguides, antireflective coatings, Bragg mirrors, etc.. However, at high titania contents such materials exhibit high viscosities and tendency to phase separation. In this paper we present a novel approach making possible to decrease viscosities of titania-based films, which is based on the preparation of Na2O-SiO2-TiO2 glasses. Films of Na2O-SiO2-TiO2 systems were prepared from input sols mixed of silica, titania and sodium oxide sols. The silica sol was prepared from tetraethyl orthosilicate (TEOS), ethanol, hydrochloric acid and water, with a TEOS c= 2 mol/l and water/alkoxide ratio 1.75. The titania sol was mixed from titanium tetraisopropoxide (TiPr), propan-2-ol, nitric acid and water, c= 0.5 mol/l, RW= 0.42. The sodium oxide sols with c= 0.5 and 1 mol/l were prepared from sodium acetate and 2-methoxyethanol. The each sol was aged for one hour. The input sols were prepared by mixing the silica and titania sols first and then the sodium sol was added. The input sols were aged for one hour. Stable input sols have been obtained with a titania content up to 30 mol.% and sodium oxide contents from 0 to 20 mol%. The input sols were deposited on silica slides by dip-coating technique at withdrawing speeds in a range of 100-300 mm/min. Applied gel layers were thermally treated at temperatures in a range of 450-900°C. Optical properties of layers were determined by UV-VIS-NIR spectrophotometry. Refractive indices of layers were determined by spectral ellipsometry and from transmission spectra. Optical properties were correlated with results of XRD spectroscopy, optical and electron microscopy, and atomic force microscopy. Homogenous and transparent films have been prepared. This research was supported by the Czech Science Foundation (contract 16-10019S).

THE BEHAVIOR OF THE GEOMETRICAL PARAMETERS OF OPTICAL BEAM OF OPTICAL PASSIVE COMPONENTS UNDER THE LONG TIME TEMPERATURE LOADING

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Topic: 6. Waveguide photonics

Type of presentation: Poster

Abstract:

The paper discuss about aging of the passive optical couplers in their burdened high temperature. The article focuses on applied research and experimental development of resources for safety operation of optical networks in environment with higher temperature. It addresses issues of accelerated aging of optical fiber components in their burdened with high temperature. How does temperature influence on optical network elements? It is necessary to specify the changes in the optical coupler and find out why these changes occur. This article is devoted experimental measurement of the impact of temperature loading on the geometrical parameters of optical beam of SM optical FBT couplers. In the paper there are compared couplers of different manufacturers and same dividing ratios of output power 1:8. Optical passive component were continuously exposed to temperature 95°C for long time period. Measurements are focused on the parameters of geometry of optical beam. Graphical and mathematical detect changes in the dissemination of energy coupler after long lasting dose of temperature loading are useful to understand the phenomenon of accelerated aging elements of optical networks in environments with an higher temperature.

FORMATION OF 2D BRIGHT SPATIAL SOLITONS IN LITHIUM NIOBATE WITH PHOTOVOLTAIC RESPONSE AND INCOHERENT BACKGROUND

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Topic: 6. Waveguide photonics

Type of presentation: Poster

Abstract:

Lithium niobate doped with some impurities demonstrates the photorefractive optical nonlinearity that makes possible optical formation of waveguide elements. At the same time, its photorefractive nonlinearity has the negative sign that allows formation only dark spatial solitons in this material exploiting normal photorefractive response. To overcome this limitation, the drift mechanism of the charge carrier transport, the pyroelectric effect and the coherent background illumination with distinct wavelengths at the photovoltaic charge carrier transport have been proposed. In this study we use the incoherent background to form two-dimensional bright spatial solitons in lithium niobate bulk. The light emitting diodes with central wavelengths from 400 to 525 nm and crystal sample doped with Fe (0,005 wt.%) are used in our experiments. To test the change of both, ordinary and extraordinary refractive indices of our crystal sample via incoherent background, the setup with interference of He-Ne laser beams reflected from the entrance and the exit surfaces of the sample are used at light propagation along direction normal to the crystal optical axis. Additionally, the evolution of narrow laser beam divergence is inspected when the incoherent background is transported to the crystal sample with common optical scheme and with optical fibers. The experimental results obtained demonstrate the strong influence of the incoherent background on diffraction divergence of narrow coherent red and green light beams using background with shorter wavelengths.

SINGLE-MODE DISTRIBUTED FEEDBACK LASER OPERATION FROM GAIN MEDIA WITH ARBITRARY MORPHOLOGIES

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Topic: 7. Organic photonic materials and devices

Type of presentation: Oral Presentation

Abstract:

Organic distributed feedback (DFB) lasers have attracted great interests in photonics, due to their single-mode operation with broad tuning range and wide choice of gain materials. However, the uses of gain media as resonators or waveguides themselves in conventional photonic structures are not suitable for lasing from irregular shaped gain media, such as dye-staining cells and tissues, in biological applications. Here we reported single-mode distributed feedback laser operation with no dependence on the morphologies of the optical gain media. A template structure comprising a one-dimensional quartz grating and a discrete thin titanium dioxide (TiO2) layer deposited atop was prepared. Based on the TiO2 grating template, single mode DFB lasing actions occurred from a variety of states of optical gain. In our study, drop-casted and spin-coated silk/rhodamine B (RhB) mixture films, methanol solution of RhB, and a flat free-standing silk/RhB film were employed as external gain media. Numerical simulations using the finite-difference time-domain (FDTD) method showed that the photons were well confined in the 25-nm thin discrete layer of TiO2 even if there is no index difference between substrate and superstrate regions. We also proved that our laser structures have large tuning range in mode peaks over changing the refractive index of the superstrate, which is a desirable property for refractive index sensing. The sensitivity of ~ 100 nm/RIU of our DFB RI sensor was obtained by further FDTD simulations. In conclusion, we demonstrated a versatile grating template to induce single mode DFB lasing from gain media with arbitrary morphologies. We expect that the findings of this study can strongly suggest the application of organic DFB dye lasers as an outstanding sensing device in the biological and environmental sciences.

INFRARED WIRE-GRID POLARIZER WITH SOL-GEL ANTIREFLECTION FILMS ON BOTH SIDES

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Topic: 7. Organic photonic materials and devices

Type of presentation: Poster

Abstract:

Low-cost infrared polarizers with the high transverse magnetic (TM) polarization transmittance and high extinction ratio are desired in various applications. In this study, the infrared wire-grid polarizer consisting of an Al grating, a Si plate, sol-gel derived zirconia films, and grating was fabricated by sol-gel method, soft imprint process, and Al shadow coating processes. A silicone mold was used because of its low surface energy, flexibility, and capability of transferring submicrosized patterns. A zirconia film was coated on Si substrate by using sol-gel method and spin coating method. Then, sol-gel zirconia grating were formed on the back side using soft imprint lithography. After the sol was dropped on the silicone mold, a Si plate was placed on this mold. The Si plate was placed on the mold filled with zirconia sol. After placing this substrate on the mold, it was heated to 150Â°C. The silicone mold was peeled off from the molded grating. The wire grids were produced by depositing around 100-nm-thick Al obliquely on the formed zirconia gel grating with a pitch of 400 nm. The fabricated polarizer exhibited a polarization function with the TM transmittance greater than that of the Si substrate in the 4.2â□□5.7 Îźm wavelength range, because the zirconia films acted as an antireflection films. The maximum transmittance exceeded 80% at a wavelength of 4.8 Îźm, the extinction ratio exceeded 26 dB at its wavelength. This increment of the TM transmission spectrum results in interference within the zirconia films. The extinction ratio exceeded 20 dB in the 3.2â□□7.8 Îźm wavelength range. This experiment verified that imprinting onto a sol is very effective for the low-cost fabrication of infrared polarizers. This wire-grid polarizer has significant potential in various application areas such as ellipsometry, spectroscopy, and security imaging.

PROPERTIES OF NEW DESIGNED THERMO- AND PHOTO- REACTING MATERIALS HAVING FLUORANS AND PORPHIRINS

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Topic: 7. Organic photonic materials and devices

Type of presentation: Poster

Abstract:

In this study, the syntheses of a new zinc porphyrin complex and fluoran molecules are reported. This novel metal porphyrin was characterized by 1H NMR, FT-IR, UV-Vis and HR-MS analysis. This porphyrin shows a strong thermo chromism effect that is reflected by its absorption and emission maxima in different medium. The reversible thermochromic property of this material was investigated at different temperatures by UV-Vis studies in toluene. The large thermochromic effect detected for the dye was attributed to pyridyl, phenyl and acetylene groups, whose association and dissociation dynamics in toluene lead to an absorption light spectral change with temperature, accompanied by a change in color. The axial coordination studies also conducted and finally, DFT calculations were performed to rationalize the molecular structures of materials.

THULIUM-DOPED OPTICAL FIBERS FOR FIBER LASERS

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Topic: 8. Non-linear materials, devices and applications

Type of presentation: Oral Presentation

Abstract:

Rare-earth doped optical fibers are inherent components of fiber lasers. These lasers are nowadays researched for a wide range of applications in spectroscopy, medicine, defense and material processing. Fiber lasers offer a good alternative to conventional solid state lasers because of their numerous advantages including high brightness, excellent beam quality, low thermal load, compactness and flexibility. In the case of high-power fiber lasers, silica is used as a matrix for luminescent rare-earth ions. Silica-based fibers exhibit thermal and chemical durability, environmental stability and high transparency. On the other hand, the solubility of rare-earth elements in pure silica is low. To increase it, alumina is commonly used as a co-dopant. Alumina can be doped from a solution or directly in the form of nanoparticles. In this contribution, we deal with preparation and characterization of silica-based specialty optical fibers for fiber lasers. The fibers were prepared by modified chemical vapor deposition process and doped with Al2O3 and Tm3+. Alumina was doped through both processes - solution doping and nanoparticle doping. Prepared preforms were characterized according to refractive index profiles and dopants distribution. The fibers were studied related to spectral attenuation, fluorescence lifetime and laser performance. In the case of nanoparticle doping, better laser characteristics were observed. Improved characteristics will be presented and trends will be explained.

MODE-LOCKING PECULIARITIES IN AN ALL-FIBER ERBIUM-DOPED RING ULTRASHORT PULSE LASER WITH A HIGHLY-NONLINEAR RESONATOR

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Topic: 8. Non-linear materials, devices and applications

Type of presentation: Oral Presentation

Abstract:

Today ultrashort pulse (USP) fiber lasers are in great demand in a frequency metrology field, THz pulse spectroscopy, optical communication, quantum optics application, etc. Therefore mode-locked (ML) fiber lasers have been extensively investigated over the last decade due the number of scientific, medical and industrial applications. It should be noted, that USP fiber lasers can be treated as an ideal platform to expand future applications due to the complex ML nonlinear dynamics in a laser resonator. Up to now a series of novel ML regimes have been investigated e.g. self-similar pulses, noise-like pulses, multi-bound solitons and soliton rain generation. Recently, we have used a highly nonlinear germanosilicate fiber (with germanium oxides concentration in the core ~ 50 mol. %) inside the resonator for more reliable and robust launching of passive mode-locking based on the nonlinear polarization evolution effect in fibers. In this work we have measured promising and stable ML regimes such as stretched pulses, soliton rain and multi-bound solitons formed in a highly-nonlinear ring laser and obtained by intracavity group velocity dispersion (GVD) variation in slightly negative region. As a result, we have obtained the low noise ultrashort pulse generation with duration < 250 fs (more than 20 bound pulses when obtained multi-bound soliton generation with intertemporal width ~ 5 ps) at a repetition rate ~ 11.3 MHz (with signal-to-noise ratio at fundamental frequency > 59 dB) and relative intensity noise <-101 dBc / Hz.

LASER FABRICATION OF MECHANICAL TRAPS FOR SENSITIVE ATOMIC FORCE MICROSCOPY INVESTIGATION OF THE LOCAL NANOMECHANICAL PROPERTIES OF LIVING CELLS

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Topic: 8. Non-linear materials, devices and applications

Type of presentation: Oral Presentation

Abstract:

Nanomechanical properties of cell membranes are of particular interest since they exhibit characteristics of many biological processes undergoing inside living cells. Nanoscale membrane fluctuations are also considered as a signature of life.1 They are correlated with cellular activities, physiology and metastatic potential and, hence, can be used for diagnostics. For nanoscale measurements of fluctuations using atomic force microscopy (AFM), microbial cells must be immobilized which is usually done via mechanical trapping, e.g. in polycarbonate membranes.2 Cell walls exhibit temperature-dependent nanomechanical motion at characteristic frequencies2 which can be used to monitor cellular response to changes in physiological conditions or exposure to certain drugs. In this work, based on the results of ultrafast-laser processing of Corning Willow glass,3 we present a laser-ablation method of microwell fabrication to immobilize living cells for AFM measurements of their nanomechanical motions. Microwells were fabricated on surfaces of glass bottom dishes made of dž100-d-m-thick borosilicate glass. They have diameters in the range of 10â??15 um and a depth of dž5â??8 um. For their fabrication, single- and multi-shot laser ablation was performed by a Ti:sapphire laser operating at dZ = 800 nm with a pulse width of dž130 fs. A range of techniques such as space-and-time resolved spectroscopy and optical profilometry were used to study laser ablation dynamics and crater (microwell) quality. First testing results of AFM measurements of nanomechanical motion of living cells trapped in the laser-produced mechanical traps will also be reported. 1. Kasas, S. et al. Detecting nanoscale vibrations as signature of life, PNAS 112, 378 (2015). 2. Pelling, A.E. et al Time dependence of the frequency and amplitude of the local nanomechanical motion of yeast. Nanomedicine 1, 178 (2005). 3. Mirza, I. et al. Ultrashort pulse laser ablation of dielectrics: Thresholds, mechanisms, role of breakdown, Scientific Reports, 6, 39133 (2016).

EFFICIENCY ENHANCEMENT OF THE MIR DFG LASER SOURCE BASED ON PERIODICALLY POLED KTP CRYSTAL BY OPTIMAL FOCUSING CONDITIONS

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Topic: 8. Non-linear materials, devices and applications

Type of presentation: Oral Presentation

Abstract:

High-resolution laser spectroscopy in mid-infrared (MIR) wavelength range is used for monitoring and measurement in various fields of everyday human life, for instance, exhaled air breath monitoring in biomedicine, leakage of dangerous chemicals detection in industry, atmospheric trace gases analysis in environmental science. The most employed laser sources for spectroscopy include quantum cascade lasers available in wide spectral ranges, fiber laser MIR supercontinuum sources, and narrow-band widely-tunable laser sources based on nonlinear optical interactions. Lasers based on a difference frequency generation (DFG) process ordinary have one major disadvantage of low output radiation power at MIR wavelengths, but quasi-phase matching (QPM) technique allows to enhance the efficiency by using periodically poled (PP) nonlinear crystals. For this purpose two main directions are used. One way is based on an engineering of QPM devices with a special periodic structure or an aperiodically poled structure. The second possibility is described in this work and concerns a calculation and optimization of focusing conditions of pump and signal beams. For a calculation of the efficiency of nonlinear optical processes Boyd and Kleinman used a conventional assumption of the equal confocal parameters of the focused Gaussian pump, signal and idler beams. Guha analytically proved that this assumption does not provide the optimal conversion efficiency. Our calculations predict an increase of the DFG efficiency by an order of magnitude when the pump beam is focused on an input edge and the signal beam is focused on an output edge of the PPKTP crystal. We also discuss the influence of the beam waist sizes on the efficiency.

ANALYSES OF ELECTRONIC AND OPTICAL PROPERTIES OF NEW TTF-BASED AZINE DERIVATIVES.

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Topic: 8. Non-linear materials, devices and applications

Type of presentation: Oral Presentation

Abstract:

The development of numerous organic and hybrid organic NLO materials very rapidly expanding area of optoelectronics and show as a promising applications in high-speed information processing and telecommunications.[1] The tetrathiafulvalene (TTF) is widely used due for its the versatile of its chemistry which provides a wide range of functionalized derivatives.[2] It well known that the TTF is strong D?-electron donor with excellent oxidation potentials and it is next one of the many advantages of this donor group for creating the new multifunctional molecules.[3] The electronic and nonlinear optical (NLO) properties of four tetrathiafulvalene-appended azine derivatives were studied experimentally as well as calculated theoretically. The processes of second and third harmonic generations in guest-host polymeric films were investigated and NLO parameters were extracted. Quantum chemical calculations of mentioned structures were carried out by The Density Functional Theory (DFT), and two different hybrid potentials was used namely B3LYP and LC-BLYP and implemented in GAMESS program package as well as computing nonlinear optical properties was utilizated GAUSSIAN program. The procedure was performed for an isolated molecule in vacuum as well as taking into account the solvent effect. The results shown that the LC-BLYP potential is better for calculation of electronic and optical properties, the values of absorptions are in better agreement with experimental data. The dipole moment of molecules indicate mentioned molecules as promosing materials in optoelectronics field. The calculation results were not significantly changed under the influence of solvent this mean that the solvent doesnâ??t effect on the intermolecular transfer of electron and also on the nonlinear responses. The organic materials will be [1]B. K. Kuanr, S. Maat, S. Chandrashekariaih, V. Veerakumar, R. E. Camley, Z. Celinski, J. Appl. Phys. 103, 2008, 07C107. [2] J-F. Bergamini, P. Hapiot, D. Lorcy, Journal of Electroanalytical Chemistry, 593, 2006, 87-91. [3] V. A. Azov, R. Gomez, J. Stelten, Tetraedron. 64,2008,1909-1917.

FORMATION OF PHOTONIC STRUCTURES IN PHOTOREFRACTIVE LITHIUM NIOBATE BY 1D AND 2D BESSEL-LIKE OPTICAL FIELDS

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Topic: 8. Non-linear materials, devices and applications

Type of presentation: Poster

Abstract:

The solid-state YAG:Nd3+ laser with light wavelength of 532 nm and semiconductor laser (light wavelength 450 nm) are used in experiments on formation of 1D and 2D Bessel-like beams from Gaussian laser beams. We use the amplitude masks and cylindrical or spherical lenses to form Bessel-like fields. 2D beams are also formed using phase masks shaped as the multi-mode optical fibers and glass hollow waveguides. Photonic phase diffraction structures and lattices are generated in photorefractive lithium niobate samples doped with iron or copper. Characteristics of diffraction structures are studied by diffraction of He-Ne laser radiation with inspection of diffraction pictures as in the near field as in the far field. The distribution of light intensity among far-field diffraction maxima is measured with photo-receiver and used to reconstruct refractive index profile of 1D grating and its temporal evolution during formation. The spatial "periods" of phase diffraction structures range in our experiments from 10 to 50 microns. We also study the discrete diffraction of focused He-Ne laser radiation within both, 1D and 2D photonic lattices induced in lithium niobate by obtained Bessel-like beams.

ALL-SOLID-STATE, SYNCHRONOUSLY PUMPED, ULTRAFAST BAWO4 RAMAN LASER WITH LONG AND SHORT RAMAN SHIFTS GENERATING AT 1180, 1225, AND 1323 NM

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Topic: 8. Non-linear materials, devices and applications

Type of presentation: Poster

Abstract:

Much attention is currently focused on synchronously pumped, extra-cavity crystalline Raman lasers generating one or two Stokes Raman components in KGW [Granados et al. Opt. Express, 18, 5289 (2010)] or diamond [Warrier et al. Opt. Express, 22, 3325 (2014)] Raman-active crystals, and also generating additional components of stimulated polariton scattering in lithium niobate crystal having both cubic and quadratic nonlinearities [Warrier et al. Opt. Express, 23, 25582 (2015)]. In this contribution we report on generation of more than two Stokes components of stimulated Raman scattering with different Raman shifts in the all-solid-state, synchronously pumped, extra-cavity Raman laser based on the Raman-active a-cut BaWO4 crystal excited by a mode-locked, 220 nJ, 36 ps, 150 MHz diode side-pumped Nd:GdVO4 laser generating at the wavelength of 1063 nm. Excitation by the pumping radiation polarized along the BaWO4 crystal optical axis resulted in Raman generation with not only usual (925cm - 1), but also additional (332cm - 1) Raman shift. Besides the 1180-nm first and 1323nm second Stokes components with the Raman shift of 925cm - 1 from the 1063nm fundamental laser wavelength, we have achieved generation of the additional 1225nm Raman component with different Raman shift of 332cm - 1 from the 1180nm component. At the 1225nm component the strongest 12-times pulse shortening from 36ps down to 3ps was obtained due to shorter dephasing time of this additional Raman line (3ps for the 332-cm - 1 line instead of 6.5ps for the 925cm - 1 line). It has to be also noted that the 1225nm generation is intracavity pumped by the 1180nm first Stokes component resulting in the strongest pulse shortening close to the 332cm -1 line dephasing time (3ps). Slope efficiency of three Stokes components generation exceeded 20%.

GENERATION OF 120 PS, 1168 NM ANTI-STOKES PULSES FROM THE ALL-SOLID-STATE, SELF-MODE-LOCKED, PARAMETRIC RAMAN CACO3 LASER WITH INTRACAVITY PUMPING BY 1338 NM ND:YAG LASER

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Topic: 8. Non-linear materials, devices and applications

Type of presentation: Poster

Abstract:

Parametric Raman conversion of laser radiation allows to generate not only Stokes, but also anti-Stokes radiation components with the frequency shift equal to the Raman frequency of Raman-active medium. In contrast to conventional stimulated Raman scattering the parametric Raman conversion needs phase matching fulfillment of parametric four-wave mixing at resonant Raman nonlinearity. It is known that phase matching can be realized for non-collinear parametric Raman wave interaction, but conversion efficiency is low because of high sensitivity to angular mismatch. Recently [S.N. Smetanin, et al. Laser Phys. Lett. 13, 015801 (2016)] fulfillment of collinear phase matching of parametric Raman interaction of orthogonally polarized waves in the birefringent Nd:SrMoO4 crystal allowed to achieve the self-Raman parametric generation with shortening of the parametrically generated pulse to 280 ps that is 10 times shorter than the fundamental Q-switched laser pulse. In this contribution, we report on novel, all-solid-state, self-mode-locked, collinearly phase-matched, parametric Raman Nd:YAG/CaCO3 laser at 1168nm anti-Stokes wavelength. We have realized parametric Raman conversion into the 1565nm Stokes and 1168 nm anti-Stokes components and self-mode-locking using single Kerr-lens and Raman-active CaCO3 nonlinear crystal inside the cavity of the diode side-pumped Nd:YAG laser generating at 1338 nm. Collinear phase matching of equally polarized Stokes-anti-Stokes coupling was self-organized due to zero dispersion of the CaCO3 crystal at the fundamental laser wavelength (1338 nm). We have demonstrated possibilities of the Stokes and anti-Stokes picosecond pulse shortening and separation of few and even only one 120ps ultra-short 1168nm anti-Stokes pulse from the self-mode-locked laser pulse train because of fast and spatially uniform depletion of pumping of intracavity Raman conversion without using any electro-optical device. We have obtained high energy output of up to 1.1uJ in the single intensive anti-Stokes 120ps ultra-short pulse which was up to 6.8% from overall output radiation pulse train energy.

POWER REQUIREMENTS REDUCING OF FBG BASED ALL-OPTICAL SWITCHING

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Topic: 8. Non-linear materials, devices and applications

Type of presentation: Poster

Abstract:

Fiber Bragg gratings (FBGs) are well known devices, but their using as all-optical switching elements is still examined. Current research is focused on optimization their properties for their using in future all-optical networks. The main problem is minimizing of switching intensities needed for achieving the changes of transmission state. Switching intensities were over several years reduced from hundreds of GW/cm2 to tens of MW/cm2 by selecting appropriate gratings and signal parameters or using suitable materials. Two principal nonlinear effects with similar power requirements can result in the bistable transmission/reflection of an input optical pulse. In the self-phase modulation (SPM) regime switching is achieved by the intense probe pulse itself. Using cross-phase modulation (XPM) a strong pump alters the FBG refractive index experienced by a weak probe pulse. As a result of this the detuning of the probe pulse from the center of the photonic band gap occurs. Using of XPM the effect of modulation instability is reduced. Modulation instability which is the main SPM degradation mechanism. We focused on nonlinear FBGs based on chalcogenide glasses which are very often used in various applications. Chalcogenide glasses thanks to their high nonlinear parameters are suitable candidates for reducing switching intensities of nonlinear FBGs.

ANALYSES OF RESOURCE RESERVATION SCHEMES FOR OPTICAL BURST SWITCHING NETWORKS

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Topic: 8. Non-linear materials, devices and applications

Type of presentation: Poster

Abstract:

With growing demands of Internet Protocol services for transmission capacity and speed, the Optical Burst Switching presents the solution for future high-speed optical networks. Optical Burst Switching is a technology for transmitting large amounts of data bursts through a transparent optical switching network. To successfully transmit bursts over OBS network and reach the destination node, resource reservation schemes have to be implemented to allocate resources and configure optical switches for that burst at each node. The one-way resource reservation schemes and the performance evaluation of reservation schemes are presented. The OBS network model is performed using OMNeT++ simulation environment. During the reservation of network resources, the optical cross-connect based on semiconductor optical amplifier is used as the core node. Optical switches based on semiconductor optical amplifiers are a promising technology for high-speed optical communication networks.

OPTICAL SELF-ACTION OF BRIGHT SOLITON BEAMS IN PHOTOREFRACTIVE LITHIUM NIOBATE SAMPLES WITH PYROELECTRIC MECHANISM OF NONLINEAR RESPONSE

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Topic: 8. Non-linear materials, devices and applications

Type of presentation: Poster

Abstract:

Compensation for the nonlinear diffraction of narrow laser beams with wavelength of 532 and the formation of photonic waveguides and waveguide circuits due to the contribution of pyroelectric effect to the nonlinear response of lithium niobate crystal have been experimentally demonstrated. Complete compensation for the linear and nonlinear diffraction broadening of light beams is obtained upon uniform heating of an undoped sample from room temperature to 55 degrees Celsius. An analysis of the light-field distribution patterns and the corresponding intensity distribution profiles allowed us to estimate the spacing for the channel waveguides. The observed behavior of bright soliton beams may be caused by their coherent interaction, which manifests itself in repulsion for anti-phase light fields and in attraction for in-phase light fields. The experimental results of this study showed a fundamental possibility of forming optically complex waveguide structures in lithium niobate crystals with pyroelectric mechanism of nonlinear response. The topology of these structures is determined by the light field distribution on the input face of crystalline sample. The optical induction of channel waveguide elements by interacting spatial solitons makes it possible to design optical systems with a more complex topology and a possibility of their dynamic reconfiguration.

DIODE-PUMPED CR-DOPED ZNMNSE AND ZNMGSE LASERS

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Topic: 8. Non-linear materials, devices and applications

Type of presentation: Poster

Abstract:

Chromium ions Cr2+ are known to have good fluorescence properties in the mid-infrared spectral region around the wavelength of 2.5 ÂIm. The aim of this study was investigation of new laser crystal materials Zn0.95Mn0.05Se, Zn0.70Mn0.30Se, and Zn0.75Mg0.25Se doped by chromium ions and comparison of their characteristics. The spectroscopic parameters as absorption and fluorescence spectra were measured. The spontaneous emission spectra were in wavelength range from 2030 nm up to 2665 nm. The realized laser systems were pumped by a laser diode generating at the wavelength of 1.69 Îzm (pulse repetition rate 10 Hz, pulse width 2 ms). The longitudinal-pumped resonator was hemispherical with a output coupler radius of curvature 150 mm. The laser emission spectra were investigated and the highest intensity of emitted radiation was achieved at wavelengths 2451 nm, 2469 nm, and 2470 nm from Cr:Zn0.95Mn0.05Se, Cr:Zn0.70Mn0.30Se, and Cr:Zn0.75Mg0.25Se laser systems respectively. The input-output characteristics of laser systems were measured: the maximum output peak power 177 mW was obtained for Cr:Zn0.95Mn0.05Se laser system with slope efficiency of 6.3 % in respect to absorbed peak power. The output beam spatial structure was also studied and during measurements was stable. For the selection of the lasing wavelength, the single 1.5 mm thick silica plate was placed inside the optical resonator at the Brewster angle between the output coupler and laser active medium. This element provided the tuning wavelength range 2292â??2593 nm, 2353â??2540 nm, and 2424â??2551 nm for Cr:Zn0.95Mn0.05Se, Cr:Zn0.70Mn0.30Se, and Cr:Zn0.75Mg0.25Se, respectively. The obtained spectral linewidth of the individual output radiation was Î?ÎtFWWH â?? 10 nm.

SOLAR-PUMPED PASSIVELY MODE-LOCKED ND:CR:YAG LASER FOR LASER ABLATION APPLICATIONS

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Topic: 9. Solar cells, Solid State Lighting + LED, LD, OLED

Type of presentation: Oral Presentation

Abstract:

Strong and broad absorption bands are known to emerge within Nd:Cr:YAG ceramics which correspond to intense parts of the solar radiation spectrum. Solar pumping is generally achieved by direct focusing of a concentrated solar beam down to an area of approximately the size of the laser medium, which is incident upon either the side or the end of the medium itself. We demonstrate a solar-pumped passively mode-locked high power Nd:Cr:YAG laser which is optically pumped by several polymer optical fibers (POFs). The sunlight is confined in the POFs in order to focus it more finely upon the laser medium using aspheric lenses. Our collimation system provides scope to investigate the improvement of beam quality inside the laser cavity. With the achievement of a higher intra cavity beam quality a semiconductor saturable absorber mirror (SESAM) can be used to generate picosecond pulses via passive mode locking. With the generation of high intensity picosecond pulses applications such as laser ablation become feasible. In addition, every POF can deliver solar energy from independent solar collectors. Thus, compared to a single collector system, the pump power can be considerably increased in a facile manner. Another interesting feature of the collimation system is that the focusing provides the intensity required to exceed the laser threshold of the solar Nd:Cr:YAG laser even at times where peak solar irradiance is unavailable, i.e., potentially partially cloudy days. Acknowledgments: This research was supported by CONICYT-PIA ACT1409.

THERMAL STABILITY OF GALLIUM ARSENIDE SOLAR CELLS

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Topic: 9. Solar cells, Solid State Lighting + LED, LD, OLED

Type of presentation: Oral Presentation

Abstract:

This article summarizes a measurement of gallium arsenide (GaAs) solar cells during their thermal processing. These solar cells compared to standard silicon cells have better efficiency and high thermal stability. However, their use is partly limited due to high acquisition costs. For these reasons, GaAs cells are deployed only in the most demanding applications where their features are needed, such as space applications. In this work, GaAs solar cells were studied in a high temperature range within 30-650 oC where their functionality and changes in surface topology were monitored. These changes were recorded using an electron microscope which determined the position of the defects. Using an atomic force microscope we determined the roughness of the surface and an infrared camera that showed us the thermal radiated places of the defected parts of the cell. The electrical characteristics of the cells during processing were determined by its current-voltage characteristics. Despite the occurrence of subtle changes on the solar cell with newly created surface features after 300 °C thermal processing, its current-voltage characteristic remained without a significant change.

OPTICAL PROPERTIES OF BULK HETEROJUNCTIONS BASED ON TIO2 AND MOS2

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Topic: 9. Solar cells, Solid State Lighting + LED, LD, OLED

Type of presentation: Oral Presentation

Abstract:

Semiconductors used in alternative energy sources such as solar cells are subject to a number of requirements (low recombination, high stability), most of which fulfill titanium dioxide (TiO2). However, the width of the TiO2 energy gap is too large (about 3.2 eV) and because it is one of the parameters that determine the conversion efficiency of solar cell, this material should be modified. Recent high hopes have been raised by the combination of TiO2 with molybdenum disulfide (MoS2), whose energy gap (bulk:1.2 eV, monolayer: 1.8 eV) causes the material to absorb light in the visible range. The electronic structure of multi-layer MoS2 and TiO2 suggest electron injection from MoS2 conduction band (CB) to TiO2 CB. To make this injection more likely the size quantum effect in MoS2 should be taken into account. If MoS2 is in few-layer state, MoS2 in combination with TiO2 is a junction with electronic level configuration that enables the diffusion of charge carriers in the junction. In this research, MoS2 and TiO2 bulk heterojunctions were obtained by magnetron sputtering and examined for optical. Based on Tauc analysis the energy gap (Eg) is 1.48 eV for MoS2 and 3.27 eV for TiO2. This means that the size quantum effect was obtained for MoS2 grains, what is good prediction for MoS2-TiO2 solar cells performance.

SURVEY TEST RUNS WITH PIXEL LIGHT SYSTEMS

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Topic: 9. Solar cells, Solid State Lighting + LED, LD, OLED

Type of presentation: Oral Presentation

Abstract:

HID, LED and laser-based high resolution automotive headlamps, as of late known as `pixel light systems´, are at the forefront of the developing technologies paving the way for autonomous driving. The underlying objective is to improve the driving experience, in any given scenario, in terms of safety, comfort and interaction for all road users. Pixel light systems are able to address a 100,000+ pixels individually. Using camera information, this capability allows for a `glare-free´ distribution of light that is perfectly adapted to the needs of all road users. First results from a Micromirror (DMD) based unit using an HID lamp source have demonstrated on-road projections at a distance of up to 25m. Current prototype concepts under development involve DMD-based units that utilize high power LEDs and LED arrays as light sources. DMD-based units allow parts of the light distribution to be modulated simultaneously. Projection capability of pixel light systems can be used for: dynamic lane change assistance and projection of navigation data, warning signs, car status information etc. This paper will investigate and highlight the advantages of these pixel light systems i.e. their unique light distribution and projection capabilities will be surveyed in carefully designed high-risk driving scenarios. As a first step, an international database of accident analysis studies performed in the last 5 years will be constructed. Using this database, scenarios will be shortlisted where pixel light systems, possibly in co-ordination with other advanced driver assistance systems, can reasonably be expected to play game changer roles. Feedback of survey participants will be documented, analyzed and the conclusions presented. Findings from this study may be used to identify areas for future research with regards to: further (technological) development of pixel light systems, behavioral response studies, examination of optimal light sources etc.

EFFICIENT CONCEPTUAL DESIGN OF AN LED-BASED PIXEL LIGHT VEHICLE HEADLAMP

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Topic: 9. Solar cells, Solid State Lighting + LED, LD, OLED

Type of presentation: Oral Presentation

Abstract:

High-resolution vehicle headlamps represent a future-oriented technology that can be used to increase traffic safety and driving comfort in the dark. A further development to the current matrix beam headlamps, LED-based pixel light systems enable ideal lighting functions (e.g. projection navigation information on the road) to be activated in any given driving scenario. Compared to other light-modulating elements such as DMDs or LCDs, instantaneous LED on-off toggling provides a decisive advantage in efficiency. For the generation of highly individual light distributions required for automotive applications, a number of approaches using an LED array may be pursued. One approach is to simply vary the LED density in the array according to the specific light distribution. Another approach that stands out makes use of an equidistant arrangement of the individual LEDs together with distortion optics to formulate the desired light distribution. The optical system distorts the light distribution in a manner that improves resolution and increases luminous intensity in the desired area. An efficient setup for pixel generation calls for one lens per LED. In view of the limited space requirements of the system, this implies that the luminous flux, efficiency and resolution outputs are primarily controlled by the lens dimensions. In this paper a concept for the second aforementioned approach i.e. equidistant LED array arrangement utilizing distortion optics is presented. As a first step, the influence of the lens geometry to the system efficiency is presented followed by the correlation with resolution and luminous flux based on the lens dimensions.

ENERGY-EFFICIENT, COLOR-SATURATED GREEN LIGHT EMITTING DIODES BASED ON QUANTUM CONFINED PEROVSKITES

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Topic: 9. Solar cells, Solid State Lighting + LED, LD, OLED

Type of presentation: Oral Presentation

Abstract:

Color-saturated green emission is crucial to achieving Rec. 2020 standard color gamut in the next-generation displays. Recently, colloidal organometal halide perovskites are attracting increasing attention because of their color-pure narrow emission, and potential to be fabricated energy-efficient and low-cost light emitting diodes (LEDs). However, it is not yet possible to achieve an ultra-pure green electroluminescence (EL) with an adequately narrow bandwidth that achieves the Rec. 2020 standard chromaticity coordinates. Here, we demonstrate efficient ultra-pure green LEDs based on colloidal perovskites. The quantum confined perovskite emitter shows a record high solid-state photoluminescence quantum yield of 92% because of high exciton binding energy of 162 meV. The quantum confined perovskite LED shows a maximum current efficiency of 10 cd A-1 and a maximum power efficiency of 7.7 lm W-1. Moreover, the EL emission locates at 529 nm with FWHM of 22.6 nm, reaching the color coordinates of (0.168, 0.773). As compared to Rec. 2020 standard color gamut, the resultant green EL shows a 97% color saturation in the 1931 CIEx,y color space. We successfully fabricate a 3 cm2 large-area device with equally high performance and color purity. Our ultra-pure green perovskite LEDs have shown the ultimate potential to fill the "green gap" in the future display devices.

HIGH EFFICIENCY UV-LEDS BASED ON ONE-DIMENSIONAL NITRIDE SEMICONDUCTOR USING NANOPARTICLES

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Topic: 9. Solar cells, Solid State Lighting + LED, LD, OLED

Type of presentation: Poster

Abstract:

Ultraviolet Light Emitting Diodes (UV-LEDs) are currently in high demand for application including chemical and biological agent detection, UV curing, sterilization, air-water purification, and many medical uses. However, III-Nitride based UV LEDs have very low light emission efficiency because of the high activation energy of Mg acceptor due to the wide bandgap and problems of ohmic contact with the high work function of the p-GaN and UV light absorption in the p-GaN layer. In order to increase efficiency of UV-LEDs, therefore, it is necessary to improve the light emission efficiency. In order to realize a high efficiency UV LEDs, the structure and material of the device are very important. Flip chip LEDs, which is able to realize high intensity by high current injection, is evaluated as appropriate structure for high power LED. Al reflective electrodes, which are widely used in high efficiency flip chip, have high reflectance in UV wavelength, but ohmic contact between Al and p-GaN is difficult. Therefore, the development of an electrode with high reflectivity and a good ohmic contact is very important for the realization of high efficiency UV-LEDs. In this research, the enhanced light emission efficiency of UV LEDs using micro-holes with nanoparticles. After full structure of UV LED epitaxial layer was grown on sapphire by MOCVD, micro-holes were etched through p-GaN, multi-quantum wells and n-GaN using the photo-lithography and the inductively coupled plasma (ICP) etching technology. Then SiO2 was deposited to a thickness that could cover multi-quantum wells. After the ITO was grown using an e-beam evaporator, ITO nanoparticles were formed through RTA and aluminum was evaporated using an e-beam evaporator. Finally, the analysis showed that the efficiency of the UV LEDs was improved from the electrical and optical characteristics of the device.

MICROSCALE LOCALIZATION AND ISOLATION OF LIGHT EMITTING IMPERFECTIONS IN MONOCRYSTALLINE SILICON SOLAR CELLS

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Topic: 9. Solar cells, Solid State Lighting + LED, LD, OLED

Type of presentation: Poster

Abstract:

An imperfections or defects may appear in commercial fabricated monocrystalline solar cells. These microstructural imperfections could have impact on the parameters of whole solar cell. The research is divided into two parts, firstly, the detection and localization defects by using several techniques including current-voltage measurement, scanning probe microscopy (SPM), scanning electron microscope (SEM) and electroluminescence. Secondly, the defects isolation by a focused ion beam (FIB) milling and impact of a milling process on solar cells. The defect detection is realized by I-V measurement under reverse biased sample. For purpose of localization, advantage of the fact that defects or imperfections in silicon solar cells emit the visible and near infrared electroluminescence under reverse biased voltage is taken, and CCD camera measurement for macroscopic localization of these spots is applied. After rough macroscopic localization, microscopic localization by scanning probe microscopy combined with a photomultiplier (shadow mapping) is performed. Defect isolation is performed by a SEM equipped with the FIB instrument. FIB uses a beam of gallium ions which modifies crystal structure of a material and may affect parameters of solar cell. As a result, it is interesting that current in reverse biased sample with isolated defect is smaller approximately by 2 orders than current before mill.

FABRICATION OF 365NM UV-POLARIZED LEDS USING METALLIC NANO-GRATING STRUCTURE

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Topic: 9. Solar cells, Solid State Lighting + LED, LD, OLED

Type of presentation: Poster

Abstract:

In recent years, highly polarized emission devices were expected to develop various applications, such as a photo-alignment device for liquid crystals, a high-resolution imaging device, and a highly touch sensor. A compact polarization control device with high transmittance is required to develop integrated devices for these applications. But the transmittance of both the metallic wire grid and the plastic film polarizer has the problem of inefficient due to the large photonic absorption in the grid materials. Recently the approach using photonic crystals to control the polarization has also been applied to 470nm GaN-based LEDs. However, this method is no suitable for device integration, considering the large size and complex design of the devices. For resolving the issue of integration, one of the candidate devices is the device using a high-contrast dielectric metallic nano-grating (MNG) structure. In the MNG, the pitch of the grating is shorter than the incident wavelength. As a result, the desirable optical characteristics of high reflectivity and polarization selectivity are obtained with optimized structures. This research is preferable for fabricating integrated devices, because the MNG can be fabricated on conventional LED devices with imprint technique. Also, the high transmittance in those devices is maintained owing to the absence of metal or polymer absorption in the UV region. In this study, we report the effect of the MNG on the nitride-based UV-LED optical characteristics. The simulation of the finite difference time domain (FDTD) technique was applied to obtain optimized structure of transmittance and polarization ratio according to the MNG period. The optimized structure was fabricated on top of the UV-LED by E-beam evaporator and inductively coupled plasma (ICP) etching. Electroluminescence (EL) spectra of the UV-LED with the MNG were measured, and the MNG optical characteristics were studied.

MICROSTRUCTURAL DEFECTS DETECTION IN CHALCOPYRITE CU(IN,GA)SE2 SOLAR CELLS BY SPECTRALLY-FILTERED ELECTROLUMINESCENCE MAPPING

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Topic: 9. Solar cells, Solid State Lighting + LED, LD, OLED

Type of presentation: Poster

Abstract:

The purpose of this research is to localize microstructural defects by an enforced local light emission from a forward/reverse-bias stressed pn-junction in various types of thin-film Cu(In,Ga)Se2 solar cells. A different nature of the local light emission from intrinsic/extrinsic imperfections in these chalcopyrite-based solar cells can be distinguished by using a spectrally-filtered electroluminescence mapping. After a light emission mapping and spectral classification of the defects in a macro-scale is performed a micro-scale exploration of the solar cell surface by using a scanning electron microscope to follow the obtained defects by electroluminescence. Additionally, the material sputtering by focused ion beam is used for a cross-section microstructural analysis of localized defects to clarify a physical nature of the imperfections (e.g. interrupted layers, Cu-rich agglomerates) which likely cause a local light emission. These macroscopic/microscopic investigations are performed independently. Then the searching of corresponding defects in micro-scale is rather difficult due to diffused light emission obtained from a macro-scale mapping. Some of the defects accompanied by a highly intense light emission very often lead to strong local overheating. Therefore, the lock-in IR thermography is also performed along with an electroluminescence mapping.

FABRICATION OF QUANTUM-DOT LIGHT-EMITTING DIODES USING AN RF-SPUTTERED TRANSPARENT-METAL-OXIDE ELECTRON-TRANSPORTING LAYER

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Topic: 9. Solar cells, Solid State Lighting + LED, LD, OLED

Type of presentation: Poster

Abstract:

Quantum-dot (QD) light-emitting diodes (QD-LEDs) with an RF-sputtered transparent-metal-oxide (TMO) electron-transporting layer (ETL) are fabricated and their characteristics are analyzed. We focus on developing TMO ETLs having proper in gap defect states for high performance QD-LEDs. The dependence of the luminous efficiency of QD-LEDs on the ETL defect density has been studied by analyzing their electrical and optical properties. From the work, it is found that an appropriate ETL defect density for causing trap-limited conduction is required to get a high performance QD-LED. Detailed results about the dependence of the QD-LED performance on the TMO ETL properties will be disclosed at the conference site.

A STUDY ON THE GROWTH OF HIGH QUALITY PHOSPHORUS DOPED P-TYPE ZNO

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Topic: 9. Solar cells, Solid State Lighting + LED, LD, OLED

Type of presentation: Poster

Abstract:

Although the ZnO has the lack of a reliable producing technology for p-type electrical conductivity because it has many native defect such as oxygen vacancy (VO) and Zinc interstitial (Zni) for self-compensation, the ZnO is an interesting and great potential material having many applications, such as ultraviolet light-emitting diodes (UV-LEDs), laser diodes (LDs), transparent conductive electrodes (TCEs) and piezoelectric devices owing to includes a large free-exciton binding energy (60meV) and direct wide bandgap (3.37eV) in the near-UV spectral region and relatively low material costs. Thus, it is necessary to understand the process of growth that has a crucial effect on electrical and structural properties to achieve stable p-type ZnO thin film. Well-known acceptors in ZnO include Group-I elements such as Lithium (Li), Natrium (Na), Kalium (K), Copper (Cu), Silver (Ag) and Group-V elements such as Nitrogen (N), Phosphorus (P), Arsenic (As), Antimony (Sb). Among these elements Group-V elements are extremely important for the realization of p-type ZnO thin film. Therefore, in order to obtain high quality epitaxial p-type ZnO thin film, we have tried to find a stabilized activation condition through rapid thermal annealing after growing phosphorus doped ZnO thin film at high temperature. In this study, we have prepared phosphorus doped p-type ZnO epitaxial thin film using a RF magnetron sputter system and RTA system. The p-type ZnO grown on sapphire substrate shows the electrical properties of concentration of 1017/cm3 with mobility of 1.2 cm2/V.s, and optical property of near band edge emission.

HIGH FLEXIBLE TRANSPARENT CONDUCTING FILM OF AMORPHOUS STRUCTURE

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Topic: 9. Solar cells, Solid State Lighting + LED, LD, OLED

Type of presentation: Poster

Abstract:

Transparent conducting oxide (TCO) is currently in high demand for application including touch panel, flexible Display, and organic light-emitting diodes (OLEDs). Especially indium-tin-oxide (ITO) has been most widely used as TCO electrode because of high visible transmittance, low electrical resistivity. However, the use of ITO has many problems due to high material costs, scarcity of indium and low flexibility. For resolving these problems, therefore, it is necessary to develop alternative other materials to ITO being used as transparent electrodes. According to recent research, thin-film transparent electrodes using TCO semiconductors have drawn great attention for the use of zinc-based oxide as an alternative to ITO as well as the use of multicomponent oxide thin films with properties suitable for specialized applications, such as very flexibility, high transmittance, and low conductivity. This paper reports the characteristic of the In/Zn-based amorphous film deposited on a sapphire substrate by RF magnetron sputtering. In addition, we have investigated composition control for improving electrical and optical properties of amorphous TCO. The amorphous TCO films were prepared by co-sputtering using ZnO and ITO target at room temperature. After optimization of the thin film conditions, thermal annealing process was performed to improve the properties of amorphous TCO film. In the optical, electrical and structural properties, amorphous TCO films showed above 85% transmittance by UV-Visible spectrometer, mobility of about 30 cm2/V-s and sheet resistance of 35 ohm/sq of Hall effect measurement.

DETECTION OF MICROSTRUCTURAL DEFECTS IN CHALCOPYRITE CU(IN,GA)SE2 SOLAR CELLS BY SPECTRALLY-FILTERED ELECTROLUMINESCENCE

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Topic: 9. Solar cells, Solid State Lighting + LED, LD, OLED

Type of presentation: Poster

Abstract:

The aim of this research is to detect and localize microstructural defects by using an electrically excited light emission from a forward/reverse-bias stressed pn-junction in thin-film Cu(In, Ga)Se2 solar cells with metal wrap through architecture. A different origin of the local light emission from intrinsic/extrinsic imperfections in these chalcopyrite-based solar cells can be distinguished by a spectrally-filtered electroluminescence mapping. After a light emission mapping and localization of the defects in a macro scale is performed a micro scale exploration of the solar cell surface by a scanning electron microscope which follows the particular defects obtained by an electroluminescence. In particular, these macroscopic/microscopic examinations are performed independently, then the searching of the corresponding defects in the micro scale is rather difficult due to a diffused light emission obtained from the macro scale localization. Some of the defects accompanied by a highly intense light emission very often lead to a strong local overheating. Therefore, the lock-in infrared thermography is also performed along with an electroluminescence mapping.

MODELING OF PHOTOLUMINESCENCE IN LASER-BASED LIGHTING SYSTEMS

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Topic: 9. Solar cells, Solid State Lighting + LED, LD, OLED

Type of presentation: Poster

Abstract:

The development of laser-based lighting systems has been the latest step towards a revolution in illumination technology brought about by solid-state lighting. Laser-activated remote phosphor systems produce white light sources with significantly higher luminance than LEDs. Such sources have a much smaller étendue, thus increasing the system´s luminous flux, while the optics used are downscaled leading to a reduction of the necessary resources and more design freedom. The weak point of such systems is often considered to be the conversion element. The high-intensity exciting laser beam in combination with the limited thermal conductivity of ceramic phosphor materials leads to thermal quenching, the phenomenon in which the emission efficiency decreases as temperature rises. For this reason, the aim of the presented study is the modeling of remote phosphor systems in order to investigate their thermal limitations and to calculate the parameters for optimizing the efficiency of such systems. The common approach to simulate remote phosphor systems utilizes a combination of different tools such as ray tracing algorithms and wave optics tools for describing the incident and converted light, whereas the modeling of the conversion process itself, i.e. photoluminescence, in most cases is circumvented by using the absorption and emission spectra of the phosphor material. In this study, we describe the processes involved in luminescence quantum-mechanically using the single-configurational-coordinate diagram as well as the Franck-Condon principle and derive the temperature dependent quantum efficiency of Ce:YAG, the predominantly used phosphor in lighting applications. Following an increasing awareness of climate change and environmental issues, the development of ecologically friendly lighting systems featuring low power consumption and high luminous efficiency is imperative more than ever. In conclusion, a better understanding of the laser-based lighting systems is an important step towards that aim as they may improve on LEDs in the near future.

PHOTONIC CRYSTAL PATTERNING OF LED SURFACES

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Topic: 10. Nanophotonics and Nanooptics

Type of presentation: Oral Presentation

Abstract:

In conventional semiconductor light emitting diodes (LEDs), the majority of generated light is trapped in high refractive index confinement layers due to the total internal reflection at thesemiconductor/air interface. It was confirmed that photonic crystal (PhC) structures are very useful inthe surface of different semiconductors for fabrication of semiconductor based PhC devices asLEDs with light emission enhancement and photodetectors. There are several promising methods for photonic crystal (PhC) patterning of LED surfaces for improving the LED efficiency, i.e. light out coupling. 1D and 2D patterns with different periods and various symmetries were fabricated using interference lithography, NSOM lithography, e-beam direct writes lithography and focused ion beam (FIB) milling. The periodicity and quality of fabricated structures has been investigated using AFM and SEM imaging. Light extraction enhancement (LEE) was studied by measuring of the lightcurrent (L-I) characteristics of untreated reference LED and patterned LEDs. The highest LEE was measured for LEDs patterned by interference lithography and the lowest LEE for LEDs patterned by FIB due to damage of the LED structure internal layers.

PERFORMANCE OF LIGHT-EMITTING SI NANOSTRUCTURES - ALMOST PERFECT NEAR-INFRARED EMITTERS

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Topic: 10. Nanophotonics and Nanooptics

Type of presentation: Oral Presentation

Abstract:

Comprehensive study of optical performance of technologically mastered multilayers of silicon nanocrystals (SiNCs) in silica matrix is presented. Absorption cross-section (ACS) is determined by two independent approaches to be about 10^(-15) cm^2 for violet excitation of SiNCs of 3-5 nm in diameter, but it decreases steeply towards longer wavelengths [1]. Two types of PL quantum yield (QY) - external and internal (EQY, IQY) - is distinguished. EQY is defined as the ratio of total number of emitted to absorbed photons for the whole ensemble, while IQY concerns only the luminescing (bright) subensemble of NCs and is equal to the ratio of radiative and total decay rates. Some SiNCs in ensemble are "dark", i.e. they absorb but not emit photons due to the presence of non-radiative recombination centres (defects) or due to transient switching-off (blinking). EQY is measured using an integrating sphere [2,3] while IQY is derived using variation of local density of optical states which affects radiative but not non-radiative lifetime, so enabling to decouple these two components. We study IQY using special wedge samples with variable distance between SiNCs and a high-n substrate. In addition, we adapted experimental techniques for slow decay and low saturation threshold of SiNCs and avoided possible artefacts [4]. Combining spectral measurements of EQY, IQY, ACS and size-distribution of NCs we obtain distribution of dark NCs. While the near-infrared emission (close to the bulk Si band gap) is almost ideal (IQY > 80 %), both IQY and population of bright NCs decreases toward shorter wavelengths causing vanishing PL below 600 nm. [1] J. Valenta et al. Appl. Phys. Lett. 108 (2016) 023102, [2] J. Valenta, Nanoscience Methods 3 (2014) 11-27 (OA), [3] J. Valenta et al., Appl. Phys. Lett. 105 (2014) 243107, [4] M. Greben and J. Valenta, Rev. Sci. Instr. 87 (2016) 126101.

EXPERIMENTAL VIZUALIZATION OF 2D PC EQUI-FREQUENCY SURFACES

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Topic: 10. Nanophotonics and Nanooptics

Type of presentation: Oral Presentation

Abstract:

Photonic crystals have been extensively studied for their unique optical properties making a promise of novel devices. Our contribution is focused on a 2D PC structure formed by Al2O3 layer on silicon substrate, patterned with periodic hexagonal lattice of deep air holes. Azimuthal angle dependences of the specular light reflection were recorded photo-electrically at various conditions and the data obtained were processed via mapping in reciprocal space. Also, the specular reflectivity along the path between the points of high symmetry is presented. It gives a possibility to visualize the equi-frequency curves and get more detailed information about the properties of our sample.

FORMATION OF AU AND AU/AG NANOSTRUCTURES IN SURFACES OF SILICATE GLASSES BY ARF EXCIMER LASER IRRADIATION

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Topic: 10. Nanophotonics and Nanooptics

Type of presentation: Oral Presentation

Abstract:

Plasmonic Au/Ag nanoparticles in glass surfaces allow to create a tunable surface plasmon resonance in a wide range of wavelengths. These nanostructures enable to realize manifold applications in photonic and optoelectronic devices. Here, the Au and Au/Ag structures have been created in soda-lime silicate glasses using ArF excimer laser irradiation (193 nm) well below the ablation threshold of the glass matrix. The pure or the silver/sodium ion-exchanged float glasses have been coated by a thin Au layer and then irradiated by ArF pulses. The optical spectroscopy demonstrated the shift of the surface plasmon resonance between 420 and 620 nm. The experiments by small angle X-ray scattering experiments (SAXS) proved the formation of pure Au or Ag nanostructures as well as of bimetallic Au/Ag species inside the glass surface by implantation like processes.

REFLECTANCE ANALYSIS OF POROSITY GRADIENT IN NANOSTRUCTURED SILICON LAYERS

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Topic: 10. Nanophotonics and Nanooptics

Type of presentation: Oral Presentation

Abstract:

Reflectance analysis of porosity gradient in nanostructured silicon layers Stanislav Jurecka1, Kentaro Imamura2, Taketoshi Matsumoto2, Hikaru Kobayashi2 1Institute of Aurel Stodola, University of Žilina, Liptovský Mikuláš, Slovakia 2Institute of Scientific and Industrial Research, Osaka University and CREST, Osaka, Japan In this work we study optical properties of nanostructured layers formed on silicon surface. Nanostructured layers on Si are formed in order to reach high suppression of the light reflectance. Low spectral reflectance is important for improvement of the conversion efficiency of solar cells and for other optoelectronic applications. Effective method of forming nanostructured layers with ultralow reflectance in a broad interval of wavelengths is in our approach based on metal assisted etching of Si. Si surface immersed in HF and H2O2 solution is etched in contact with the Pt mesh roller and the structure of the mesh is transferred on the etched surface. During this etching procedure the layer density evolves gradually and the spectral reflectance decreases exponentially with the depth in porous layer. We analysed properties of the layer porosity by incorporating the porosity gradient into construction of the layer spectral reflectance theoretical model. Analysed layer is splitted into 20 sublayers in our approach. Relative permittivity in each sublayer is computed by using Bruggeman effective media theory and theoretical spectral reflectance of modelled multilayer is computed by using Abeles matrix formalism. Porosity gradient is extracted from the theoretical reflectance model optimized in comparison to the experimental values. Resulting values of the structure porosity development provide important information for optimization of the technological treatment operations.

THE ELECTROMAGNETIC CENTROID, THE PROBLEM OF FOCUS IN THE MICROSCOPY OF REAL THICK SAMPLES AND SUPERRESOLUTION

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Topic: 10. Nanophotonics and Nanooptics

Type of presentation: Poster

Abstract:

Samples for which a "canonical" focal plane of an optical path may be found should have properties of a point of mass or of a planar object of zero thickness. Images combining such ideal object then may be analysed by a deconvolution algorithm which includes a theoretical distribution of the electromagnetic field in xy planes along the optical axis. Real life point spread functions (better object spread functions) of real objects are in all practical cases far from ideal. We have analysed real object spread functions of a diffracting object which is includes the interaction of the light with the object and transformation of the resulting profile of the electromagnetic field by the optical path of the microscope. There may, indeed, be found a darkest object of the size of one camera pixel and a plane to which an ordinary user would attribute the commonplace name focus. Indeed this object corresponds to a darkest part of a wave-free region which is built behind the diffracting object. We suggest to call these object electromagnetic centroid. In order to replace the definition of a focal plane by an operational definition which may be exactly defined in any microscopic measurement, we have developed an algorithm which calculates information difference upon exchange of the value of the pixel at a position in the xy plane captured at one level along the z-axis by the value at the same position captured at the next level. When the information difference is zero, we assume that an electromagnetic centroid passed the focal plane of the objective lense system. By this definition we obtain operational focus of the real world microscopic image. The definition of the structure which gives rise to the microscopic response may be obtained with theoretically unlimited precision.

A NEW GENERATION OF REAL-TIME WEATHER MONITORING CAMERAS

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Topic: 11. Education and Multimedia in Photonics

Type of presentation: Oral Presentation

Abstract:

A new generation of WILLIAM (WIde-field aLL-sky Image Analyzing Monitoring system) camera includes new features such as monitoring of rain and storm clouds during the day observation. Development of the new generation of weather monitoring cameras responds to the demand for monitoring of sudden weather changes. However, new WILLIAM cameras are ready to process acquired image data immediately, release warning against sudden torrential rains, and send it to user´s cell phone and email. Actual weather conditions are determined from image data, and results of image processing are complemented by data from sensors of temperature, humidity, and atmospheric pressure. In this paper, we present the architecture, image data processing algorithms of mentioned monitoring camera and spatially-variant model of imaging system aberrations based on Zernike polynomials.

CONSIDERATIONS OF EDUCATION IN THE FIELD OF BIOPHOTONICS IN ENGINEERING: THE EXPERIENCE OF THE SUBJECT FUNDAMENTALS OF BIOPHOTONICS

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Topic: 11. Education and Multimedia in Photonics

Type of presentation: Poster

Abstract:

Education in the field of photonics is usually somehow complex due to the fact that most of the programs include just a few subjects on the field, apart from specific Master programs in Photonics. Typically, education in photonics is implemented by means of subjects in science or engineering Bachelor and Master levels. There are also specific doctorate programs dealing with photonics. In the particular field of biophotonics, education difficulties are even greater, as it is complex to find subjects on the field in bachelor or master programs, and even in doctoral programs. Apart from the problems shared with photonics in education in general, biophotonics specifically needs an interdisciplinary approach between biomedical and technical or scientific fields. This relationship is always needed, but most of the time is hard to establish or even to maintain. In this work, we present our education experience in teaching the subject Fundamentals of Biophotonics, intended preferentially to engineering Bachelor and Master degrees students, but also to science and medicine students. First it was necessary to join a teaching group coming from the scientific technical and medical fields, working together in the subject. This task was easier as our research group, the Applied Optical Techniques group, had previous contacts and experience in working with medicine professors and medical doctors at hospitals. The orientation of the subject, intended for both technical and medical students, has to be carefully selected, in order for it to be as self-contained as possible. Professors´ profiles, subject program, teaching strategies, students´ profiles, evaluation results and students´ opinions are presented. All this information could be employed by other education institutions willing to implement studies on biomedical optics.