Atomfizika, optiskās tehnoloģijas un medicīnas fizika/ Atomic physics, optical technologies and medical physics

Report of Abstracts

Abstract ID : **1**

Fotonu atstarošana un laušana / Reflection and refraction of photons

Content

Izmantojot no jauna radīto 3D fotona modeli, apskatīsim fotonu atstarošanos un refrakciju starp divām dialektriķu virsmām. Caurizgājušo un atstarojošo fotonu amplitūda tiek noteikta ar Fresnela formulām līdzīgi kā plakana viļņa gadījumā. /
Using the recently proposed model of 3D photons, the reflection and refraction of photons on the boundary between two dielectrics is considered. The amplitudes of the reflected and transmitted photons are determined by the Fresnel formulae, the same way as for the plane waves.

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Comments:

Uzstāsimies latviski.

Status: ACCEPTED

Submitted by **VEILANDE, Rita** on **Monday, January 3, 2022**

Abstract ID : 2

THEORETICAL AND NUMERICAL STUDIES OF THE IMPACT OF THE MAGNETIC FIELD OF RADIATION ON AMINO ACIDS

Content

Amino acids are the structural units of the proteins. By joining together, amino acids form peptides (short polymer chains) or polypeptides / proteins (longer polymer chains). Non-protein amino acids also have important roles as metabolic intermediates, such as in biosynthesis, or are used to synthesize other molecules. For example, tryptophan is a precursor of the neurotransmitter serotonin [1], serine plays a crucial role in the metabolism and signaling activities in living organisms [2], while threonine is an important constituent of collagen, elastin, and enamel protein.
Shortly after the deposition of high-energy ionizing quanta into a biological medium, electrons with different energies are formed and are able to destroy biological molecules, such as DNA and proteins, and cause chromosome aberrations, leading to cancer mutations, genetic transformations etc. [3].
Due to their scientific and medical interest, many research groups have investigated the structural changes of amino acids using electron ionization mass spectrometry, where the mass spectra are typically interpreted by theoretical calculations [4].
In this work we will investigate theoretically and numerically the effects of the magnetic field of radiation on the fragmentation of amino acids. Since the effects of the electric field are larger by a factor of $1/\alpha$ (α is the fine-structure constant) compared to those of the magnetic field, as a first approximation we will neglect the terms of the oscillating magnetic field in the Hamiltonian and leave only the ones including the electric field. The effects of the magnetic field of the radiation will be accounted for only by using the method of anisotropic Gaussian type orbitals (AGTO) [5], e. g. we will introduce the anisotropy in the wavefunction in order to describe the elongation of electron orbitals and densities along the field direction. As a testing ground for our theoretical model we will use light atoms, following the procedure outlined in [6].
Later on, various amino acids will be analyzed, including geometrical parameters of the initial molecule rearrangement.
In the case of fragmentation, additional analysis will be performed be in order to determine whether it is due to a simple bond cleavage or to more complex reactions involving molecular rearrangements.
This presentation is based upon work from COST Action CA18212 - Molecular Dynamics in the GAS phase (MD-GAS), supported by COST (European Cooperation in Science and Technology).

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[6] W. Zhu and S. B. Trickey, J Chem Phys 147, 244108 (2017)

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Status: ACCEPTED

Submitted by **KIROVA, Teodora** on **Wednesday, January 5, 2022**

Abstract ID : 3

As, Hg un Tl augstfrekvences bezelektrodu lampu salīdzinājums vides piesārņojuma noteikšanai

Content

Mūsdienās arvien lielāka uzmanība tiek pievērsta ekoloģijai un vides piesārņojumam, sakarā ar to pieaug nepieciešamība noteikt dažādu vielu koncentrācijas vidē, turklāt ļoti toksisku vielu gadījumā ir svarīgi spēt detektēt ļoti zemas koncentrācijas vērtības. Pie šādām toksiskām vielām pieder arī darbā aplūkotie gaismas avotu pildījumi – dzīvsudrabs, arsēns un tallijs.
Atomu absorbcijas spektrometrija ļauj noteikt dažādu vielu koncentrāciju ar augstu jutību, bet, protams, liela nozīme ir gaismas avota parametru pareizai izvēlei. Šis darbs ir veltīts augstfrekvences bezelektrodu gaismas avotu ar dažādu pildījumu (As, Tl, Hg) galveno raksturlielumu salīdzināšanai to izmantošanai augstas precizitātes atomu absorbcijas analizatoros. Īpaša uzmanība tiek pievērsta UV spektrāllīnijām 193,7 nm un 197,2 nm As, 377,6 nm Tl un 253,7 nm Hg. Visi mērijumi tika veikti ar Furjē spektrometru.

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Submitted by **ZORINA, Natalja** on **Wednesday, January 5, 2022**

Abstract ID : 4

Ergokalciferola un kolekalciferola modelētie un nomērītie spektri / Calculated and measured spectra of ergocalciferol and cholecalciferol

Content

Izmantojot DFT jeb Blīvuma funkcionāļa teorijas aprēķinus, šajā pētījumā tika modelētas ergokalciferola (D2) un kolekalciferola (D3) optiskās īpašības un tās salīdzinātas ar jau ziņotajiem datiem, kā arī prezentētas aprēķinātas un nomērītas D2 unD3 optiskās absorbcijas līnijas, bet aprēķini salīdzināti ar aprēķinātajiem optiskās caurlaidības, FTIR ATR un Ramana spektriem. Modelēto un nomērīto spektru atbilstība ir laba. Jaunas optiski aktīvas spektra joslas ir prognozētas UV un IR spektrālajos apgabalos. D2 un D3 optiski aktīvie spektrālie apgabali ir līdzīgi. C = C stiepšanās vibrācijas līnijas var tikt izmantotas savienojumu identificēšanai. [Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy 269 (2022) 120725] /
In this study ergocalciferol (D2) and cholecalciferol (D3) optical properties are studied by density functional theory calculations, compared to reported data, and the new calculated and measured D2 and D3 optical absorption lines are presented, as well as the calculations compared with spectral measurements of optical transmission, FTIR ATR and Raman spectra. Calculated and measured spectra fit good. New active bands predicted in UV and IR. Optically active regions of D2 and D3 are similar. C = C stretch line can be signature. [Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy 269 (2022) 120725]

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Status: ACCEPTED

Submitted by **VEILANDE, Rita** on **Tuesday, January 11, 2022**

Abstract ID : 5

Dzīvsudraba piesārņojums melno stārķu izkārnījumos

Content

Šajā pētījumā mēs ziņojam par dzīvsudraba koncentrācijas mērījumiem melnā stārķa (Ciconia nigra) izkārnījumos no dažādām ligzdošanas vietām Latvijā. Putnus plaši izmanto kā bioloģiskos monitorus, lai novērtētu vides stāvokli, piemēram, vides piesārņojuma līmeni. Dzīvsudrabs (Hg) savukārt ir labi zināms vides piesārņotājs, kas var uzkrāties ūdens ekosistēmās, sasniedzot kaitīgu koncentrāciju, jo īpaši metildzīvsudrabs (MeHg), kas bioloģiski akumulējas un magnificējas barības ķēdē. Tā kā melnais stārķis ir zivēdājputns, tas ir pakļauts lielākam dzīvsudraba uzņemšanas riskam nekā putni, kas nav zivēdājputni. Provizoriskie rezultāti liecina, ka melno stārķu ekskrementi satur zināmu daudzumu dzīvsudraba un ka tā koncentrācija dažādās ligzdošanas vietās atšķiras – analizētajos paraugos dzīvsudraba koncentrācija bija sastopama robežās no 10 līdz 522 ng/g.

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Comments:

Uzstāsimies latviski.

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Submitted by **VEILANDE, Rita** on **Tuesday, January 11, 2022**

Abstract ID : 6

Dzīvsudraba piesārņojuma novērtēšana, izmantojot melno stārķu olu čaumalas

Content

Ir zināms, ka putnu olas un to čaumalas var izmantot vides monitoringam. Šajā darbā mēs pētījām dzīvsudraba (Hg) koncentrāciju melno stārķu olu čaumalās. Dzīvsudrabs ir plaši pazīstams toksisks elements, īpaša uzmanība tiek pievērsta tā organiskajām formām, jo īpaši metildzīvsudrabam, jo tas barības ķēdē bioakumulējas un magnificējas. Savukārt melnie stārķi uzturā galvenokārt patērē zivis un tādējādi ir pakļauti lielākam dzīvsudraba uzņemšanas riskam.
Darba ietvaros tika analizēti 34 čaumalu paraugi no dažādām stārķu ligzdošanas vietām Latvijā. Rezultāti parādīja, ka dzīvsudraba koncentrācija olu čaumalās ir zemāka (5-22 ng/g) nekā membrānās (42-293 ng/g), kā arī novērojama atšķirība starp paraugiem no dažādām ligzdošanas vietām.

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Submitted by **ABOLA, Anda** on **Friday, January 14, 2022**

Abstract ID : 7

Infrasarkano spektru pētījumi induktīvi saistītās plazmas spektrālo līniju avotos.

Content

Infrasarkano spektru pētījumi induktīvi saistītās plazmas spektrālo līniju avotos.

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Mēs ziņojam par jauniem infrasarkanā spektra mērījumiem induktīvi saistītās plazmas (ISP) izlādē spektra rajonā no 5000-15000 cm-1,kas atbilst 667-2000 nm viļņu garumam. Mērījumi tika veikti ar pašu izgatavotajiem ISP spektrālo līniju avotiem uz eksperimentālās iekārtas, kas balstās Furjē Transformācijas Spektrometra izmantošanu [1].
Pētījumu izraisīja interese no Astrofiziķu puses par dažādu atomu un jonu spektrālajām līnijām spektra infrasarkanajā rajonā. Šādas līnijas ir novērotas starpzvaigžņu telpā un no tām zinot atomārās konstantes oscilatoru stiprumus un Einšteina keficientus var noteikt elementu koncentrāciju astrofizikālajos objektos, kur citas koncentrāciju noteikšanas metodes nav pieejamas. Šīs konstantes var noteikt mēros spektrālo līniju intensitātes un ierosināto līmeņu dzīves laikus [2]
ISP spektrālo līniju avotu (agrāk literatūrā sauktu par augstfrekvences bezelektrodu lampām) izgatavošana Atomfizikas un spektroskopijas institūtā ir sena tradīcija jau no pagājušā gadsimta 70 gadiem. [2] Atkarībā no izmantošanas veida tie var būt ļoti dažādi, skat [3,4].
Šim eksperimentam tika izgatavotas vienkāršas lampas ap 2 cm diametra kvarca sfēras, kas tika pievienotas pie vakuumsistēmas. Sfēru iekšējās virsmas tika attīrītas izmantojot izlādi cēlgāzē un pēc tam lampas tika uzpildītas ardažiem mikrogramiem pētāmā elementa un cēlgāzi. Tika izgatavota Hg,Se,Te, As, Zn, Cd lampas ar Ar un Xe gāzes pildījumu.
Tika izmērīti visu iepriekš minēto elementu lampu spektri un konstatēts, ka mērītajā spektra diapazonā pārsvarā ir novērojamas pārsvarā cēlgāzes līnijas un nedaudz atomu līnijas, bet netika novērotas onu līnijas. Darbs pie lampu parametru optimizācijas tiek turpināts, kā arī jauna veida hibrīdu līnija avotu izstrādes kurās tiek kombinēta ISP un dobā katoda izlādes

Pateicības.
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Atsauces
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Status: ACCEPTED

Submitted by **BERZINS, Uldis** on **Thursday, January 20, 2022**

Abstract ID : 8

Ag-doped 3D scaffolds modification for osteogenic applications and tissue engineering

Content

Problem of cellular architectures and bone implants design that has high integration and mechanical support is vastly relevant. By Wolff's law, bone will remodel in response to the loads it is placed under, hence to maintain bone density bioimplant structure should be very porous and smooth. Especially efficient from the standpoint of scaffolds is triply periodic minimal surfaces, which could be printed directly from metal powder. On the other hand using coatings and nanoparticles is way to reach decent biocompatibility. Combining selective laser sintering (SLS) and plasma electrolytic oxidation (PEO), it's possible to assemble and modify porous 3D scaffold with high antibacterial and osteoinductive properties.

In this research, we used SLS-PEO process to fabricate 3D scaffolds from TiAl4V alloy, and turn it into strong antibacterial material. Ca-P coating and silver ions as dopants increase probability of bio-chemical reactions stimulating the bio-active surface of implant. Optimal characteristics of implants were defined through trial of different regimes and study of the surface structure via XRD, SEM, Raman, IR-spectroscopy. As our study has shown depending on preliminary pore size (during SLS), micro-nanopore size (post-treatment after PEO) and the concentration of nanoparticles in the electrolyte the functional properties could be tuned.

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Status: ACCEPTED

Submitted by **BURANYCH, Volodymyr** on **Thursday, January 20, 2022**

Abstract ID : 9

ZnO-Schiff base nanostructures as optical chemical sensors for metal ion detection

Content

Organic-inorganic functional composites is new class of materials, used in biomedical, photocatalysis and sensor applications. Such composites are used in chemical sensors for detection of metal ions for environmental monitoring of coil and water sources. Inorganic core is mainly used as transducer, whereas the organic shell has high selectivity to the target molecules. The recent sensors studies have showed good sensitivity of electrochemical and electrical composite sensors. However, optical properties of the composite nanomaterials have not been applied for chemical sensors.

In the present work ZnO-Schiff bases (SB) composite nanofibers have been used for optical chemical sensors for detection of Zn2+ ions. Structure and electronic properties of the ZnO-SB nanostructures have been studied by TEM, SEM and FTIR.

Diffuse reflectance and photoluminescence have been used to study optical properties of the nanocomposites.

Sensor properties have been measured towards 0-20 nM of Zn2+ ions. Sensitivity, selectivity and limit of detection towards Zn2+ ions were calculated

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Status: ACCEPTED

Submitted by **VITER, Roman** on **Friday, January 21, 2022**

Abstract ID : 10

Application of Polydopamine Functionalized Zinc Oxide for Aflatoxin B1 Sensor Design

Content

Aflatoxin B1 (AFB1) is known as the most common and highly toxic contaminant for human and animal health. It was categorized as a Group I carcinogen by the International Agency for Research on Cancer (IARC). The main places, where it could be found is feed and food, during growing or harvesting time.

Nowadays, there are number of methods, that were developed for AFB1 detection. Such as thin-layer chromatography (TLC), enzyme linked immunosorbent assay (ELISA), liquid chromatography combined with mass spectrometry (LC-MS/MS), high-performance liquid chromatography (HPLC). The main limitations of these methods include an expensive equipment, professional personnel, and time-consuming.

AFB1 needs a detection method which will combine sensitivity, selectivity, and convenience of use for its operator.

Recently polydopamine (PDA) has gained huge interest. Each year the number of research studies grows a lot.

Polydopamine is a synthetic polymer, mussel-inspired by proteins from mussel, that are very adhesive to wet stone etc. And can be attached on hydrophobic and hydrophilic surfaces. Due to a number of functional groups, which exist on PDA surface, such as indole, catechol, quinone, amine etc., it could be used as a surface functionalization for the further immobilization step.

Nowadays, development of detection methods for AFB1 is of great demand.

In the present research we performed study on optical biosensor combining with microfluidic system based on ZnO/PDA/PEI platform for AFB1 detection.

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Status: ACCEPTED

Submitted by **FEDORENKO, Viktoriia** on **Friday, January 21, 2022**

Abstract ID : 12

Chitosan electrospun nanofibers: surface morphology and hydrophobicity after different crosslinking

Content

Background. Chitosan (Ch) materials fabricated with electrospinning techniques are one of the most prevalent for medical application. However, electrospinning of chitosan solution is a complicated procedure because of its high viscosity and free amino groups. Among solvents tested for dissolving the chitosan dichloromethane (DCM) and trifluoroacetic acid (TFA) is the most suitable solvents to succeed in chitosan fibers producing. Otherwise, these solvents influence the chitosan structure and wettability. Post-treatment in alkali solutions provided to maintain the fibrous structure and obtain stable chitosan membranes changes properties of chitosan nanofibrous materials.
Aim. The study's objective was to evaluate the surface morphology and surface hydrophobicity of electrospun Ch-DMC/TFA membranes (as-spun and post-treated with 1M sodium hydroxide (NaOH) aqueous and 70% ethanol solutions) depending on solvents ratio.
Methods. 3.5% chitosan solution was prepared by dissolving Ch powder in TFA/DCM solution in a ratio of 7:3 (Solution 1) and 9:1 (Solution 2). Electrospun membranes were made with the following parameters: electric field 30–35 kV, the pump rate was set at 5.0 ml/h, the distance between the needle tip and collector 15 cm. Scanning electron microscopy (SEM) images of the samples were used for fiber size, porosity, and pore size distribution assessment. The static contact angle (CA) was measured to estimate the properties of the nanofibrous surface.
Results. The samples of both co-solvents ratios displayed regular, randomly oriented nanofibers. The average diameter of non-treated Samples 2 enlarged from 0.2 ± 0.010 μm to 1.07 ± 0.048 μm for samples treated with 1M NaOH aqueous solution and only to 0.3 ± 0.01 μm for 1M NaOH 70% ethanol-treated samples. The porosity decreased less manifestly after ethanol crosslinking. Sample 2 maintained porosity more effectively after both types of treatment. Nanofibers showed a hydrophobic nature with contact angles around 132,4° and 132,3° for Samples 1 and 2. Due to the crosslinking, CA has been modified slightly to range not up to 95° for all samples.
Conclusion. The ethanol solution provides gentler treatment and preserves the high porous structure of both samples. Otherwise, chitosan membranes (Solution 2) treated with NaOH ethanol retained morphology most effectively. The contact angle measurement results confirmed that the fabricated nanofiber displayed fewer hydrophobic features after alkali treatment despite the TFA/DCM co-solvent ratio and method of crosslinking.
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Status: ACCEPTED

Submitted by **KORNIIENKO, Viktoriia** on **Friday, January 21, 2022**

Abstract ID : 13

INFLUENCE OF AUTOCLAVING ON ANTIBACTERIAL PROPERTIES OF SILVER NANOPARTICLES

Content

Background. One of the main requirement to substances for biomedical use is their sterility. The most often and available method of sterilization is autoclaving. However, it can cause physico-chemical changes in the material and the loss of its properties. Silver nanoparticles possess prominent antibacterial activity, but impact of sterilization on this effect is not obvious.
Aim. Study of the influence of the autoclaving pretreatment on the antibacterial properties of silver nanoparticles (AgNPs).
Methods. AgNPs were provided by Nano Pure Co (Poland). The strain of E.faecalis, E.coli, S.aureus was isolated from patient. AgNPs were treated with autoclaving (t- 121 °C, P – 775 mm of Hg, 20 minutes). Antimicrobial activity of the treated and nontreated nanoparticles was examined by tube serial dilution method with determination of the minimum inhibitory concentration. All tests were carried out in triplicate.
Results. The results indicate that AgNPs inhibited the visible growth of the tested microorganisms (MIC) at concentration equal to 5, 10, 5 μg / ml for E. faecalis, E. coli, S. aureus respectively. Use of the autoclaving as pretreatment of the nanoparticles caused the enhancement of their antibacterial effectiveness and decrease of the the MIC for all strains of bacteria to two times.
Conclusions. The antibacterial results showed that properties of AgNPs with pre-treatments, such as autoclaving, could help to enhance their antibacterial activity against E. faecalis, E. coli, S. aureus.
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Status: ACCEPTED

Submitted by **HOLUBNYCHA, Viktoriia** on **Friday, January 21, 2022**

Abstract ID : 14

Silicate-, fluoride- enriched oxide coatings on magnesium for orthopaedic applications

Content

Background. Plasma electrolytic oxidation (PEO) is a modern strategy for formation of protective coatings with bioactive properties on the magnesium based materials for orthopedic application. Silicate- and fluoride-containing baths are used for creation of oxide layers with enhanced corrosive properties and bioactive functional groups on magnesium. The investigations on optimal parameters for obtaining the native oxide/hydroxide films are still in progress.
Aim. The study aimed to select the PEO process parameters to achieve the best magnesium surfaces' physicochemical properties for further biomedical applications.
Methods. Pure magnesium cubes with 1x1x1 cm³ size were ground on all surfaces up to 800 grit using SiC papers, washed with isopropanol and dried with warm air. The process PEO was performed in the three different electrolytes: **1.** 10 g/L Na₂SiO₃·5H₂O, 5 g/L NH₄F, 10 g/L NaOH; **2.** 20 g/L Na₂SiO₃·5H₂O, 5 g/L NH₄F, 10 g/L NaOH; **3.** 30 g/L Na₂SiO₃·5H₂O, 5 g/L NH₄F, 10 g/L NaOH. Anodizing was conducted at a current density 0,1 A/cm² and three maximum voltages: 150, 200, and 225 V, for 3min. The surface and cross-sectional analysis as well as the chemical composition were analyzed by scanning electron microscope (SEM JEOL JSM-7600F, JEOL Ltd., Tokyo, Japan) equipped with an EDX detector (Edax Inc., USA).
Results. The surface morphology of the obtained coatings presents a porous structure with the pore size from 0.008 ± 0.01 μm to 0.034 ± 0.041 μm. The pore size increase with voltage value. The pores distribution is more uniform at 200 V. The chemical composition of the coatings finds is composed of Mg, Si, O, and F. A high amount of Si and F is detected at the lowest Na₂SiO₃ concentration in the solution. The thickness of the anodic film is more considerable at the low silicate concentration and reached 2.42 ± 0.45 μm at 225 V.
Conclusion. The pore size and its distribution, the thickness, and the chemical composition of the obtained films are more appropriate at the low concentration of the Na₂SiO₃ and 200 V for further in-vitro investigation.

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Submitted by **HUSAK, Yevheniia** on **Friday, January 21, 2022**

Abstract ID : 15

Viability assessment of C. albicans biofilms by laser speckle contrast imaging following sonosensitization

Content

Few fungal species, including Candida clade, are capable of forming biofilms within a human host. *C. albicans* biofilms can spread through intestinal mucosa, reproductive tract, mouth cavity, skin. As more favorable sites, they can colonize prosthetic biomaterials, such as heart valves, dental implants, prosthetic joints and penis implants [1]. *C. albicans* is the predominant fungus identified on the medical equipment surfaces inserted into human body: pacemakers, hemodialysis grafts and various catheters [2]. Once formed, further dissemination of fungal cells can occur via the bloodstream and lead to development of sepsis. For up to 35% of hospitalized patients, the hematogenous dissemination of *C. albicans* infection is lethal [3].

In this study, the antibiofilm strategy used was to repurpose the well-known drug protoporphyrin IX (PpIX) to improve its action against *C.albicans* biofilm in combination with ultrasounds treatment. We have tested continuous therapeutic ultrasounds at 880kHz with a 5W/cmˆ2 output power, which had been certified for use on humans [4]. Likewise, aminoleavulinic acid induced PpIX has been certified for use in human cancer patients in Europe, Japan and USA [5].

The potential of laser speckle contrast imaging (LSCi) to evaluate sonosensitization induced cytotoxicity was examined due to the lack of a quick and non-invasive methods to detect the suppression of biofilm-forming microbial viability. The LSCI experimental setup and the estimation principle of SC is described in full in [6]. We investigated the correlation between speckle contrast (SC) parameter measured immediately after *C.albicans* sonosensitization and cell metabolic activity evaluated by MTT assay which is employed as the cell viability indicator.

In vitro biofilm formation models proved to resemble *C.albicans* biofilms observed in natural environment [7]. In this study, to create a biofilm, a colony of *C. albicans* clinical isolate (11017) obtained from a patient's ascitic fluid at the Republican Hospital of Panevėžys (Lithuania) was transferred to 20 ml of liquid yeast extract peptone dextrose (YPD) medium and incubated for 18 h at 37 ℃ with shaking. Then the cells were pelleted twice at 3000 rpm, 18 ℃, 10 min. in PBS. The cell suspension was transferred to the sterile tissue culture dish with 2 ml of modified RPMI-1640 medium, supplemented with 2% glucose and L-glutamine, without sodium bicarbonate, with 0.165 mol/l 4-morpholinepropanesulfonic acid (MOPS), buffered to pH 7.0. The cells were prepared at the optical density OD600 nm = 0.01 and incubated in thermostat at 37 ℃ for 24 h. After incubation, the supernatant was carefully aspirated and the non-adhered cells were washed twice with 1 ml of sterile PBS, trying not to damage the biofilm.

A mature biofilm was visualized by using a light microscope. Viable and hyphae-forming *C. albicans* cells were observed. Optical coherence tomography (sd-OCT) revealed the mesoscale structure of biofilm, highlighting tens of micron sized pores and larger voids in the extracellular matrix. Ultrasounds application alone led to mechanical disruption of biofilm matrix and the appearance of planktonic cells. Targeting the biofilm matrixome with ultrasounds microstreaming, acoustic jets and cavitation was effective in removing the cells' protective microenvironment; subsequently the planktonic cells possess lower tolerance to increased chemical and physical assaults [8]. Biofilm disruption also allows reinstate the immune system response to biofilm, e.g. by disposing the β-glucans component of *C. albicans* cells to neutrophils [7].

In a following set-up, the activation of PpIX by ultrasounds accounted for production of hydroxyl, peroxyl, alkoxyl and porphyrin radicals, starting with 0.6 - 1.5 W/cmˆ2 ultrasounds output power [9]. With sensitizing drug added, the antibiofilm therapy targets both the matrixome and individual *C.albicans* cells (matrix embedded and planktonic) providing the multitargeted treatment against the biofilm.

Empirically, the obtained MTT results showed, that the viability of cells in *C. albicans* biofilms after ultrasounds exposure was decreased by increasing the ultrasounds exposure time and applying sonosensitization with PpIX. The decrease in laser speckle contrast values correlated to a decrease

in cell viability in *C. albicans* biofilms, and the SC values increased when the viability was restored (Rˆ2=0.87) within 24 hours after treatment.
Although sonosensitization was ineffective in removing *C. albicans* biofilms entirely, our results suggest that speckle contrast parameter is indicative for *C.albicans* biofilm structure impairment and fungal cell viability decrease estimate. There are hardly any *in vitro* methods present to monitor the biofilm response to the treatment in a non-contact way. While no additional details can be estimated from the speckle pattern alone (e.g. related to the response of different cell species within the treated biofilm; or the structural and functional properties impaired) the speckle contrast parameter is offered as quick-way to classify the *C. albicans* response to the treatment at the macro scale. Complementary diagnostic information on biofilm persistence, virulence, matrix remodeling, growth stage, metabolic state, nutrient availability, and microenvironment is proposed to determine by combining speckle statistics with some of multimodal diagnostic methods including Raman spectroscopy, FTIR, kinetic spectroscopy, photoluminescence, diffuse reflectance, and OCT imaging.

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Submitted by **TAMOSIUNAS, Mindaugas** on **Saturday, January 22, 2022**

Abstract ID : 16

ZnO-Au-mAb platform development for Listeria monocytogenes detection

Content

The main actual challenge of food safety is to control and prevent foodborne pathogens contamination of the fruits at each production step. The CDC estimate that foodborne diseases are responsible for about 76 million illnesses, which result in 325,000 hospitalizations and 5000 deaths in the United States each year. European Centre for Disease Prevention and Control reported about 2502 confirmed listeriosis cases in the EU in 2018. According these data, the number of listeriosis cases continuously growth since 2013. Listeria monocytogenes can survive and grow over a wide range of environmental conditions such as refrigeration temperatures, low pH and high salt concentration. This allows the pathogen to overcome food preservation and safety barriers, and pose a high risk to human health.

The existing food quality control for detection of Listeria monocytogenes involves standard microbiological, ELISA and PCR methods, which are precise, expensive and long term (1-5 days). They confront with requirements to short lifetime of fresh fruits. Biosensors could be alternatives for standard methods of food control due to fast mode and relatively high selectivity.

One of the most interesting metal oxide material is zinc oxide (ZnO)—n-type semiconductor with wide band gap (3.37 eV), high isoelectric point (pH 9–9.5) and intense room temperature photoluminescence. To improve selectivity, the surface of ZnO nanostructures can be effectively functionalized by different groups, which are suitable for covalent binding of biomolecules. ZnO-photoluminescence biosensors have been used for detection of food pathogens. Modification of ZnO surface with Au nanostructures leads to new effects, based on ZnO photoluminescence and SPR effects from Au nanostructures. Adsorption of biomolecules on the ZnO-Au surface is more sensitive than bare ZnO what makes these nanostructures attractive for biosensor applications. ZnO/Au nanostructures are easily compatible with polydopamine (PDA) nanolayer.

In this research ZnO nanorods obtained by chemical bath deposition on glass substrate. Au-based salt reduced to Au nanoparticles on the surface of ZnO nanostructures, assisted by UV irradiation within different time periods and Au conformal coating deposited over ZnO. Functionalization of ZnO-Au performed on Au layer of ZnO-Au via forming Au-S-COOH groups within thiolization process. SEM, TEM, FTIR and optical assessment of new nanosystems were done to select appropriate regimens of deposition.

New ZnO-Au platforms will be used to provide monoclonal antibodies (against Listeria monocytogenes) binding for diagnostic platform development.

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Submitted by **POGORIELOV, Maksym** on **Saturday, January 22, 2022**

Abstract ID : 17

A multidisciplinary approach drives laboratory medicine progress

Content

Enormous advances in discovering genetics, pathogenesis, and molecular biology of different diseases have defined the central place of laboratory medicine in the diagnostic workup of various pathologies. This has ensured the predominant role of laboratory testing in medical practice and decision-making. However, it is important to recognize what factors contribute to laboratory medicine's development. This study discusses the key trends and solutions determining the development of laboratory medicine and its role in health care transformation.

At the end of the past century, it was predicted that five technologies would have the greatest impact on the practice of laboratory medicine, including molecular diagnostics, near-patient testing, image analysis, robotics, and information management. This assumption has been realized completely. Nowadays, molecular diagnostics, laboratory automation, and the implementation of big data approaches have become essential features of laboratory practice. One of the key factors contributing to this progress is the multidisciplinary translational research approach.

Indeed, a multidisciplinary approach based on the interplay between different fields of medicine and non-medical disciplines, including physics, chemistry, biotechnologies, and data sciences, has become the mainstream of further laboratory medicine development and the growth of its transformational potential. One of the best examples is using nanotechnologies for nanoparticle (colloidal gold)-based lateral flow immunoassays, electrochemical sensors, and DNA sequencers. An interdisciplinary approach defines the development and implementation of new technologies for discovering novel biomarkers for precise diagnostics and personalized treatment. The discovery of nanoscale materials and their application in laboratory practice can expand biomarkers' range and improve analytical tools.

The other side of multidisciplinary teamwork is the implantation of artificial intelligence (AI) in laboratory management and practice. Automation and AI have transformed the field of anatomic pathology, facilitating digital pathology development. Besides, the application of AI and big data concepts into laboratory medicine has been improving diagnostic accuracy, refining laboratory workflows, fostering clinical decision-making support systems, and leading to higher efficiencies.

Conclusion: Multidisciplinary approach is essential for driving Laboratory medicine progress and transforming the nature of the medical practice. Translating interdisciplinary research and implementing artificial intelligence is essential for improving patients' outcomes and future precision medicine development.

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Submitted by **Prof. SULAIEVA, Oksana** on **Saturday, January 22, 2022**

Abstract ID : 18

Infrared thermography hotspot mapping patterns of the thigh in septic shock patients.

Content

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Background. Infrared thermography has recently been gaining more attention in preoperative evaluation of perforator arteries for free flap surgery. Thermographycally perforator arteries are seen as skin hotspots in color-coded images and correspond well to standard diagnostic methods. In this study, we evaluated skin thermographic hotspot patterns of the anterior thigh in septic shock patients, by using infrared thermography. We hypothesed that abnormal peripheral perfusion during critical illness affects hotspot patterns, normally seen in hemodynamically stable individuals.

Aim. The aim of this study was to classify skin thermographic hotspot patterns into types during septic shock and determine type association with outcomes.

Methods. We performed a prospective observational study. After hemodynamic resuscitation in septic shock patients requiring vasopressors, during the first 24 hours of ICU admission thermographic images of the anterior thigh were taken using FLIR A600 (FLIR systems, Sweden) camera. Thermographic images were further visually analyzed using FLIR ReasearchIR MAX (4.40.11.35) software and classified either to homogenous (no hotspots seen) or heterogeneous (hotspots seen) types. Clinical data, demographic data, and outcomes were collected.

Results. Eighty-one patients were included in the study. Out of them in 69 % (n=56) of cases, infrared thermography imaging of the anterior thigh has been classified as a heterogeneous type, with identified on average 11 (SD=5) hotspots. The temperature gradient between skin hotspot temperature (M=32.9℃; SD=1.5) and adjacent skin area temperature (M=31.5℃; SD=1.4) was 1.2℃ (SD=0.7). There was a statistically significant ICU survival distribution between heterogeneous and homogonous types (Log Rank test, $\chi 2(1) = 5.781$, p=0.02). However, there was no significant association between 28-day survival and hotspot pattern (Fisher's exact test, p= 0.1).

Conclusions. Thermographic absence of skin hotspots might be associated with poor early outcomes, representing acute critical illness severity and peripheral perfusion abnormalities.

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Status: ACCEPTED

Submitted by **VASILJEVS, Edgars** on **Saturday, January 22, 2022**

Abstract ID : 19

Biophotonic techniques for rare skin disease assessment

Content

Rare diseases are often associated with significant disability, high rate of hospitalization and admission to long-term care, high cost of illness and immense mortality rate which leads to a high burden on society at large. In the European Union, a disease is defined as rare when its prevalence is lower than 1 in 2,000 people and it is estimated that the overall population prevalence of rare diseases is 3.5–5.9% [1]. Scientific research and development of diagnostic and treatment methods is constrained due to limited amount of freely accessible medical data.
For early diagnosis and treatment to prevent complications and decrease the disease burden effective screening approaches followed by verification with genetics analysis would be crucial. Some of these diseases present with cutaneous clinical manifestations which may indicate advanced involvement of internal organs. Since skin is an organ that is most accessible for examination, techniques that could assess skin lesions for signs of known rare diseases would be beneficial for screening of at-risk population. Multispectral methods that have been used for skin cancer diagnosis and evaluation [2] are good stepping stones for the development of new techniques for the assessment of specific rare disease with clinical manifestations on the skin.
The topic of this presentation is also the topic of the author's initiated doctoral thesis. Therefore, the background and planned future activities of the thesis will be presented.

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Submitted by **PLORINA, Emilija Vija** on **Monday, January 24, 2022**

Abstract ID : 20

Conducting polymers in the design of affinity sensors

Content

The most important methods of electrochemically generated polymers including electrochemical [1], chemical [2] and biochemical [3-6] will be discussed. The applicability of electrochemically generated polymer based functional layers in the design of various types of electrochemical biosensors will be discussed [6]. Some attention will be focused on the development of glucose biosensors based on electrochemically generated polymers. Glucose oxidase (GOx) from Penicillium vitale is frequently used enzyme in the design of glucose sensors, therefore, advantages and limitations in the application of this enzyme will be discussed. We have demonstrated, that this method is suitable for the synthesis of polypyrrole [3], polyaniline [4], polytiophene and some other conducting polymer based layers and nanoparticles. We have demonstrated that during such kind of synthesis of nanoparticles and/or nanostructured layers the enzymes becomes entrapped within conducting polymer layer. In some other ours researches we showed that redox processes, which are part of metabolism of living cells, can be applied for the synthesis of conducting polymer – polypyrrole (Ppy), and formed Ppy nanoparticles can be entrapped within cells [5]. The applicability of electrochemically generated polymers in the design of electrochemical affinity sensors [1] will be discussed.

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Oral presentation is Preferred

Status: ACCEPTED

Submitted by **RAMANAVICIUS, Arunas** on **Tuesday, January 25, 2022**

Abstract ID : 21

Formation of titanium oxide and suboxide nanostructures with favourable properties for biomedical applications

Content

Titanium dioxide (TiO2) nanomaterials are known for their numerous and diverse applications from common daily products to biomedicine. To extend TiO2 application there is a high interest in synthesis of titanium suboxide structures (TixOy) with new properties. Thus, there is a high demand for a simple and efficient method for the production of new materials with desirable properties [1,2].
This research is dedicated to show a simple technology for the formation of controllable composition titanium suboxides from aqueous solutions to extend materials of titanium oxide applications. It was investigated that our formed nanostructures have strong hydrophilic properties as well as significantly lower bandgap and nanoplatelet-shaped morphology. In order to prove the formation of suboxides, EPR and XRD were employed. Ellipsometry was used to measure the thickness and calculate band gaps of the films. The modelling was also used to calculate the porosity of structures showing it is nearly 80%. This parameter could be useful for the application of such structures for various implants and other biomedical applications.

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Status: ACCEPTED

Submitted by **RAMANAVIČIUS, Simonas** on **Tuesday, January 25, 2022**

Abstract ID : 22

Photoluminescence properties of ZnSe:Al, ZnSe:Cu nanoparticles obtained by chemical synthesis

Content

Semiconductor nanocrystals of A₂B₆ group are promising materials for semiconductor electronics, biomedical imaging and disinfection. Existing synthesis methods make it possible to obtain nanocrystals with a narrow size distribution, specified surface morphology and high stability. The ability to control the band gap and the luminescence wavelength makes these nanocrystals useful for optoelectronics. Luminescent semiconductor nanoparticles with wide absorption spectrum and pronounced luminescence peaks in the visible and near-IR regions are very promising for medical diagnostics

Among the semiconductor crystals of the A₂B₆ group, the most studied are CdS and CdSe. Cheap and simple method of obtaining, as well as high quantum yield of radiation in the visible region of the spectrum can be mentioned as the main advantages of these materials. A serious disadvantage of these materials is their cytotoxicity. Therefore, it is advisable to use nanocrystals of selenide and zinc sulfide for biomedical applications. In order to be used as markers for fluorescence tomography, nanocrystals must have effective radiation in red and near-IR regions. Aluminum and copper impurities are effective activators of radiation in these regions in bulk ZnSe crystals. Therefore, the optical and luminescent properties of ZnSe:Al and ZnSe:Cu nanocrystals were studied.

Zinc selenide nanocrystals were obtained by a chemical method. The source of zinc ions was zinc chloride, and the source of selenium ions was sodium selenosulfate. For doping with aluminum or copper, a 1% solution of aluminum chloride or copper chloride was added to a 10% solution of zinc chloride. The synthesis of nanoparticles was carried out in 1 ml of a 5% gelatin solution and had the following form:

 $ZnCl_2+Na_2SeSO_3 \rightarrow ZnSe\downarrow+Na_2SO_3+Cl_2\uparrow$ (1)

$ZnCl_2+Al_2Cl3+Na_2SeSO_3 \rightarrow ZnSe{:}Al\downarrow+Na_2SO_3+Cl_2\uparrow$ (2)

$ZnCl_2+CuCl_2+Na_2SeSO_3 \rightarrow ZnSe{:}Cu\downarrow+Na_2SO_3+Cl_2\uparrow$ (3)

After removing residual reaction products, a colloidal solution of nanoparticles was deposited on a quartz substrate and placed in an oven until the polymer film dried. For X-ray diffraction and SEM studies, the solution was deposited on silicon substrates. On X-ray diffractograms, the dominant peaks were identified, which correspond to the (111), (220), (311) planes in ZnSe. Similar planes were found in ZnSe: Al and ZnSe: Cu nanocrystals.

For comparison, bulk ZnSe, ZnSe: Al and ZnSe: Cu crystals obtained by diffusion doping of Al and Cu impurities at various temperatures of growth were studied. The temperature varied from 750 to 900° C.
The optical density and photoluminescence spectra were investigated to establish the nature of optical and luminescent transitions in studied nanocrystals as well as to determine the average size of nanoparticles and the concentration of an optically active impurity. For this purpose, the sets of samples with different ratio of initial and impurity components were selected.

The optical density spectra of undoped ZnSe nanocrystals showed that a decrease in the concentration of the initial zinc chloride and sodium selenosulfate from 0.1 g / ml to 0.01 g / ml leads to a shift of the band gap towards high energies from 3.3 to 3.78 eV, which is confirmed by the colloidal solution color change from pale yellow to colorless.

The average radius of the nanoparticles was estimated by SEM and in the effective mass approximation by the change in the band gap. It was 4-5 nm.
Doping with aluminum or copper shifts the optical absorption edge to lower energies. In this case, the magnitude of the shift increases with growth of dopant concentration. A similar low-energy shift is observed in bulk ZnSe: Al and ZnSe: Cu crystals. This shift cannot be explained only by the particle size increase. In bulk crystals, such a shift is explained by inter-impurity Coulomb interaction, which is a characteristic of group III elements and transition element impurities. The concentration of aluminum and copper in the studied ZnSe: Al nanocrystals was calculated from the value of the shift of the band gap between undoped ZnSe nanoparticles

Investigation of ZnSe nanocrystals photoluminescence spectra has shown the presence of broad photoluminescence bands localized in the 550-850 nm region. The change in the temperature of nanocrystals from 300 to 430 K did not cause a shift in the studied spectra. The position of the spectra remained unchanged even with a change in the band gap width of nanocrystals. The presence of a number of bends and a large (˜ 150 nm) half-width of the bands indicate their non-elementary nature. The spectra modeling by elementary Gaussian components program revealed a series of elementary emission lines localized at 580, 600, 630, 680, 700, 750 and 800 nm. The identical elementary emission lines were observed earlier in bulk ZnSe single crystals.

Emission at a wavelength of 580 nm appears due to associative native defects *(V_{Zn}V_{Se})⁻*. The emission line at a wavelength of 600 nm appears due to associative defects (V_{Zn}D_{Se}) where the donor is either VSe or an uncontrolled donor impurity, an VII group element, for example, Cl, Br, I. The other emission lines were associated with defects *(V_{Zn}D_{Zn})⁻* with different distances between donors and acceptors. Here the donor is the uncontrolled Al, In, Ga impurities.

Doping with aluminium during the growth of nanocrystals leads to an increase of the emission intensity in the 500-1000 nm region. Further increase of the emission intensity with increasing Al₂Cl₃ concentration is explained by an increase of the donor impurity concentration in investigated nanocrystals.
In the emission spectra of ZnSe:Al nanocrystals, elementary emission lines are emitted at 580, 600, 630, 680, and 700 nm. It was found that a change of Al₂Cl₃ concentration and the choice of the stabilizing matrix type do not lead to a shift of the elementary and integral emission lines to the short-wave or long-wave region. The change in technological conditions leads to a change in the intensity of the elementary emission lines, which is explained by the redistribution of the concentration of native and impurity defects that create the associative centers. The shift of the emission integrated maximum to the smaller wavelengths region with increasing Al₂Cl₃ concentration from 0.001 to 0.002% can be explained by increasing in the intensity of the elementary emission line at 600 nm due to associative defects *(V_{Zn}Cl_{Se})⁻*.

Doping of ZnSe nanocrystals with copper during the growth process leads to a shift of the emission spectra to the shortwave region. The photoluminescence spectra of ZnSe:Cu nanocrystals with a CuCl₂ concentration of 0.001–0.003% are broad non-elementary emission bands localized in the region of 500–750 nm. The decomposition of the spectrum into elementary Gaussian components allowed us to identify a series of lines with maxima at 520, 540, 590, 660 nm. Elementary radiation lines with such maxima are not observed in undoped ZnSe nanocrystals. In bulk ZnSe: Cu crystals at T = 300 K, the emission bands at 590 and 660 nm are also detected. In bulk crystals he emission band at 550 nm at T = 77 K is observed. The emission lines in bulk crystals and polycrystalline ZnSe films are not connected with isolated CuZn, but are caused by the complexes. The emission line at 520 nm is due to transitions *(Cu_{Zn}⁻*,V_{Se}⁺)⁻*. The radiation line at 540–550 nm is associated with transitions within the associative center *(Cu_{Zn}⁻, Cl_{Se}⁺)⁻*. The emission line at 660 nm is due to radiative transitions involving doubly charged copper ions within the donor-acceptor pair *(Cu_{Zn}²⁻, Cl_{Se}⁺)⁻*. The emission line at 590 nm is most likely due to transitions involving a doubly charged copper ion and a single-charged selenium vacancy within the center *(Cu_{Zn}²⁻, V_{Se}⁺)⁻*. A further increase in the concentration of cop-

per chloride to 0.005% and more leads to strong absorption in the near-IR region and concentration quenching of the observed radiation lines, and the colloidal solutions of the nanoparticles become dark gray in color.

ZnSe, ZnSe: Al, ZnSe: Cu nanoparticles with a diameter of up to 10 nm were successfully synthesized using "green" synthesis method and organic stabilizing agents. The nature of radiation transitions in ZnSe and ZnSe: Al, ZnSe: Cu nanocrystals have been established. It was experimentally confirmed that the emission lines caused by the luminescence on donor – acceptor pairs in nanocrystals are identical to the emission lines in bulk crystals. This proves that ZnSe: Al and ZnSe: Cu nanocrystals can be effectively used as a material for biomedical visualization, optoelectronics, etc. due to both optical and luminescent properties, and simplicity and low cost of fabrication technology.

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Submitted by **TEPLIAKOVA, Irina** on **Tuesday, January 25, 2022**

Abstract ID : 23

"Fast" and "slow" chameleon dressed states in Autler-Townes spectra of alkali atoms

Content

Interest in the processes of the formation of light-dressed states in atomic systems is motivated by the possibility to employ them in solving a wide range of fundamental and applied problems in areas of quantum information, optics, and physics of cold media. Upon interaction with atoms or molecules, resonant laser radiation alters ("dresses") the structure of unperturbed quantum states, transforming them into superpositions of the initial ("bare") states. Traditionally, the dressed states emerging in Λ type excitation schemes, and their higher–dimensional generalizations such as tripods, are categorized as either "bright" or "dark" states [1]. The bright states interact with the laser radiation, while the dark states remain decoupled from the radiation. In a previous work, we have identified a new class of dressed states, "chameleon states" [2]. Properties of the chameleon states resemble a mixture of bright and dark state properties. Analysis of chameleon states' behavior in multilevel excitation schemes [3] reveals that chameleon states can be further categorized as "fast" or "slow". This extended classification aids one in deciphering the structure of excited states from recorded fluorescence spectra, thereby expanding the possibilities of optical diagnostics of cold media.

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Submitted by **CINIŅŠ, Artūrs** on **Tuesday, January 25, 2022**

Abstract ID : 24

Application of MXenes (Ti3C2Tx) structures in adsorption and detection of organic molecules

Content

Recently, MXenes have appeared as a new class of 2D materials with either metallic conductivity [1,2], some attractive semiconducting properties, or both, which can be well exploited in the design of sensors, biosensors, and biofuel cells. MXenes have some structural relation and even similarity of some physical properties with other 2D materials such as graphene [3,4]. Due to the high surface area and suitable structural composition applications as adsorbents, photocatalysts are reported as well.
In this study, different morphology MXenes (Ti3C2Tx) were prepared by the wet chemical method from precursor Ti3AlC2. Raman spectroscopy, SEM, EDX, XRD, were used for the characterization of formed structures. MXenes were tested as adsorbents for methylene blue dye adsorption and removal from aqueous solutions in a broad pH interval. Also, thin films of Ti3C2Tx have been applied in the formation of SERS based sensor for salicylic acid detection.

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Abstract ID : 25

Pārskata ziņojums par ERAF projekta Nr. 1.1.1.1/18/A/155 “Uz čukstošās galerijas modas mikrorezonatora bāzes veidota optisko frekvenču ķemmes ģeneratora izstrāde un tā pielietojumi telekomunikacijās” īstenošanu.

Content

ERAF projekta Nr.1.1.1.1/18/A/155 mērķis ir ir iegūt jaunas zināšanas par čukstošo galeriju modu rezonatoru optiskajām frekvenču ķemmēm un izstrādāt, konstruēt un testēt ķemmes ģeneratora prototipu telekomunikāciju pielietojumiem. Projektu īsteno komanda no LU Atomfizikas un spektroskopijas institūta, RTU Telekomunikāciju institūta un SIA AFFOC Solutions. Projekta īstenošanas laiks: 16.05.2019. - 15.05.2022.

Čukstošās galerijas modu rezonatori (ČGMR) ir piesaistījuši interesi savu optisko īpašību un daudzveidīgo pielietojumu dēļ. Izvēloties piemērotu materiālu ar ļoti zemu absorbciju un izgatavojot ļoti gludu virsmu, ČGMR var sasniegt īpaši augstas optiskā labuma (Q faktora) vērtības. ČGMR ir piemēroti nelineāro efektu mijiedarbībai un frekvences ķemmes ģenerēšanai. Frekvenču ķemmes aptver plašu spektrālo intervālu, kas ļautu datu pārraides sistēmās aizstāt dārgus lāzeru blokus viļņgarumdales multipleksēšanas metodei. Šī metode apvieno vairākus optiskos viļņu garuma signālus datu nosūtīšanai vienlaicīgi pa vienu optisko šķiedru, tādējādi ļaujot pārsūtīt lielus datu apjomus. Šobrīd multipleksēšanai izmanto vairākus atsevišķus lāzera avotus, kas ģenerē optiskos nesējus datu pārraidei, kas ir dārgi un katrs nesējs cieš no starojuma frekvences nenoteiktības. ČGMR ģenerēta frekvenču ķemme varētu samazināt izmaksas, nodrošināt uzlabotu energoefektivitāti. Turklāt nepieciešams tikai viens gaismas avots ķemmes ierosināšanai, kas nodrošina stabilu intervālu starp ģenerētajām frekvences līnijām (skat. fig. 1).

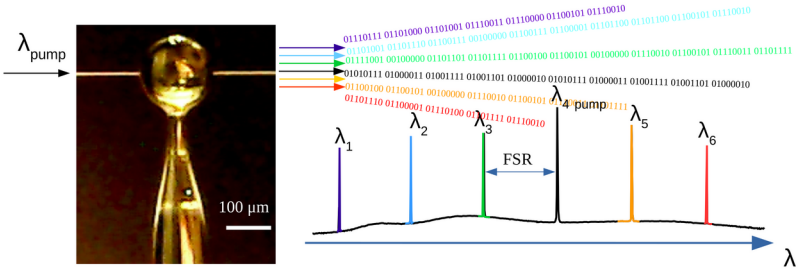

Figure 1: Viens lāzers ČGMR ģenerē optisko frekvenču ķemmi, kuras līnijas ir ekvidistantas, un tās varētu aizstāt dārgus lāzera blokus viļņgarumdales multipleksēšanas datu pārraides metodei.

Lai ģenerētu frekvences ķemmes ar mazjaudas pumpēšanu, ir testētas dažādas ČGMR ģeometrijas un materiāli. Mikrosfēras var izgatavot ar dažādu rādiusu, lai mainītu brīvo spektra diapazonu (FSR) un attālumu starp ģenerētajām frekvenču ķemmes līnijām. Izmantošanai viļņgarumdales multipleksēšanas pārraides sistēmā ir vēlamas ģenerētas līnijas optiskā C joslas (1530-1565 nm) reģionā ar kanālu atstatuma intervālu starp tām, kas atbilst (ITU-T G.694.1) norādītajiem atstatuma intervāla datu kanāliem.

Projektā laikā ir izgatavoti un testēti mikrosfēras, mikrotoroīdu un mikrodisku rezonaoti, ģenerētas optiskās frekvenču ķemmes un demonstrēta datu pārraide. Projekta galvenie sasniegtie rezultāti jau ir publicēti 4 rakstos [1-4], un 7 konferencēs prezentēti 13 referāti.

Lai ģenerētu frekvenču ķemmi WGMR tika sapārots ar 1550 nm lāzeri, izmantojot trapecveida

šķiedru. Attālums starp ķemmes līnijām sakrita ar ČGMR brīvo spektrālo apgabalu, ko nosaka rezonatora izmērs. Tika iegūtas 800 GHz, 400 GHz, 200 GHz un 100GHz ķemmes. Daļai no ģenerētajiem optiskajiem nesējiem bija pietiekama optiskā signāla-trokšņa attiecība, lai tos varētu izmantot datu pārraides demonstrēšanai. Ilgtermiņa ķemmes stabilitātes izpēte parādīja, ka temperatūras stabilizācija var būt būtiska datu pārraides pielietojumiem telekomunikācijās, lai izmantotu ķemmes līnijas kā datu nesējus. ČGMR ir jāaizsargā arī no mitruma un putekļiem, lai samazinātu tā degradēšanos.

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Comments:

Tagad šķiet attēls strādā

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Submitted by **BRICE, Inga** on **Wednesday, January 26, 2022**

Abstract ID : 26

Collapse of Xe polarized atomic states in magnetic fields.

Content

Ionization of two-photon excited states 5p5(2P3/2)6p[3/2, 5/2]2, M = 2 (jl-coupling) of xenon atoms by circularly polarized probe light was studied experimentally in a supersonic beam. The observed photoionization signals revealed oscillation structure due to the Larmor precession of atomic states in an external magnetic field. We derived analytical formulas for the photoelectron current and explained the diversity in the structure of the detected oscillations in terms of the principal lines among multiplet components of optical transitions. The obtained numerical data demonstrate collapse and revival (beating) behavior of the photocurrent due to nonlinearity of Zeeman shifts in the presence of the Paschen–Back effect. Our results indicate the possibility of implementing Doppler-free spectroscopy involving bound-free transitions.

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Abstract ID : 27

Selectivity of glycerol droplet microresonator humidity sensor

Content

Environmental control is important in many areas – industrial processing, scientific studies, food packaging. One of the main parameters is humidity. To achieve higher sensitivity than that of commercial humidity sensors, we have created a humidity sensor that is based on glycerol droplet. Glycerol is highly hygroscopic and has a specific glycerol-water ratio for every relative humidity percent (RH, %). It is cheap and environmentally friendly. We use the droplet as a whispering gallery mode (WGM) microresonator. WGMs are known for their high Q factors, which lead to high sensitivity and precision. When WGMs are excited in the droplet, resonance dips can be seen in the transmission spectrum. As RH changes, the resonant wavelength (observed as resonance dips) shifts due to a change in the droplet's radius and refractive index. We can detect the shift and use it as a humidity sensor. We have successfully created an experimental set-up and original data analysis method that allow us to follow the resonant wavelength shift in real-time. Results show that the sensor has an average sensitivity of 2.85 nm/% RH in the 50–70 % RH range, it is stable and has a long lifetime. To further investigate the properties of the glycerol droplet sensor, we tested its selectivity and tried two coupling methods (free-space and tapered fiber). Selectivity is an important factor as air in factories, hospitals, and other places usually contains more than just water molecules. We decided to test the sensor's response to two different gases – ethanol and acetone. Results show that glycerol is highly selective and does not absorb ethanol/acetone molecules, meaning that it can be used for trustworthy humidity measurements. We discovered that free-space coupling is best used at RH > 50 % and tapered fiber coupling at low humidity due to fiber degradation.

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