6th International Symposium on Lasers in Medicine and Biophotonics

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Center of Laser Technology and Material Science

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Program

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2-6 November, 2020

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Topics

Section A. Advanced laser medical systems and technologies

New medical applications and advanced laser medical systems for ophthalmology, dermatology, urology, endoscopic and microsurgery, dentistry and other specialties

Section B. Laser interaction with cells and tissues: clinical imaging and spectroscopy

Optical clearing and light transport in cells and tissues • Laser trapping and manipulation of biological particles • Nonlinear interactions of light and tissues • Speckle phenomena in tissues • Quantification and imaging of cells, blood and lymph flows • Terahertz waves interaction with cells and tissues • Autofluorescence and photodynamic diagnosis • Optical coherence tomography and diffuse optical imaging • New developments in non-invasive optical technologies • Laser microscopy and spectroscopy of tissues

Section C. Photonics and nanobiotechnology

Analytical biophotonics, chemical and biosensing principles and instrumentation, nanomaterials, methods and systems for diagnostics and therapy

Section D. Photodynamic processes in biology and medicine

Photosensitizers for biology and medicine • Direct optical single oxygen generation • Photodynamic therapy • Photothermal action of laser radiation on bio-objects • Protection of organs and tissues against powerful and laser radiation • Photodynamic diagnosis • New photosensitizers for theranostics • Photodynamic action on pathogenic microflora

Section E. Nanophototheranostics

Laser radiation interaction with nanophotosensitizers • Spectral and luminescent properties of nanophotosensitizers • Pharmacokinetics and pharmacodynamics of nanophotosensitizers • Influence of the microenvironment on the nanophotosensitizers optical properties • Fluorescence diagnostics in vivo using nanophotosensitizers • Photodynamic therapy and hyperthermia with nanophotosensitizers, crystalline organic nanophotosensitizers, rare-earth-doped nanophotosensitizers • Bioimaging using nanophotosensitizers

6th International A.M. Prokhorov Symposium on Lasers in Medicine and Biophotonics

Opening and Plenary Session - Monday, November 2, Hall 2 10:20-14:00				
Section		Tuesday, November 3	Wednesday, November 4	Thursday, November 5
SYA	Advanced laser medical systems and technologies	Hall 7 09:00-18:45		
SYB	Laser interaction with cells and tissues: clinical imaging and spectroscopy	Hall 8 14:30-19:00		Hall 8 09:00-19:00
SYC	Photonics and nanobiotechnology	Hall 9 09:00-19:00		Hall 9 09:00-19:00
SYD	Photodynamic processes in biology and medicine		Hall 6 17:00-19:00	Hall 7 09:00-19:00
SYE	Nanophototheranostics	Hall 8 09:00-13:30		
Poster Session is avaliable from Tuesday, November 3 till Friday, November 6 at https://online.laseroptics.ru				

6th International Symposium on Lasers in Medicine and Biophotonics
Plenary Session

10:20 - 14:00
Session Chair: *I.A.Shcherbakov, Prokhorov General Physics Inst. RAS, Russia*

10:30-11:15 MoSYP-01

Recent progress in the use of nanodiamonds in oncology for active targeting delivery of chemotherapeutic drugs

E. Osawa[1], E. Chow[2], D. Ho[2], H. Huang[3], T. Tanaka[4]; [1]NanoCarbon Research Inst., AREC, Faculty of Textile Science and Technology, Shinshu Univ., Japan; [2]National Univ. of Singapore, Singapore; [3]Shanghai Inst. of Technology, China; [4]National Inst. of Technology, Fukushima College, Japan

We have been developing active targeting drug delivery system for chemotherapy of cancer in later stages. Using nanodiamond as the drug carrier, we succeeded in the medium animal tests without targeting capabilities. We plan to adopt antigen-antibody reactions for active targeting using folic acid functionalities as the built-in antigen. We will present the preliminary computational results.

11:15-12:00 MoSYP-02

Photodiagnosis and targeted photodynamic therapy for the treatment of metastatic melanoma

H. Abrahamse; Univ. of Johannesburg, South Africa

Metastatic melanoma (MM) has a poor prognosis. Combined photodynamic diagnosis (PDD) and therapy (PDT) can be used for both diagnosis and tumor destruction. This study demonstrated that the efficacy of PDT treatment via the bio-active antibody PS drug targeting of MM improved.

12:30-13:15 MoSYP-03

Label-free optical diagnosis of malignant and benign neoplasms with different nosologies and localizations

I.V. Reshetov[1,2], K.I. Zaytsev[3,4], I.N. Dolganova[4,5], E.N. Rimskaya[4], K.G. Kudrin[2], M.A. Schedrina[1], D.S. Ponomarev[7], V.N. Kurlov[5], A.A. Potapov[6], and V.V. Tuchin[8,9]; [1]Inst. for Regenerative Medicine, Sechenov Univ.; [2]Academy of Postgraduate Education FSCC FMBA; [3]Prokhorov General Physics Inst. RAS; [4]Bauman Moscow State Technical Univ.; [5]Inst. of Solid State Physics RAS; [6]Burdenko Neurosurgery Inst.; [7]Inst. of Ultra High Frequency Semiconductor Electronics RAS; [8]Saratov State Univ.; [9]Inst. of Precision Mechanics and Control RAS, Russia

We discuss a potential of combining several optical instruments operating in different spectral ranges for improvement of the sensitivity and specificity of differentiation between healthy (intact) and malignant tissues.

13:15-14:00 MoSYP-04

Laser printing of biomaterials and living cells *Plenary*

B. Chichkov; Leibniz Univ. Hannover, Inst. of Quantum Optics, Germany

In this lecture, we will discuss laser-based techniques applied for precise generation of 3D scaffolds for tissue engineering and for printing living cells into 3D patterns.

SY: Section A. Advanced Laser Medical Systems and Technologies

09:00 - 11:00
Session Chairs:
D.G. Kochiev, A.M.Prokhorov General Physics Inst., RAS, Russia
V.P. Minaev, NTO "IRE-Polus", Russia

TuSYA-01 09:00-09:30
Thulium-doped fiber lasers with direct pumping. Medical perspectives. *(Invited paper)*
A.A. Kolegov[1], A.V. Lappa[2], G.S. Sofienko[1], E.A. Belov[1], D.N. Bagavetdinov[1], A.O. Leshkov[1], Y.V. Ivchenko[1], E.G. Akulinin[1], I.V. Krochek[3], I.A. Abushkin[4], S.V. Sergiyko[3], A.E. Anchugova[2,3], A.S. Zarezina[2]; [1]Russian Federal Nuclear Center–Zababakhin All-Russia Research Inst. of Technical Physics, [2]Chelyabinsk State Univ., [3]South-Ural State Medical Univ., [4]Medical Laser Technologies Center, Russia.
A family of compact tulium fiber lasers of 40 W power and 1.908 and 1.94 mcm wavelengths is presented. There has been implemented the original scheme with one-piece fiber resonator, direct laser-diode pumping, and jointless output of radiation into the working lightguide. The devices are designed to perform operations of a wide class in open and endoscopic surgery.

TuSYA-02 09:30-10:00
Optimization of the endovenous laser coagulation using two-micron laser radiation *(Invited paper)*
S.A. Artemov, A.N. Belyaev, O.S. Bushukina, S.A. Khrushchalina, S.V. Kostin, A.A. Lyapin, P.A. Ryabochkina, A.D. Taratynova; National Research Mordovia State Univ., Russia
Paper provides overview of endovenous laser coagulation (EVLC) clinical techniques using radiation of different wavelengths. Results of in-vivo own EVLC experiments using radiation with wavelength of 1910 nm are presented. It was shown that successful vein occlusion is observed with lower radiation power (4 - 6 W) and minimal damage to perivenous tissues compared to 0.81, 0.98, 1.5-μm radiation.
This research was supported by RFBR Grant(s) # 18-29-20039

TuSYA-03 10:00-10:30
Biological atomic-force microscopy: is it worth it? *(Invited paper)*
P.S. Timashev; Sechenov Univ., Semenov Inst. of Chemical Physics RAS, Inst. of Photonic Technologies, Research Center "Crystallography and Photonics" RAS, Russia
Atomic force microscopy (AFM) and related techniques such as nanoindentation have become a powerful tool in biomedical research. Here, we present our experience in AFM application for fundamental and applied studies related to regenerative medicine.
This research was supported by RFBR Grant(s) # 18-29-06059, 20-02-00712

TuSYA-04 10:30-10:45
EVLO 1.940 microns - a new step in the treatment of varicose veins. *(Invited paper)*
K.A. Kaperiz[1], V.Yu. Bogachev[1,2];[1]. "The First Phlebological Center",[2]. Pirogov Russian National Research Medical Univ., Russia
The experiments showed that radiation with a wavelength of 1.94 μm provides sufficient damage to the venous wall at a significantly lower linear energy density than radiation with a wavelength of 1.55 μm.

TuSYA-05 10:45-11:00
Study of laser radiation blood plasma heating and coagulation
V.P. Minaev[1], V.Yu. Bogachev[2,3], K.A. Kaperiz[2], N.V. Minaev[4]; [1]IRE-Polus Ltd, [2]"The First Phlebological Center", [3]Pirogov Russian National Research Medical Univ., [4]Inst. of Photonic Technologies, FRC "Crystallography and Photonics" RAS, Russia
Investigation results of laser induced blood plasma heating and coagulation are presented. The laser radiation with wavelengths 1.55 and 1.94 μm and fibers with flat end and radial fibers were used.
This research was supported by RFBR Grant(s) # 17-02-00832

SY: Section A. Advanced Laser Medical Systems and Technologies

11:30 - 13:30
Session Chairs:
D.G. Kochiev, A.M.Prokhorov General Physics Inst., RAS, Russia
V.P. Minaev, NTO "IRE-Polus", Russia

TuSYA-06 11:30-12:00
Optical coherence tomography of brains: ex vivo study of healthy and malignant tissues *(Invited paper)*
I.N. Dolganova[1,2], P.V. Aleksandrova[1,2], N.A. Naumova[1,2], P.V. Nikitin[3], K.I. Zaytsev[2,4], S.T. Beshplav[3], V.V. Tuchin[5]; [1]Inst. of Solid State Physics RAS; [2]Bauman Moscow State Technical Univ.; [3]Burdenko Neurosurgery Inst.; [4]Prokhorov General Physics Inst. RAS; [5]Saratov State Univ., Russia
In this talk, we present the results of the ex vivo experimental studies by means of optical coherence tomography of malignant and healthy tissues of brain, including samples of human brain glioma of different grades and rat glioblastoma model. The extraction of features based on attenuation and homogeneity helps to analyze differences of tissues.
This research was supported by RFBR Grant(s) # 18-08-00853

TuSYA-07 12:00-12:30
Optically-controlled measurements of cryodestruction of biological tissues using sapphire shaped crystals *(Invited paper)*
I.N. Dolganova[1,2], A.K. Zotov[1], I.A. Shikunova[1], K.I. Zaytsev[2,3], V.N. Kurlov[1]; [1]Inst. of Solid State Physics RAS; [2]Bauman Moscow State Technical Univ.; [3]Prokhorov General Physics Inst. RAS, Russia
Sapphire appticator for cryosurgery with the ability of monitoring freezing of biological tissue is proposed. The conception is based on diffuse optical spectroscopy. The design of applicator allows to detect spatially resolved optical signals reflected and scattered from tissue. We demonstrate the results of experimental studies using tissue phantoms and ex vivo samples.

TuSYA-08 12:30-12:45
1.55μm laser-induced boiling technology in the treatment of bone cysts in children
I.A. Abushkin[1], V.M. Chudnovsky[2], V.G. Abushkina[1]; [1]Center for Medical Laser Technologies; [2]Ilyichov Pacific Oceanological Inst., Russia
The technology of coagulation of bone cysts in children by the method of laser-induced boiling is presented. The 1.56 μmi laser was more efficient than the 0.97 μm laser. In 5 children with a solitary and one child with an aneurysmal cyst, one session of 1.56 μm laser coagulation was enough to get a good result.

TuSYA-09 12:45-13:00
Photocoagulation of a double 1.55 + 1.94 μm wavelength in the treatment of vascular anomalies
I.A. Abushkin[1], V.M. Chudnovsky[2], V.P. Minaev[3], V.O. Lapin[1], O.A. Romanova[1], M.Y. Galiulin[1]; [1]Center for Medical Laser Technologies, [2]Ilyichev Pacific Oceanological Inst., [3]«IRE-Polus» Ltd, Russia
The results of the treatment of vascular anomalies (hemangiomas and malformations) by interstitial thermotherapy with double 1.55 + 1.94 μm laser radiation are presented. In the experiment and the clinic, it was shown that interstitial coagulation of vascular formations with double 1.55 + 1.94 μm laser radiation is more effective than the previously used 0.97 and 1.56 μm wavelengths.

TuSYA-10 13:00-13:15
Embryo microsurgery with femtosecond laser: novel techniques for assisted reproductive technologies
I.V. Ilina[1], M.A. Filatov[2], Y.V. Khramova[2], D.S. Sitnikov[1,3]; [1]Joint Inst. for High Temperatures RAS; [2]Lomonosov Moscow State Univ.; [3]Moscow Inst. of Physics and Technology, Russia
Two femtosecond laser-based techniques for embryo microsurgery are proposed. The first one uses laser to create code on the embryo envelope and minimize the risk of embryo mix-up. The second one enables laser-assisted hatching to be performed at the early blastocyst stage (when the inner cell mass and the trophoblast are distinguished)to initiate starting of hatching at the prescribed site.
This research was supported by RFBR Grant(s) # 19-32-70036

TuSYA-11 13:15-13:30
Laser mass spectrometry of volatile organic compounds for diagnosis of pathological processes.
A.B. Bukharina[1], M.Y. Kochevalina[2], A.V. Pento[1], Ya.O. Simanovsky[1], E.I. Rodionova[2], S.M. Nikiforov[1]; [1]Prokhorov General Physics Inst. RAS; [2]Kharkevich Inst. for Information Transmission Problems RAS, Russia
A method of mass spectrometric analysis of volatile organic compounds(VOC) of biological samples at atmospheric pressure was developed. The method uses laser plasma radiation for ionization of molecules. Multivariate statistics was used for the mass spectra analysis. The possibility of identification of progressing oncological process in mice with analyzing the composition of VOCs of the urine samples was showcased.
This research was supported by RFBR Grant(s) # 18-32-01018

SY: Section A. Advanced Laser Medical Systems and Technologies

14:30 - 16:30
Session Chairs:
D.G. Kochiev, A.M.Prokhorov General Physics Inst., RAS, Russia
V.P. Minaev, NTO "IRE-Polus", Russia

TuSYA-12 14:30-15:00
Development of novel medical instruments based on sapphire shaped crystals *(Invited paper)*
V.N. Kurlov[1], I.N. Dolganova[1,2], I.A. Shikunova[1], G.M. Katyba[1,2,3], M.A. Shcherina[4], A.K. Zotov[1], K.I. Zaytsev[2,4]; [1]Inst. of Solid State Physics RAS; [2]Bauman Moscow State Technical Univ., [3]Prokhorov General Physics Inst. RAS; [4]Inst. for Regenerative Medicine, Sechenov First Moscow State Medical Univ., Russia
We present a set of medical instruments based on sapphire shaped crystals, which are able to combine several modalities: tissue resection, aspiration, intraoperative diagnosis, laser therapy, and coagulation. They are biocompatible and resist multiple sterilization. Application of the edge-defined film-fed growth technique leads to the fabrication of sapphire instruments with complex form and shape.
This research was supported by RFBR Grant(s) # 18-08-01230, 18-38-20140

TuSYA-13 15:00-15:30
High-efficient DFG of fiber lasers radiation in the spectral region of 3um for soft tissue ablation *(Invited paper)*
I.A. Larionov[1,2], A.S. Gulyashko[1], D.A. Alekseev[1], V.A. Tyrtyshnyy[1]; [1]NTO «IRE-Polus», Russia; [2]Moscow Inst. of Physics and Technology, Russia
High-efficient 3μm wavelength laser source is proposed for soft tissue surgery. Device is based on difference frequency generation of Er and Yb fiber lasers radiation in periodically poled lithium niobate. Average output power exceeds 20W with M2 parameter 1.2. Medical ex vivo experiments have confirmed high ablation rate with small coagulation zone and absence of carbonization in cut region.

TuSYA-14 15:30-15:45
Evaluation of blue diode laser alone and in combination with Tm fiber laser as a tool for laparoscopic surgery
V.A. Arkhipova[1], M.E. Enikeev[2], E.E. Laukhtina[2], A.V. Kurkov[3], V.A. Andreeva[1], I.V. Yaroslavsky[4], G.B. Altschuler[4]; [1]NTO IRE-Polus, [2]Sechenov Univ., Research Inst. for Urology and Reproductive Health, [3]Sechenov Univ., Inst. for Regenerative Medicine, Russia; [4]IPG Medical Corp., USA
We compared the cutting and coagulation efficiency of the blue laser, the Tm laser, and the combination of them during laparoscopic partial nephrectomy (LPN). The combination of the blue and Tm lasers provided the most promising results in terms of resection rate and hemostasis.

TuSYA-15 15:45-16:00
Theoretical and experimental study of temperature fields and tissue response in fractional laser regeneration of cartilage
A.A. Kovalenko[1], V.A. Andreeva[1], E.N. Sobol[2], I.V. Yaroslavsky[2]; [1]NTO IRE-Polus, Russia; [2]IPG Medical Corp., USA
We conducted a theoretical and experimental study of thermal fields created in bovine knee cartilage in vitro by fractional treatment with an Er fiber laser (1.56 μm). The data were used to identify laser parameters suitable for fractional laser procedure to induce cartilage regeneration.

TuSYA-16 16:00-16:15
Three years of clinical experience using super-pulse Tm fiber laser lithotripter for treating urolithiasis
A.G. Martov[1,2], D.V. Ergakov[1,2], M.A. Gyseynov[2], A.S. Andronov[1,2]; [1]Pletnev Clinical Hospital, [2]Inst. of Continuous Medical Education, Russia
We evaluated clinical performance of Super-pulse Thulium Fiber Laser system for lithotripsy of urinary stone tract. 214 subjects were involved in clinical study. Our data show that this system is efficacious and safe for lithotripsy.

TuSYA-17 16:15-16:30
Influence of laser irradiation to the structure of dental implant surface during professional oral hygiene
S.V. Tarasenko, S.I. Repina, R.D. Garipov, E.A. Morozova; Sechenov First Moscow State Medical Univ., Russia
Aim: to compare the surface of implants after laser influence. Materials and methods: The effect of 5 types of surgical lasers on dental implant surface was investigated using scanning electronic microscope. Results: The damage of the surface depended on wavelength and mode and was minimal after Nd:YAG–KTP, CO2 and «IRE-Polus» lasers. Conclusion: Adjusting of the working mode is necessary.

SY: Section A. Advanced Laser Medical Systems and Technologies

17:00 - 17:45
Session Chair:
D.G. Kochiev, A.M.Prokhorov General Physics Inst., RAS, Russia
V.P. Minaev, NTO "IRE-Polus", Russia

TuSYA-18 17:00-17:15
Ultra-precise minimally invasive laser surgery with picosecond laser pulses
V.A. Arkhipova[1], V.A. Andreeva[1], I.V. Yaroslavsky[2], G.B. Altshuler[2]; [1]NTO IRE-Polus, Russia; [2]IPG Medical Corp., USA
We conducted an experimental ex vivo study of feasibility using a picosecond (ps) laser emitting at 1030 nm for precise minimally invasive (micro) surgery. The results indicate that plasma generated by the ps laser enables deep and coagulation-free ablation. Thus, ps laser technology can be of high value for dermatology as well as for other specialties requiring precise cutting.

TuSYA-19 17:15-17:30
Opto-thermal computer modeling of laser-stone interaction during laser lithotripsy
E. Startseva[1,2], V. Andreeva[1], I. Yaroslavsky[3]; [1]NTO "IRE-POLUS", Russia; [2]National Research Nuclear Univ. MEPhI, Russia; [3]IPG Medical, USA

TuSYA-20 17:30-17:45
Optimizing laser litotripsy with super-pulse Tm fiber laser through controlling pulse shape and modulating pulse sequence
A.A. Kovalenko[1], V.A. Andreeva[1], I.V. Yaroslavsky[2], G.B. Altshuler[2]; [1]NTO IRE-Polus, Russia; [2]IPG Medical Corp., USA
Objective of the study was to improve efficiency, safety of laser lithotripsy through both modifying temporal profile of the laser pulses and manipulating various characteristics of the pulse sequence. Modulating the pulse energy and the peak power (amplitude modulation) as well as modulating the repetition rate (frequency and amplitude-frequency modulation) were investigated in vitro using a super-pulse Tm fiber laser.

SY: Section B. Laser Interaction with Cells and Tissues: Clinical Imaging and Spectroscopy

14:30 - 16:30
Session Chair: *V.V. Tuchin, Saratov State University, Saratov, Russia*

TuSYB-01 14:30-15:00
Study of the impact of optical clearing on skin absorption, scattering and autofluorescence properties *(Invited paper)*
W. Blondel[1], S. Zaytsev[1,2], V. Colas[1], G. Khairallah[1,3], P. Rakotomanga[1], C. Soussen[4], E. Genina[2,5], C. Daul[1], V. Tuchin[2,5], M. Amouroux[1]; [1]Univ. de Lorraine, CNRS, CRAN UMR[7]039, France; [2]Saratov State Univ., Russia; [3]Metz-Thionville Regional Hospital, Department of Plastic, Aesthetic and Reconstructive Surgery, France; [4]CentraleSupélec, CNRS, Université Paris-Sud, L2S UMR[8]506, France; [5]Tomsk State Univ., Russia;
In this study, the changes in Spatially Resolved Diffuse Reflectance and AutoFluorescence spectra acquired on ex vivo human skin during optical clearing process (topical application) are investigated and their impact on skin optical properties (absorption, scattering and fluorescence) analyzed using inverse problem solving and multidimensional data processing approaches.
This research was supported by RFBR Grant(s) # 18-52-16025

TuSYB-02 15:00-15:30
Large area brain imaging *(Invited paper)*
F.S.Pavone; Univ. of Florence, Italy
In this work large area reconstruction are obtained using a mesoscale light sheet system for structural analysis and a light sheet two-photon microscope for functional information. Both modalities are capable to sample whole brain with single cell resolution, with light sheet imaging being capable to perform high rate volumetric imaging allowing to map in real time whole-brain calcium dynamics

TuSYB-03 15:30-15:45
Optical properties of brain structures that could be met by neurosurgeon
K.A. Achkasova[1], K.S. Yashin[1], A.A. Moiseev[2], E.B. Kiseleva[1], M.M. Karabut[1], E.V. Zagaynova[1], N.D. Gladkova[1]; [1]Privolzhsky Research Medical Univ.,2- Inst. of Applied Physics RAS, Russia
It is necessary for neurosurgeon to distinguish different structures of the human brain during the surgery what is not always easy. Different human brain structures including cortex, basal ganglia and white matter were studied by cross-polarization optical coherence tomography with following calculation of optical coefficients from the OCT data. Statistically significant differences were found between mentioned brain structures.
This research was supported by RFBR Grant(s) # 18-29-01049_mk

TuSYB-04 15:45-16:00
Superresolution imaging by using far field and near field label free microscopy techniques
G.A. Stanciu, D.E. Tranca, S.G. Stanciu, R. Hristu, A. Toma; Center for Microscopy-Microanalysis and Information Processing, Univ. Politehnica of Bucharest, Romania*
In our work qualitative and quantitative results based on label free imaging in laser scanning microscopy are presented. To image different materials, including biological samples we used a multimodal microscopy system integrating several far field and near field microscopy techniques.

TuSYB-05 16:00-16:15
In vitro test system for studing regeneration based on laser microsurgery of multicellular spheroids
N.V. Kosheleva[1,2].3, I.V. Ilina[4], I.M. Zurina[1,3,5], A.A. Gorkun[1,5], D.S. Sitnikov[4], I.N. Saburina[1,3]; [1]FSBSI "Inst. of General Pathology and Pathophysiology", [2]Lomonosov Moscow State Univ., [3]FSBEI FPE "Russian Medical Academy of Continuous Professional Education", Ministry of Healthcare of Russia, [4]Joint Inst. for High Temperatures RAS, [5]Sechenov Univ., Russia
Technique of laser microsurgery of spheroids from mesenchymal and epithelial cells with nanosecond laser pulses was used to develop a model for studying regeneration in vitro. Reparative processes with wound restoration occurred gradually over seven days due to rearrangement of surviving cells without proliferation. Skin anti-ageing drugs were tested on the developed model of cell spheroid's regeneration.

TuSYB-06 16:15-16:30
Temporal correlation transfer in a head model
V.L. Kuzmin[1], A.Yu. Valkov[1,2], Yu. Zhavoronkov[2]; [1]Peter the Great St. Petersburg Poytechnic Univ., [2]St. Petersburg State Univ. , Russia
The simulation results for the intensity temporal correlation function in a multi-layer head model are presented, permitting to use the diffuse correlation spectroscopy for detection of intracranial hematomas. The novel Monte Carlo algorithm for simulation of radiation transfer in multilayer media is applied generalizing the widely known MCML method. The spatial and temporal plots are calculated numerically.
This research was supported by RFBR Grant(s) # 16-02-00465

SY: Section B. Laser Interaction with Cells and Tissues: Clinical Imaging and Spectroscopy

17:00 - 19:00
Session Chair: ***M.Yu. Kirillin,*** *Privolzhsky Research Medical Univ., Russia*

TuSYB-07 17:00-17:30
Complementary fluorescence and optoacoustic imaging for monitoring of photodynamic therapy of glioma employing BPD based nanoconstructs: pilot animal studies *(Invited paper)*
I. Turchin[1], M. Kirillin[1], D. Kurakina[1], A. Orlova[1], V. Plekhanov[1], E. Sergeeva[1], P. Subochev[1], E. Sergeev[1], V. Perekatova[1], A. Nerush[1], D. Yuzhakova[2], E. Kiseleva[2], M. Shirmanova[2], S. Bano[3], S. Mallidi[3,4], T. Hasan[3]; [1]Inst. of Applied Physics RAS, Russia; [2]Privolzhsky Research Medical Univ., Russia; [3]Wellman Center for Photomedicine, Massachusetts General Hospital, USA; [4]Tufts Univ., USA
We report on a novel approach to monitor photodynamic therapy procedure based on the simultaneous fluorescence and optoacoustic imaging with the use of a liposome nanoconstructs contain benzoporphyrin derivatives and the fluorescent IRDye800 dye. We demonstrate the results of a preliminary in vivo study with combined fluorescence and optoacoustic custom-made setups on a NUDE mouse with human glioblastoma U-87.
This research was supported by RFBR Grant(s) # 17-54-33043 onko-a

TuSYB-08 17:30-18:00
Endogenous and exogenous fluorescence diagnostics of colorectal cancer *(Invited paper)*
E. Borisova[1,2], Ts. Genova[1], N. Penkov[3], H. Valkov[3], B. Vladimirov[3], L. Avramov[1]; [1]Inst. of Electronics, Bulgarian Academy of Sciences, Bulgaria; [2]Saratov State Univ., Russia; [3]University Hospital "Tzaritza Yoanna – ISUL", Bulgaria
We investigated the characteristic endogenous fluorescence spectral differences of cancerous and healthy colorectal tissues, ex vivo using excitation-emission matrices in a broad spectral range (ex.280-500 nm, em. 300-800 nm). For an improvement of the contrast required during in vivo tumours observation, delta aminolevulinic acid was applied as a precursor of protoporphyrin IX (PpIX) for colorectal tumor detection and progress evaluation.

TuSYB-09 18:00-18:30
On the origin of NIR fluorescence in biotissues *(Invited paper)*
E.A. Shirshin; Lomonosov Moscow State Univ., Russia
We aim at elucidating the origin of NIR fluorescence of biotissues, which is ubiquitously observed and rarely used for diagnostical applications. The nature of fluorophores responsible for this signal remains unclear. Here we discuss the possible mechanisms of NIR fluorescence formation based on a set of in vitro and in vivo experiments, focusing on the role of oxidation processes.

TuSYB-10 18:30-18:45
The possibilities of optical methods in the early diagnosis of gliomas
O. Cherkasova[1,2], A. Mankova[3], M. Konnikova[2], P. Solyankin[2], D. Vrazhnov[4,5], Yu. Kistenev[4,6], A. Sinko[2], Y. Peng[7],E. Zavjalov[8]; [1]Inst. of Laser Physics SB RAS, [2]Inst. on Laser and Information Technologies - Branch of the Federal Scientific Research Centre "Crystallography and Photonics" RAS, [3]Lomonosov Moscow State Univ., [4]Tomsk State Univ., [5]Inst. of Strength Physics and Materials Science SB RAS, [6]Siberian State Medical Univ., Russia; [7]Univ. of Shanghai for Science and Technology, China; [8]Federal Research Center "Inst. of Cytology and Genetics SB RAS, Russia
A novel approach based on the Raman and absorption spectroscopy for detection of gliomas molecular markers in brain tissue and blood will be discussed. Using the mice model of the U87 human glioblastoma, we have shown the possibility of glioma development control by a combination of Raman, IR, and Terahertz pulsed spectroscopy.
This research was supported by RFBR Grant(s) # 19-52-55004

TuSYB-11 18:45-19:00
Multi-factor modeling of OCT-scan formation in the presence of scatterer motions
A.L. Matveyev[1], L.A. Matveev[1], A.A. Sovetsky[1], A.A. Zykov[1], A.A. Moiseev[1], G.V. Gelikonov[1], A. Vitkin[2], V.Y. Zaitsev[1]; [1]Inst. of Applied Physics RAS, Russia; [2]Univ. of Toronto and University Health Network, Canada
We present a robust semi-analytical multi-factor model of OCT-scan formation with rigorous accounting for the beam-focusing effects. In view of difficulties in performing highly-controlled phantom experiments, application of the developed realistic numerical model opens very flexible and convenient possibilities for evaluating the influence of scatterer motions of different types using numerically simulated OCT scans.
This research was supported by RFBR Grant(s) # 19-02-00645

SY: Section C. Photonics and Nanobiotechnology

09:30 - 11:00
Session Chairs:
P.I. Nikitin, A.M.Prokhorov General Physics Inst., RAS, Russia
V. Shipunova, Shemyakin-Ovchinnikov Inst. of Bioorganic Chemistry RAS, Russia

TuSYC-02 09:30-10:00
Novel plasmonic metamaterials for ultrasensitive optical biosensing *(Invited paper)*
A.V. Kabashin[1,2]; [1]Aix Marseille Univ, CNRS, LP3, France; [2]MEPhI, Inst. of Engineering Physics for Biomedicine (PhysBio), Russia
This presentation will address pathways to improve the performance of plasmonic biosensors. Our approach is based the design of sensing-oriented plasmonic metamaterials, which could outperform natural materials in terms of sensitivity to refractive index variations. The presentation will demonstrate several promising metamaterials for biosensing, which radically improve the sensitivity and obtain novel attractive functionalities for biological sensing/recognition

TuSYC-03 10:00-10:30
Luminescent nanoparticles as labels for bioassay *(Invited paper)*
I.Yu. Goryacheva, A.A.Kokorina, A.M. Abramova, D.V. Shpuntova , E.A.Mordovina, D.V. Tsyupka, A.S. Novikova, D.D. Drozd, P.S. Pidenko, T.S. Ponomaryeva, P.D. Strokin, A.N. Mitrophanova, O.A. Goryacheva; Saratov State Univ., Russia
Luminescent nanoparticles of different nature present a perspective tool for research and analysis. Application in assay allows to increasing of assay sensitivity, comparing to coloured nanoiparticles without the assay procedure complication. Additional perspectives are related with the sensitivity of luminescence nanoparticles to the environment properties, including presence of quenchers. FRET application discussed in details.

TuSYC-04 10:30-11:00
Ultrasensitive interferometric and magnetic analytical systems for simultaneous express detection of multiple disease biomarkers *(Invited paper)*
A.V. Orlov, A.V. Pushkarev, E.N. Mochalova, N.V. Guteneva; Prokhorov General Physics Institute of the Russian Academy of Sciences, Russia
Ultrasensitive analytical systems are developed for simultaneous express detection of multiple molecular diagnostic biomarkers. Both sandwich and competitive immunoassays are realized. The systems are based on registration of nanoparticles by nonlinear magnetization with sensitivity up to a few nano-emu and on optical label-free spectral-correlation method that allows real-time quantitative monitoring of biochemical reactions with widely available single-used sensor chips.

SY: Section C. Photonics and Nanobiotechnology

11:30 - 13:30
Session Chairs:
P.I. Nikitin, A.M.Prokhorov General Physics Inst., RAS, Russia
V. Shipunova, Shemyakin-Ovchinnikov Inst. of Bioorganic Chemistry RAS, Russia

TuSYC-05 11:30-12:00
Digital holographic microscopy and tomography in research of cellular response to photodynamic treatment *(Invited paper)*
I.V. Semenova; Ioffe Inst., Russia
An approach is developed to research of cellular response to photodynamic treatment based on digital holographic microscopy and tomography. It allows for noninvasive monitoring of cell cultures over long time and provides quantitative data on major cellular parameters. Experiments were performed on both established cell lines and cell lines developed from tumor material of individual patients with different malignancies.

TuSYC-06 12:00-12:30
"Two-way road": how do QDs affect the cells and how do the cells affect QDs? *(Invited paper)*
E.S. Kornilova[1,3,4], I.K. Litvinov[1], E.A. Leontieva[1], A.O. Orlova[2], T.N. Belyaeva[1]; [1]Inst. of Cytology RAS, [2]ITMO Univ.; [3]Peter the Great St. Petersburg Polytechnic Univ.; [4]St. Petersburg State Univ., Russia
QDs are attractive fluorophores for basic research and biomedical applications. However, QDs are complex physical entities. When introduced into organism and cells, QDs is affected by biological microenvironment. Additionally, QDs themselves can affect cells, altering physiological outcomes, which leads to incorrect results' interpretation and side effects. We summarize our data on interdependence of QDs design and cell response to QDs

TuSYC-07 12:30-13:00
Optical methods for monitoring the interaction of porous silicon nanoparticles with biological objects *(Invited paper)*
L.A. Osminkina, M.B. Gongalsky; Lomonosov Moscow State Univ., Russia
New approaches for visualization of porous silicon nanoparticles interaction with cancer cells are realized in vitro by luminescent confocal microscopy, Raman micro-spectroscopy, two-photon excited fluorescence and coherent anti-Stokes Raman scattering microscopy. It was shown that these photonic methods can be used to study the kinetics of dissolution, as well as the release of drugs from the nanoparticles inside the cells.

TuSYC-08 13:00-13:15
Multimodal upconversion nanoparticles with controlled drug release as drug delivery system
P.A. Demina[1,2], N.V. Sholina[2], R.A. Akasov[2], N.A. Arkharova[2], Y.V. Grigoriev[2], I.M. Asharchuk[2], A.V. Nechaev[3], E.V. Khaydukov[2,1], A.N. Generalova[1,2]; [1]Shemyakin-Ovchinnikov Inst. of Bioorganic Chemistry RAS, [2]FSRC "Crystallography and Photonics" RAS, [3]MIREA - Russian Technological Univ., Russia
The lanthanide-doped upconversion nanoparticles (UCNPs) gained great attention as nanoplatforms for optical bioimaging and drug delivery systems. In this work, we developed the multimodal system based on UCNPs modified with thermosensitive polymer and Ag nanoparticles (AgNPs), containing chemotherapeutics, such as doxorubicin and flavin mononucleotide, for visualization and therapy. The drug delivery, cytotoxicity and optical properties were studied.
This research was supported by RFBR Grant(s) # 18-29-20064 mk

TuSYC-09 13:15-13:30
Rational design of nanoparticle-based agents for effective targeted drug and gene delivery to eukaryotic cells
E.N. Mochalova; Prokhorov General Physics Inst. RAS, Russia
Nanoparticles functionalized with different bioreceptors have considerable potential for use in targeted drug and gene delivery applications. Here we show a comprehensive strategy for the development of such nanoparticle-based agents. We used a number of optical techniques including confocal microscopy, scanning electron microscopy, and imaging flow cytometry to achieve agents` reliable performance in eukaryotic cell culture.
This research was supported by RFBR Grant(s) # 19-515-06010

SY: Section C. Photonics and Nanobiotechnology

14:30 - 16:30
Session Chairs:
P.I. Nikitin, A.M.Prokhorov General Physics Inst., RAS, Russia
V. Shipunova, Shemyakin-Ovchinnikov Inst. of Bioorganic Chemistry RAS, Russia

TuSYC-10 14:30-15:00
Nanophotonic approaches to biosensing applications *(Invited paper)*
A. Rakovich[1], S. Po1, M.P. do Carmo[1], M. Zhao[1], E. Leggett[1], S. Carter-Searjeant[1], H. Walker[2], A. Lauri[2], S. Anguiano[3], M. L. Guyon[3], A. Reynoso[3], L. Urbano[4], E. Cortes[5], P.A. Huidobro[6], P. Manning[7], A. Fainstein[3], S.A. Maier[2,5], M. L. Pedano[3], M. Green[1]; [1]KCL, UK; [2]ICL, UK; [3]CAB, CNEA, Argentina; [4]Univ. of Hertfordshire, UK; [5]LMU, Germany; [6]Univ. de Lisboa, Portugal; [7]Newcastle Univ., UK
I discuss the development of hybrid plasmonic substrates that can be implemented into the Krechmann configuration for simultaneous qualitative and quantitative detection of analytes; the use of techniques based on plasmonic structures that enable control of analyte motion and thus concentration of analytes in the sensing area; and finally, the development of a theranostic agent based on conjugated polymer nanoparticles.

TuSYC-11 15:00-15:30
Layered material platform for surface plasmon resonance biosensing - ultrasensitive detection of toxins and malaria. *(Invited paper)*
A.N. Grigorenko; Univ. of Manchester, UK
We show that the use of graphene and other layered materials for protection and bio-functionalization broadens the range of metals that can be used for plasmonic biosensing and could increase the sensitivity of surface plasmon resonance chips by 3-4 orders of magnitude. Hence, layered materials provide new platform for SPR biosensing, paving the way for compact and ultrasensitive biosensors.

TuSYC-12 15:30-16:00
Magnetic and gold nanoparticles optimized for cancer treatment via cell hitchhiking *(Invited paper)*
M.N. Yakovtseva[1], O. Betzer[2,3], A.V. Lunin[1], E.N. Mochalova[1,4], M. Beiderman[2,3], M. Motiei[2,3], S.D. Zvereva[1], O.B. Proushinskaya[1], T. Sadan[2,3], R. Popovtzer[2,3], M.P.Nikitin[1]; [1]Moscow Inst. of Physics and Technology, Russia; [2]Bar-Ilan Univ., Israel; [3]The Institute of Nanotechnology and Advanced Materials, Bar-Ilan Univ., Israel; [4]Prokhorov General Physics Inst. RAS, Russia
To date, targeting and treatment of cancer by nanoparticles has been limited due to physiological obstructions. A novel approach for prolongation of nanoparticle circulation is cellular 'hitchhiking'. In this work, we studied the main characteristics of nanoagents based on magnetic and gold particles, to ensure optimal physicochemical characteristics. The developed agents promise to overcome some challenges of the cancer treatment.
This research was supported by RFBR Grant(s) # 19-515-06010, 18-32-20222

TuSYC-13 16:00-16:15
Conjugated polymer nanoparticles as multi-modal photodynamic therapy probes
M. Zhao[1], E. Leggett[1], S. Carter-Searjeant[1], S. Po[1], M. P. Carmo[1], L. Urbano[2], P. Manning[3], M. Green[1], A. Rakovich[1]; [1]Kings College London, UK; [2]Univ. of Hertfordshire, UK; [3]Newcastle Univ., UK
We report on the development of a multi-modal photodynamic therapy agent based on nanoparticles of PTB7 conjugated polymer. Several properties of the developed PTB7 nanoparticles will be discussed, including their size, stability, fluorescent properties and generation of reactive oxygen species. Some cellular assays will also be presented to highlight the potential of these nanoparticles as a versatile photodynamic therapy platform.

TuSYC-14 16:15-16:30
Fouling-proof real-time optosensors for polyvalency-based characterization of circulating antibodies
A.V. Pushkarev, K.G. Shevchenko, B.G. Gorshkov, N.V. Zhukov, N.N. Orlova, V.A. Bragina; Prokhorov General Physics Inst. RAS, Russia
Biosensors and an original assay format are developed to completely characterize antibodies in human serum and resolve the bottleneck of label-free measurements of kinetics, which is non-specific binding of serum components. The achieved analytical characteristics which surpass those of the majority of label-based biosensors are further improved by magnetic nanoparticles.

SY: Section C. Photonics and Nanobiotechnology

17:00 - 18:45
Session Chairs:
P.I. Nikitin, A.M.Prokhorov General Physics Inst., RAS, Russia
V. Shipunova, Shemyakin-Ovchinnikov Inst. of Bioorganic Chemistry RAS, Russia

TuSYC-15 17:00-17:30
Polariton-assisted control of broadband emission and FRET efficiency of strongly coupled dye label excitons in tunable optical microcavity. *(Invited paper)*
I. Nabiev[1,2]; [1]Univ. de Reims Champagne-Ardenne, France; [2]National Research Nuclear Univ. MEPhI, Russia
Resonance interaction between a localized electromagnetic field and excited states in molecules paves the way to control fundamental properties of matter. Here, we have engineered a tunable optical microcavity with extra-low volume of electromagnetic modes and demonstrated controllable modification of the broad photoluminescence emission and an efficiency of FRET between organic dye labels of biological molecules in strong coupling regime.

TuSYC-16 17:30-17:45
Plasmonic control of analyte motion
M. P. Carmo[1], S. Po[1], M. Zhao[1], A. Lauri[2], P. A. Huidobro[3], A. Rakovich[1]; [1]Kings College London, United Kingdom; [2]Imperial College London, United Kingdom; [3]Universidade de Lisboa, Portugal
Analyte trapping and manipulation have applications in different research fields. Plasmonic nanostructures can concentrate energy to sub-diffraction dimensions and originate optical traps capable of acting on nanometer-size objects, but they lack the ability to manipulate them. Here we present different Brownian ratchet devices that are able to optically trap and manipulate nanometer-sized beads by periodically modulating an external light source.

TuSYC-17 17:45-18:00
Electroconductivity of cartilage in the temperature range from -10°C to 50°C with laser heating
E.M. Kasianenko[1,2], A.I. Omelchenko[1]; [1]Inst. of Photonic Technologies, FSRC "Crystallography and Photonics" RAS, [2]Lomonosov Moscow State Univ., Russia
Dependence of electrical conductivity of cartilage in course of laser heating by pulse periodical radiation and cooling in the condition of natural convection was studied. Various ranges of non-monotonic behaviours of temperature dependency of the conductivity have been revealed. It is shown that measurement of electrical conductivity allows controlling the state of free charges, mobility and concentration of cartilage.
This research was supported by RFBR Grant(s) # 18-29-02124

TuSYC-18 18:00-18:15
3D networks of carbon nanotubes, created by laser treatment for coatings of implantable devices
A.V. Kuksin[1], D.T. Murashko[1], U.E. Kurilova[1], P.N. Vasilevsky[1], A.Yu. Gerasimenko[1,2]; [1]National Research Univ. of Electronic Technology, Russia; [2]First Moscow State Medical University, Russia
This paper presents method for creating three-dimensional networks of single-walled carbon nanotubes by laser welding. Single-walled carbon nanotubes were deposited on SiO2 substrate. After that they were irradiated with pulsed laser. Structural and hardness parameters of networks were studied. Such 3D networks have improved strength, thermal and electrical conductivity, and can be used as framework for coatings in implantable devices.

TuSYC-19 18:15-18:30
Optical waveguide made with usage of plasmonic material that has highly confined travelling mode with moderate losses
I. Nechepurenko[1], E. Chubchev[1], A. Dorofeenko[1,2,3], A. Vinogradov[1,2,3], A.A. Lisyansky[4,5,6]; [1]Dukhov Research Inst. of Automatics (VNIIA), Russia; [2]Inst. for Theoretical and Applied Electromagnetics RAS, Russia, [3]Moscow Inst. of Physics and Technology, Russia, [4]Queens College of the City Univ. of New York, USA, [5]The Graduate Center of the City Univ. of New York, USA
We propose an optical transmission line having both subwavelength cross-sections and mode area. The proposed line can be implemented as a core-shell waveguide. We find the relations between material and geometrical parameters to make a traveling mode highly confined. The required plasmonic shell is rather thin, the losses are moderate and could be easy compensated by using an amplifying material

TuSYC-20 18:30-18:45
Highly versatile and biocompatable intracellular delivery system based on the plasmonic nanoparticles layers and NIR laser exposure
T. Pylaev[1], E.S. Avdeeva[1], B.N. Khlebtsov[1], N.G. Khlebtsov1,2; [1]IBPPM RAS; [2]Saratov State Univ., Russia
Herein we present simple, reusable, and cell-friendly platform that uses plasmonic nanoparticles layers of variable geometry and tunable surface density. The nanoparticle layers show good uniformity with unchanged plasmonic properties and can be easily implemented on the bottoms of multiwell culture plates, coverslips, microslades etc. 2-D plasmonic nanoparticles layers have a broad list of potential applications in modern nanobiotechnology.

SY: Section E. Nanophototheranostics

09:00 - 10:45
Session Chair*: V. Loschenov, Prokhorov General Physics Inst. RAS, Russia*

TuSYE-01 09:00-09:30
Investigation of singlet and triplet oxygen in water and aqueous dispersions of nanosize micelles *(Invited paper)*
A.A. Krasnovsky, A.S. Kozlov, A.S. Benditkis;
In connection with the crucial role of singlet and triplet oxygen in photodynamic oxygenation in biological and chemical systems and also in photodynamic cancer treatment, this paper presents a review of the contemporary information on photonics of triplet and singlet oxygen in water, deuterium oxide and aqueous dispersions of detergent micelles and major methods of their elucidation.

TuSYE-02 09:30-09:45
Intra-articular PDT mechanisms for osteoarthritis treatment
V.I Makarov[1], T.A. Zharova[2], Kogan E.A.[2], Smorchkov M.M.[3], A.V. Lychagin[2], S.V. Ivannikov[2], N.V. Zharkov[2], V.B. Loschenov[1]; [1]Prokhorov General Physics Inst. RAS, [2]Sechenov First Moscow State Medical Univ., [3]Priorov Central Research Inst. of Traumatology and Orthopedics, Russia
This study focuses on investigation of intra-articular photodynamic therapy mechanisms for osteoarthritis treatment. Also, a search for determination of the most effective dose of photosensitizer chlorine e6 for anti-inflammatory photodynamic therapy of osteoarthritis was carried out. The results of photodynamic therapy with Photoditazin at various administered doses in the treatment showed that 3.2 mg/kg photosensitizer dose is the most effective.
This research was supported by RFBR Grant(s) # 18-29-01062

TuSYE-03 09:45-10:00
The investigation of the photodynamic efficiency of chlorine e6 on a model of multicellular tumor spheroids using the developed video fluorescent equipment.
D.S. Farrakhova[1], Yu.S. Maklygina[1], D.V. Yakovlev[2], K.T. Efendiev[3], A.V. Borodkin[1], M.V. Loschenov[1], L. Bezdetnaya[4,5], V.A. Oleinikov[2], A.D. Plyutinskaya[6], T.A. Karmakova[6], A.A. Pankratov[6], V.B. Loschenov[1,3]; [1]Prokhorov General Physics Inst. RAS, [2]Shemyakin and Ovchinnikov Inst. of Bioorganic Chemistry RAS, [3]National Research Nuclear Univ. "MEPhI", Russia; [4]Centre de Recherche en Automatique de Nancy, CNRS, Université de Lorraine, [5]Inst. de Cancérologie de Lorraine, France; [6]National Medical Research Radiological Centre of the Ministry of Health of the Russian Federation, Russia
Cancer is the main problem of all developed and many developing countries of the world and the cause of death and disability of population. Today, the actual problem is receipt of reliable information about the boundaries of malignant neoplasms and the detection of pathology in the early stages.

TuSYE-04 10:00-10:15
Single-fiber system development for simultaneous photodynamic therapy and monitoring the photosensitizer concentration for stereotactic brain operations
D.M. Kustov[1], P.V. Grachev[1], E.I. Kozlikina[1,2], V.B. Loschenov[1,2]; [1]Prokhorov General Physics Inst. RAS [2]National Research Nuclear Univ. MEPhI, Russia
In neurosurgery exists the need to treat deep-seated brain tumors by stereotactic photodynamic therapy. Since access to tumor is limited and carried out through a small diameter hole, the choice a suitable equipment is difficult. To improve the treatment method, we have developed a single-fiber system for delivery laser radiation and determining the photosensitizer concentration in a biological object.
This research was supported by RFBR Grant(s) # The research was supported by the RFBR project No 18-29-01062.

TuSYE-05 10:15-10:30
Shortwave-infrared emitters for biological imaging based on Yb-Er-Tm and Yb-Er-Ho tridoped core-shell NaGdF4 nanoparticles
D.V. Pominova, V.Yu. Proydakova, I.D. Romanishkin, A.V. Ryabova, P.V. Grachev, S.V. Kuznetsov, V.V. Voronov, P.P. Fedorov, V.B. Loschenov; Prokhorov General Physics Inst. RAS, Russia
The shortwave-infrared emitters based on Yb-Er-Tm and Yb-Er-Ho tridoped core-shell NaGdF4 nanoparticles with several tunable intense luminescence bands in in 1000-1600 nm range were obtained. Studies on biological tissue phantoms and biological tissue samples have shown that coating of nanoparticles with passive shell effectively prevents the quenching of their luminescence in biological media.

TuSYE-06 10:30-10:45
Yb-Er-doped nanoparticles synthesis temperature effect on upconversion luminescence lifetime
I.D. Romanishkin, V.Yu. Proydakova, S.V. Kuznetsov, D.V. Pominova; Prokhorov General Physics Inst. RAS, Russia
Rare-earth doped crystalline nanoparticles are promising theranostic agents. Their optical parameters can vary depending on the synthesis process. Dependence of upconversion luminescence lifetime of Yb-Er-doped nanoparticles from their synthesis temperature was studied using Maximum entropy method. Higher synthesis temperature results in longer upconversion luminescence lifetime and its narrower distribution, suggesting higher structural homogeneity.

SY: Section E. Nanophototheranostics

11:30 - 13:15
Session Chair*: V. Loschenov, Prokhorov General Physics Inst. RAS, Russia*

TuSYE-07 11:30-12:00
Metabolic FLIM and oxygen PLIM in theranostic applications *(Invited paper)*
A. Rück[1], P. Schäfer[2], B. von Einem[3], I.S. Kritchenkov[4], S. Kalinina[1]; [1]Univ. Ulm, Germany; [2]Childrens Hospital of Philadelphia, USA; [3]Neurological University Clinic Ulm, Germany; [4]St. Petersburg State Univ., Russia
A common property during tumor development is altered energy metabolism. FLIM of metabolic coenzymes is now accepted to be the most reliable method to determine cell metabolism. The phosphorescence lifetime of newly developed drugs is able to indicate local oxygen changes. Simultaneous imaging of phosphorescence and fluorescence lifetime parameters enables analysis of bioenergetic alterations and oxygen consumption in theranostic applications.

TuSYE-08 12:00-12:15
Application of time-resolved fluorescence microscopy to assess the metabolic state of tissue macrophages in photodynamic therapy
A.V. Ryabova[1], I.D. Romanishkin[1], A.S. Skobeltsin[2], D.V. Pominova[1], V.B. Loschenov[1]; [1]Prokhorov General Physics Inst. RAS, [2]JSC BIOSPEC, Russia
In order to optimize the current clinical evaluation of photodynamic therapy, new approaches based on the use of fluorescence lifetime imaging microscopy to assess the state of the tumor cells microenvironment, which will allow quantifying the parameters determining the mechanisms of the PS, light and oxygen effect on tumor macrophages and tumor cells are explored. Work supported by RFBR, 20-02-00928.
This research was supported by RFBR Grant(s) # 20-02-00928

TuSYE-09 12:14-12:30
The optical estimation of glioma cell composition using fluorescence lifetime imaging
Yu.S. Maklygina[1], I.D. Romanishkin[1], T.A. Savelieva[1,2], V.B. Loschenov[1,2]; [1]Prokhorov General Physics Inst. RAS, [2]National Research Nuclear Univ. "MEPhI", Russia
Gliomas are one of the most common brain tumors occurring in children and adults. Gliomas are primary, diffusely infiltrating brain tumors. There are few effective therapies for these type of cancer, and patients with malignant glioma fare poorly, even after aggressive surgery, chemo- and radiotherapy.
This research was supported by RFBR Grant(s) # 18-29-01062

TuSYE-10 12:30-12:45
Automatic attenuation correction technique for fluorescent analysis of the photosensitizer concentration in biological tissues
T.A. Savelieva[1,2], M.N. Kuryanova[2], E.V. Akhlyustina[2], K.G. Linkov[1], G.A. Meerovich[1,2], V.B. Loschenov[1,2]; [1]Prokhorov General Physics Inst. RAS, [2]National Research Nuclear Univ. MEPhI, Russia
The interpretation of fluorescence spectra is problematic since fluorescence from tissues is affected by absorption and scattering at both the excitation and emission wavelengths. In this regard, we studied the influence of optical properties on the intensity of the fluorescence signal, and we proposed an algorithm for analyzing the concentration of the photosensitizer by the fluorescence signal, leveling this effect.
This research was supported by RFBR Grant(s) # 18-29-01062

TuSYE-11 12:45-13:00
Improving the sharpness of NIR images during mapping sentinel lymph nodes and tissue transplants
P. Grachev[1] , E. Basko[2] , M. Klementeva[2] , A. Moskalev[1] , A. Shiryaev[3] , I. Reshetov[3] , G. Zhemerikin[3] , O. Startseva[3] , D. Melnikov[3] , D. Kornev[3] , L. Amirkhanova[3] , V. Loschenov[1]; [1]Prokhorov General Physics Inst. RAS, [2]National Research Nuclear Univ. MEPhI, [3]First Moscow State Medical Univ., Russia
The Indocyanine Green is used for imaging lymph nodes, lymphatic pathways and blood vessels and tissue boundaries in an interdisciplinary setting. Fluorescent imaging with ICG helps to assess blood flow in the examine areas. Due to optical properties ICG fluorescence can be detect from deep located lymph nodes. Although quality of such images can be improved with deconvolution methods.
This research was supported by RFBR Grant(s) # 17-00-00162 K, 17-00-00159

TuSYE-14 13:00-13:15
Zeolite based magnetic nanocomposites for drug delivery and hyperthermia
V.A. Hovhannisyan[1], S.J. Chen[1], K. Siposova[2], A. Musatov[2], Z. Mitroova[2], P. Kopcansky[2]; [1]College of Photonics, NCTU, Taiwan; [2]Inst. of Experimental Physics SAS, Slovakia
Clinoptilolite zeolite (CZ) nano/microparticles and their interaction with photodynamic dyes are studied by multiphoton microscopy. The release of dyes from CZ in the presence of biomolecules is investigated. Magnetic CZ particles are fabricated and applied to local tissue heating using an alternative magnetic field. The inhibitory and destructive effects of magnetic CZ on protein fibrillation are observed.

SY: Section D. Photodynamic Processes in Biology and Medicine

17:00 - 18:15
Session Chair*: I.M.Belousova, Vavilov State Optical Inst., Russia*

WeSYD-01 17:00-17:30
Update on the Ruthenium coordination complex based photosensitizer TLD1433 in phase I and II clinical trials for Non-muscle invasive Bladder Cancer *(Invited paper)*
L. Lilge[1,2], M. Roufaiel[3], A. Mandel[3], M. Nesbit[1,4], G. Kulkarni[1,4], M.I Jewett[1,4]; [1]University Health Network, [2]Univ. of Toronto, Department of Medical Biophysics, [3]Theralase Technologies Inc., [4]Univ. of Toronto, Department of Urology, Canada
We report on the outcome of a Phase 1B clinical trial for non muscle invasive bladder cancer using TLD1433, a ruthenium coordination complex. 6 patients participated in this clinical trial which contained a drug dose escalation. The high success rate is due to a combination of photosensitizer installation, short wavelength activation by 525 nm light and personalized irradiance dosimetry.

WeSYD-02 17:30-17:45
How to personalize PDT treatment: from dose definition to an actual plan
L. Lilge[1,2], C. Fisher[1], Ch. McFadden[2], D. Molenhuis[2], J. Cassidy[3], A.-A. Yassine[3], F. Schwiegelshohn[3], T. Young-Schultz[3], V. Betz[3]; [1]University Health Network, [2]Univ. of Toronto, Medical Biophysics, [3]Univ. of Toronto, Electrical and Computer Engineering, Canada
A procedure pipeline to achieve personalized PDT treatment, from clinical images to full treatment plan is presented. The treatment plan accommodates anatomical detail and tissue response measures and provides source location and power as output. The plan needs to be invariant to known unknowns such as the photosensitizer concentration and the tissue optical properties.

WeSYD-03 17:45-18:15
Biomedical image processing with thin films of bacteriorhodopsin for breast cancer diagnostics *(Invited paper)*
D.V.G.L.N. Rao; Univ. of Massachusetts, USA
We studied transient Fourier holographic gratings based on photo induced isomerization properties of thin polymer films of the protein complex Bacteriorhodopsin (bR). Real time medical image processing is demonstrated by recording and reconstructing the transient photo isomerization grating formed in the bR film using Fourier holography.

SY: Section B. Laser Interaction with Cells and Tissues: Clinical Imaging and Spectroscopy

09:00 - 11:00

ThSYB-12 09:00-09:30

Overcoming the Abbe diffraction limit in THz spectroscopy and imaging of soft biological tissues *(Invited paper)*

K.I. Zaytsev[1,2], N.V. Chernomyrdin[1,2], G.M. Katyba[2,3], I.N. Dolganova[2,3], V.N. Kurlov[3]; [1]Prokhorov General Physics Inst. RAS, [2]Bauman Moscow State Technical Univ., [3]Inst. of Solid State Physics RAS, Russia

In this work, we consider several novel modalities of THz imaging, which overcome the Abbe diffraction limit and hold strong potential in THz biophotonics. Among them: the THz solid immersion microscopy, the THz imaging relying on photonic jets and photonic hooks, and the THz scanning-probe near-field microscopy based on a flexible sapphire fiber.

This research was supported by RFBR Grant(s) # 18-38-00504

WeSYB-13 09:30-10:00

Remote assessment of human stress state by analyzing of IR-THz radiation from facial areas *(Invited paper)*

E. Berlovskaya[1], O. Cherkasova[2,3], I. Ozheredov[1,3], D. Nikolaev[4], T. Adamovich[5], E. Isaychev[5], S. Isaychev[5], A. Makurenkov[1], A. Varaksin[6], S. Gatilov[6], N. Kurenkov[6], A. Chernorizov[5], A. Shkurinov[1,3]; [1]Lomonosov Moscow State Univ., [2]Inst. of Laser Physics SB RAS, [3]Inst. on Laser and Information Technologies, Branch of the Federal Scientific Research Centre "Crystallography and Photonics" RAS, [4]Inst. for Information Transmission Problems RAS (Kharkevich Inst.), Russia [5]Faculty of Psychology, Lomonosov Moscow State University, Moscow, Russia [6]CJSC Pattern Recognition Research Company, Moscow, Russia

The potential for remote assessment of the human stress state is very important field of research in the area of technologies with a risk of man-made disasters. A new approach to diagnostics of stress state is proposed, based on the analysis of the terahertz contribution while simultaneously recording of the infrared and terahertz emissions from a human face.

This research was supported by RFBR Grant(s) # 17-29-02487

ThSYB-14 10:00-10:30

Terahertz antennas featuring plasmonic and dielectric structures for biomedical applications *(Invited paper)*

D.V. Lavrukhin1,2, I.A. Glinskiy[1,2], N.V. Zenchenko[3], R.A. Khabibullin[1,3], I.V. Minin[4,5], O.V. Minin[4,5], K.I. Zaytsev[2,3], D.S. Ponomarev[1,2]; [1]Mokerov Inst. of Ultra High Frequency Semiconductor Electronics RAS, [2]Prokhorov General Physics Inst. RAS, [3]Bauman Moscow State Technical Univ. [4]Tomsk Polytechnic Univ., [5]National Research Tomsk State Univ., Russia

We report on our recent approaches focused on the enhancement of optical light confinement in photoconductive antennas (PCAs) by implementation of periodic metallic (plasmon-assisted) and dielectric nanostructures into PCA's photoconductive gap.

ThSYB-15 10:30-10:45

Study of dry pellets of blood plasma using THz spectroscopy

A. Lykina[1], M. Konnikova[2], M. Chernyaeva[3], P. Gavrilova[1], I. Mustafin[4], E. Domracheva[3], V. Anfertev[3], D. Vrazhnov[5], V. Prischepa[6], Y. Toropova[7], D. Korolev[7], A. Shkurinov[2]; [1]ITMO University, [2]Lomonosov Moscow State Univ., [3]IPM RAS, [4]Ioffe Inst., [5]Tomsk State Univ., [6]ISPMS SB RAS, [7]Almazov National Medical Research Centre, Russia

Study of a phantom of a biological object for measurements in the THz frequency range. The phantoms were represented as a pellet of blood plasma in the diabetic and the control groups. These objects were analyzed using THz pulsed spectroscopy and a high-resolution THz spectrometer. The components of the dry blood plasma were identified by the detected spectral lines.

This research was supported by RFBR Grant(s) # 17-00-00275, 17-00-00270, 17-00-00272, 17-00-00184, 17-00-00186

ThSYB-16 10:45-11:00

Study of temperature dependence on THz transmission of albumin solution

M.R. Konnikova[1], M.M. Nazarov[2], O.P. Cherkasova[1,3,4]; [1]Institute on Laser and Information Technologies - Branch of the Federal Scientific Research Centre "Crystallography and Photonics" RAS, [2]National Research Center "Kurchatov Institute", [3]Inst. of Laser Physics SB RAS, [4]Novosibirsk State Technical Univ., Russia

The dependence of the THz transmission spectra of bovine serum albumin solution on the temperature is experimentally studied. The differences between BSA solutions absorption with concentrations from 0 to 500 mg/ml with a change in their temperature (from 20 to 80°C) are analyzed. With increasing protein concentration, the transmission amplitude increases, and with increasing solution temperature — it decreases.

This research was supported by RFBR Grant(s) # 17-00-00275, 17-00- 00270, 18-52-00040

SY: Section B. Laser Interaction with Cells and Tissues: Clinical Imaging and Spectroscopy

11:30 - 13:30
Session Chair: *E. Borisova, Inst. of Electronics BAS, Russia*

ThSYB-17 11:30-12:00
Advances in tissue optical clearing: new steps to clinics *(Invited paper)*
V. Tuchin; Saratov State Univ., Tomsk State Univ., Inst. of Precision Mechanics and Control RAS, Bach Inst. of Biochemistry, Research Center of Biotechnology RAS, ITMO Univ., Russia
The enhancement of probing/treatment depth and image contrast for a number of human and animal tissues (skin, gingival mucosa, dura mater, brain tissues, myocardium, muscle, colorectal mucosa, cartilage, etc.) investigated by using immersion optical clearing (OC) will be demonstrated. Diffuse reflectance spectroscopy, collimated transmittance, OCT, photoacoustic microscopy, fluorescence, SHG and Raman microscopies will be shown to be beneficial at OC.

WeSYB-18 12:00-12:30
Tuning the oxidative stress with near infrared irradiation: cellular mechanisms *(Invited paper)*
S.G. Sokolovski[1], E.U. Rafailov[1, 2]; [1]Aston Univ., UK; [2]Saratov State Univ., Russia
The photobiomodulation (PBM) and photodynamic therapy are similar generating oxidative stress (OS). The PBM active spectrum covers 400-1000nm diapason and addresses its energy to electron-chain-enzymes. Whereas 1265nm irradiation capable of inducing OS by direct triplet-to-singlet oxygen transformation has distinguish mechanism(s) involving cytosolic calcium, glutathione enzymes activity changes, DNA damage, mitochondria respiration modulation brings up the specific applications.

ThSYB-19 12:30-13:00
Line curvature algorithm in laser ektacytometry of red blood cells *(Invited paper)*
S.Yu. Nikitin, V.D. Ustinov, S.D. Shishkin, M.S. Lebedeva; Lomonosov Moscow State Univ., Russia
The problem of measuring red blood cell deformability by laser diffractometry in a shear flow (ektacytometry) is considered. Using numerical modeling we show that in particular case of a bimodal ensemble of erythrocytes the laser ektacytometry enables one to estimate subpopulation of weakly deformable erythrocytes in a blood sample.
This research was supported by RFBR Grant(s) # 17-29-03507

WeSYB-20 13:00-13:15
Studying slow-deformation phenomena in cartilaginous samples using Optical Coherence Elastography
Yu.M. Alexandrovskaya[1,2], O.I. Baum[1,2], A.A. Sovetsvky[2], A.L. Matveyev[2], L.A. Matveev[2], E.N. Sobol[3], V.Yu. Zaitsev[2]; [1]Inst. of Photonic Thechnologies RAS, Centre "Crystallography and Photonics", Russia; [2]Inst. of Applied Physics RAS, Russia; [3]Arcuo Medical Inc, United States
The capabilities of strain mapping based on analysis of complex-valued OCT signal for real-time visualization slow processes in cartilage modified by laser radiation or immersion agent application are presented. The developed OCE-based continuous strain mapping provides a deeper insight in tissue mechanics and opens new prospect for designing medical control systems.
This research was supported by RFBR Grant(s) # 18-29- 02124

ThSYB-21 13:15-13:30
Monitoring of processes involving white blood cells using endogenous fluorescence
B.P. Yakimov[1], A.N. Semenov[1], M.A. Gogoleva[1], S.A. Rodionov[2], A.V. Priezzhev[1], E.A. Shirshin[1,3]; [1]Lomonosov Moscow State Univ., [2]Priorov Central Inst. for Traumatology and Orthopedics, [3]Inst. of Spectroscopy RAS, Russia
The possibility of using spectrally and time-resolved endogenous fluorescent response to monitor processes involving white blood cells was investigated

SY: Section B. Laser Interaction with Cells and Tissues: Clinical Imaging and Spectroscopy

14:30 - 16:30
Session Chair: A. *Lugovtsov, Lomonosov Moscow State Univ., Russia*

ThSYB-22 14:30-15:00
Translation of ALA-induced PPIX for brain tumor interventions *(Invited paper)*
R. Sroka, A. Rühm, N. Markwardt, C. Heckl, M. Aumiller, H. Stepp; University Hospital of Munich, Germany
Malignant gliomas are a devastating brain tumor disease with very poor prognosis. Photoactive drugs and their use for fluorescence guided resection, optical guided biopsy and photodynamic therapy supports innovative treatment modalities in neurosurgery. Besides the medical needs, requests and boundary conditions the physics and the technical developments aiming in clinical applications are presented.

WeSYB-23 15:00-15:30
Development of photodynamic therapy protocols with assistance of optical monitoring techniques *(Invited paper)*
M.Yu. Kirillin[1], A.V. Khilov[1], D.A. Kurakina[1], M.A. Shakhova[1,2], E.A. Sergeeva[1], A.G. Orlova[1], A.E. Meller[1,2], A.M. Mironycheva[2], A.S. Malygina[2], I.L. Shlivko[2], N.Yu. Orlinskaya[2], I.V. Turchin[1], S.V. Gamayunov[3]; [1]Inst. of Applied Physics RAS, [2]Privolzhsky Research Medical Univ., [3]Nizhny Novgorod Regional Clinical Oncology Center, Russia
We report on performance of PDT assisted by optical monitoring techniques: dual-wavelength fluorescence imaging and optical coherence tomography. Both techniques provide complementary information of PS distribution and photobleaching and tissue reaction to PDT. The proposed approach allowed to perform a comparative analysis of different PDT regimens in animal study and develop an improved protocol for PDT of basal cell carcinoma.

WeSYB-24 15:30-16:00
Controlling biological processes by light *(Invited paper)*
A Möglich; Univ. of Bayreuth, Germany
Sensory photoreceptors control diverse biological adaptations to light and can be harnessed for optogenetics, i.e. the control by light of physiological processes. We investigate the structural and mechanistic bases of potoreception in the light-oxygen-voltage and phytochrome photoreceptor families. Pertinent knowledge is applied to the engineering of novel photoreceptors.

ThSYB-25 16:00-16:30
High resolution Raman detection of 12CO2 and 13CO2 isotopes in human breath *(Invited paper)*
A.V. Polishchuk, V.V. Kurikova, K.M. Grigorenko, V.V. Vitkin; ITMO University, Russia
We present an effective system for detecting carbon isotopes 12CO2 and 13CO2 in human breath with an extremely low concentration level of ~0.01%. The Raman detector consists of a 5W-CW-solid-state laser at 532 nm, a focusing system, a gas cell and a high-resolution Czerny-Turner based spectrometer. Such a system is in demand in the medical diagnosis of various diseases.

SY: Section B. Laser Interaction with Cells and Tissues: Clinical Imaging and Spectroscopy

17:00 - 19:00
Session Chair: *Ilya Turchin, Inst. of Applied Physics RAS, Russia*

ThSYB-26 17:00-17:30
Multi-modal Imaging in Live Cell Microscopy *(Invited paper)*
H. Schneckenburger[1], V. Richter[1], C. Cremer[2]; [1]Aalen Univ., [2]Univ. of Heidelberg, Germany
Methods of high resolution deep view microscopy of living cells and tissues are reported. These techniques include Structured Illumination Microscopy (SIM) for optimizing resolution, Light Sheet Fluorescence Microscopy (LSFM) for 3D imaging at low light exposure and a combination of both methods. Applications are concentrated on localization of cellular metabolites, signal transduction as well as cell and tissue diagnostics.

ThSYB-27 17:30-18:00
Optical study of RBCs and platelets aggregation and its correction in arterial hypertension *(Invited paper)*
A.E. Lugovtsov, P.B. Ermolinskiy, A.I. Maslyanitsina, A.N. Semenov, Yu.I. Gurfinkel, L.I. Dyachuk, A.V. Priezzhev; Lomonosov Moscow State Univ., Russia
Using laser techniques we showed that in arterial hypertensive patients, the ability of RBCs and platelets to aggregate is enhanced relative to the control group. The hypothesis that cells aggregation can be corrected (reduced) in AH by integrin IIb/IIIa glycoproteins (IGP) inhibition of fibrinogen adsorption on RBC membrane was verified experimentally.

ThSYB-28 18:00-18:30
Probing of red blood cell dynamics using optical trap combined with micro-Raman spectroscopy *(Invited paper)*
Mithun N[1], Jijo Lukose[1], Ganesh Mohan[2], Shamee Shastry[2], Santhosh Chidangil[1]; [1]Centre of Excellence for Biophotonics, [2]Kasturba Medical College, Manipal Academy of Higher Education (MAHE), India
The response of human live red blood cells suspended in intravenous fluids (IV) is investigated using Raman Tweezers technique. Raman spectral variations were further compared with red blood cells suspended in AB blood plasma. Hemoglobin deoxygenation in red blood cells was observed with increase in laser power in all the intravenous fluids.

WeSYB-29 18:30-19:00
OCE-based quasistatic elasto-spectroscopy to characterize tumors by their linear and nonlinear elasticity *(Invited paper)*
A. Plekhakov[1], E.V. Gubarkova[1], M.A. Sirotkina[1], A.A. Sovetsvky[2], A.L. Matveyev[2], L.A. Matveev[2], N.D. Gladkova[1], E.V. Zagaynova[1], V.Y. Zaitsev[2]; [1]Privolzhsky Research Medical Univ., [2]Inst. of Applied Physics RAS, Russia
We present a novel method, which can be called "elasto-spectroscopy" based on compressional Optical Coherence Elastography. The method relies on initial determining of characteristic stiffness ranges for various morphological components of the tissue by comparing OCE-based stiffness maps and histology. Such pre-calibration allows one to perform morphological segmentation of OCE-images demonstrating excellent correlation with segmentation of conventional histological images.
This research was supported by RFBR Grant(s) # 18-32-20056

SY: Section C. Photonics and Nanobiotechnology

09:15 - 11:00
Session Chairs:
P.I. Nikitin, A.M.Prokhorov General Physics Inst., RAS, Russia
V. Shipunova, Shemyakin-Ovchinnikov Inst. of Bioorganic Chemistry RAS, Russia

ThSYC-21 09:15-09:45
Hybrid disk-shaped nanoresonators on metal film for SERS chemical and biosensing *(Invited paper)*
A.K. Sarychev[1], A.V. Ivanov[1], A.N. Lagarkov[1], G. Barbillon[2], I.V. Bykov[1], I.A. Ryzhikov[1]; [1]Inst. for Theoretical and Applied Electrodynamics RAS, Russia; [2]EPF-Ecole d'Ingenieurs, France
We report the SERS signal from gold and silver of nanodisk resonators. The enhancement is obtained by the addition of a silicon layer between the nanodisks. We experimentally investigated the sensitivity of the suggested Au, Ag/Si disk-shaped nanoresonators for SERS sensing. Enhancement factors in the range of five-eight orders on magnitude are found for the detection of thiophenol molecules.

ThSYC-23 09:45-10:00
Optical Label-Free Method for Investigation of Polyvalent Antigen-Antibody Interactions for Diagnostics of Hepatitis B
V.A.Bragina, V.R. Cherkasov, A.V. Babenyshev, A.G. Burenin, D.O. Novichikhin, N.V. Guteneva; Prokhorov General Physics Institute of the Russian Academy of Sciences, Russia
An optical method is developed for quantitative label-free registration of equilibrium and kinetic parameters of polyvalent antigen-antibody interactions in real time. As model of polyvalent antigen, the biomarker of hepatitis B surface antigen (HBsAg) was used. The kinetic parameters of interaction of each antibody with HBsAg were determined to find proper reactants for immunochromatographic assay for quantitative detection of HBsAg.

ThSYC-24 10:00-10:30
Plasmonic silver nanoparticles for theranostics of HER2-positive cancer *(Invited paper)*
V.O. Shipunova, M.M. Belova, P.A. Kotelnikova, S.M. Deyev, Shemyakin-Ovchinnikov Inst. of Bioorganic Chemistry RAS, Russia
We developed the method of green synthesis of silver nanoparticles possessing by surface plasmon resonance. We showed that after light irradiation, particles were able to generate heat and to selectively kill HER2-overexpressing cells being non-toxic without irradiation. The developed cost-effective method of targeted silver nanoparticle synthesis can be considered as effective tool for designing cancer treatment strategies in vivo.

ThSYC-25 10:30-10:45
Membrane-associated heat shock protein Hsp70: a novel theranostic target for nanoparticle-based therapy
M. Shevtsov[1], Y. Marchenko[4], B. Nikolaev[4], L. Yakovleva[4], R. Tagaeva[4], N. Yudintceva[2]; [1]Technical Univ. Munich, Germany; [2]Inst. of Cytology RAS, Russia; [3]First Pavlov State Medical Univ. of St. Petersburg, Russia; [4]Research Inst. of Highly Pure Biopreparations, Russia
Hsp70 is overexpressed on the membrane of tumor cells and serves as a recognition structure for cancer theranostics. Hsp70-targeted nanoparticles of various formulations (superparamagentic nanoparticles, gold nanorods, quantum dots, etc) were designed for diagnostics and therapy of tumors. Combined therapy approaches consisting of immune check-point inhibitors, radiotherapy and targeted nanoparticles further significantly increased animal overall survival in preclinical models.
This research was supported by RFBR Grant(s) # 19-58-55001

WeSYC-26 10:45-11:00
Biocompatible cancer-targeted multimodal bioimaging agents synthesized via acid-promoted transformation
A.V. Lunin[1,2], S.M. Dolotova[2], S.P. Krechetov[3], D.V. Rogozhnikov[3], V.R. Cherkasov[1,3]; [1]Sirius Univ. of Science and Technology, [2]Shemyakin-Ovchinnikov Inst. of Bioorganic Chemistry RAS, [3]Prokhorov General Physics Inst. RAS, Russia
We demonstrate the strategy to synthesize novel monodisperse biocompatible iron oxide nanoparticles. We show specificity and high imaging abilities of the nanoparticles as visible light- and infrared-active optical labels for in vitro and in vivo studies. The results demonstrate that synthetic strategy could be used to design versatile nanoagents for diagnostics and in vivo imaging.
This research was supported by RFBR Grant(s) # 19-33-51011

SY: Section C. Photonics and Nanobiotechnology

11:30 - 13:30
Session Chairs:
P.I. Nikitin, A.M.Prokhorov General Physics Inst., RAS, Russia
V. Shipunova, Shemyakin-Ovchinnikov Inst. of Bioorganic Chemistry RAS, Russia

ThSYC-27 11:30-12:00
Nanostructured theranostic carriers: preparation, properties, applications *(Invited paper)*
D.A. Gorin; Skolkovo Inst. of Science and Technology, Russia
Modern medicine requires to combine the imaging and therapy tools in one object. Two types of nanostructured carriers were elaborated. There are composite carriers containing gold nanorods and/or indocyanine green (ICG) dye. Optimal compositions and structures of nanostructured shells from point of view of photoacoustic and fluorescent signal intensities required for the detection of nanostructured carriers in vivo were found.

ThSYC-28 12:00-12:30
Photoswitchable capsule for cell tracking *(Invited paper)*
P.A. Demina[1], O.A. Sindeeva[1], A.M. Abramova[1], E.S. Prikhozhdenko[1], A.V. Sapelkin[1,2], I.Y. Goryachev[1], G.B. Sukhorukov[1,2,3]; [1]Saratov State Univ., Russia; [2]Queen Mary Univ. of London, United Kingdom; [3]Skolkovo Inst. of Science and Technology, Russia
The talk highlights the fabrication of micron sized capsules enabling optical switch of emitted fluorescence. Mechanism of color switch is based on photo chemistry of encapsulated rhodamine dye induced by carbon nanoparticles formed in capsule wall. Various biological cells are able to internalise these capsules and following switching of capsules appearance gives us a tool for cell tracking over hours/days.

ThSYC-29 12:30-13:00
Biosensing and theranostics based on functionalized magnetic and plasmonic nanoparticles *(Invited paper)*
P.I. Nikitin; Prokhorov General Physics Inst. RAS, Russia
Multiplex biosensing techniques have been developed for rapid measurements of ultra-low concentrations of small molecules, oligonucleotides and cancer biomarkers based on gold and magnetic nanoparticles. New methods have been proposed and demonstrated for targeted drug delivery with nanoparticles to suppress cancer cells in vitro and tumors in animals in vivo, to inhibit the growth of lung metastases of aggressive melanoma.

ThSYC-30 13:00-13:15
Gold nanorods-based oligonucleotides carrier quantitative characterisation
H.J. Łaszewski[1,3], B. Palpant[2], M. Buckle[1], C. Nogues[1]; [1]LBPA UMR CNRS[8]113, ENS Paris-Saclay, [2]LPQM UMR CNRS[8]537, CentraleSupélec, France
Gold nanorods are attracting a lot of attention due to their extraordinary optical properties, and potential use for medical applications. The issue of the attachment of double stranded oligonucleotides onto GNR surfaces is crucial for the development of quantitative DNA/RNA delivery carried by GNRs. This work presents a fluorescence-based characterisation method for assessing the attachment of dsDNA to GNR surfaces.

ThSYC-31 13:15-13:30
Prospective of Laser-Induced Fluorescence as a Non-Invasive Tool for Ecotoxicological Assessments
A.B. Utkin[1,2], B. Duarte[3], M.T. Cabrita[4]; [1]INOV INESC Inovação, Lisbon, Portugal; [2]CeFEMA, Universidade de Lisboa, Lisbon, Portugal; [3]MARE-FCUL, Universidade de Lisboa, Lisbon, Portugal; [4]CEG-IGOT, Universidade de Lisboa, Lisbon, Portugal
This work reports preliminary results of the application of the laser-induced fluorescence technique to ecotoxicological assessments. The research is focused on the investigation of manifestation of the trace-element stress in the fluorescence emission spectra of photosynthetic pigments in marine phototrophs.

SY: Section C. Photonics and Nanobiotechnology

14:30 - 16:30
Session Chairs:
P.I. Nikitin, A.M.Prokhorov General Physics Inst., RAS, Russia
V. Shipunova, Shemyakin-Ovchinnikov Inst. of Bioorganic Chemistry RAS, Russia

ThSYC-32 14:30-15:00
Fluorescence time-resolved spectroscopy and macroscopy of tumors *(Invited paper)*
V. Shcheslavskiy[1,2], M. Shirmanova[2], M. Lukina[2], E. Kiseleva[2], A. Gavrina[2], W. Becker[1]; [1]Becker&Hickl GmbH, Germany; [2]Privolzhsky Research Medical Univ., Russia
We present the approaches based on time-resolved luminescence signals recorded by time-correlated single photon counting for investigation of tumors. The combination of different techniques allows to probe both surface of tumors on a macroscale and their internal layers. The experiments deliver information about metabolism and oxygenation of tumors.

ThSYC-33 15:00-15:30
Exploring tumor-stroma interactions using combined autofluorescence and SHG imaging *(Invited paper)*
M.V. Shirmanova[1], M.M. Lukina[1], N.I. Druzhkova[1], V.V. Dudenkova[1], A.I. Gavrina[1], V.E. Zagainov[2], N.I. Ignatova[1], E.V. Zagaynova[1]; [1]Privolzhsky Research Medical Univ.; [2]Privolzhsky Federal District Medical Center, Russia
We present the results of investigation of metabolic activity of cancer cells and fibroblasts and structure of collagen in 3D model in vitro and mouse tumors in vivo. The metabolism was assessed using fluorescence lifetime imaging of the metabolic cofactor NAD(P)H. Second harmonic generation (SHG) imaging was used to analyze the extent and properties of collagen.
This research was supported by RFBR Grant(s) # 17-00-00193

ThSYC-34 15:30-16:00
Acoustic detection of nanoparticle structural stability in physiological media after their laser irradiation *(Invited paper)*
I.V. Zelepukin[1,2], A.A. Popov[1], A.V. Kabashin[1,3], S.M. Deyev[1,2], A.V. Zvyagin[1,4,5]; [1]National Research Nuclear Univ. MEPhI, Russia; [2]Shemyakin-Ovchinnikov Inst. of Bioorganic Chemistry RAS, Russia; [3]Aix Marseille Univ, CNRS, LP3, France; [4]Sechenov First Moscow State Medical Univ., Russia; [5]ARC Centre of Excellence for Nanoscale BioPhotonics, Macquarie University, Australia
Here we present a method of photoacoustic detection of nanoparticle degradation. To validate the method we used biodegradable silicium nanoparticles, which can absorb light in the Uv-Vis region and generate acoustic waves in response. The photoacoustic method allows measuring kinetic of their degradation in real-time with high limit of detection up to a hundred ng of particles.
This research was supported by RFBR Grant(s) # 19-29-04012

ThSYC-35 16:00-16:15
Hybrid plasmonic-SERS based biosensing
S. Po[1], M.P. Carmo[1], M. Zhao[1], S. Anguiano[2], M.L. Guyon[2], A. Reynoso[2], E. Cortes[3], S. Maier[3], A. Fainstein[2], L. Pedano[2], A. Rakovich[1]; [1]King's College London, UK, [2]Centro Atomico Bariloche, CNEA, Argentina, [3]Ludwig Maximilian Univ. of Munich, Germany
Providing a fast, reliable, and sensitive alternative to methods of detecting and characterising analytes in solution will be invaluable to the healthcare services. We present a method to simultaneously acquire qualitative and quantitative information for a sample, combining SERS and surface plasmonic resonance. The method is based on the use of a plasmonic substrate consisting of a metallic nanoparticle-on-a-film geometry.

ThSYC-36 16:15-16:30
Plasmon resonance enhanced nontoxic nanoagents for in vivo detection of antibiotic resistant bacteria.
E.L. Kolychev[1,2], A. Ringaci[1], A.A. Kotov[1], K.G. Shevchenko[1,2], M.P. Nikitin[1]; [1]Moscow Inst. of Physics & Technology (National Research University), [2]Prokhorov General Physics Inst. RAS, Russia
The rapid progress in the development of methods for the study of biological systems determines the interest in synthesis of optical labels for effective marking of pathogens. The conjugation of magnetic gold-coated nanoparticles and quantum dots was performed using polymeric coatings, which are applied to design of brighter agents and can be used for detection and eradication of pathogens.

SY: Section C. Photonics and Nanobiotechnology

17:00 - 17:30
Session Chairs:
P.I. Nikitin, A.M.Prokhorov General Physics Inst., RAS, Russia
V. Shipunova, Shemyakin-Ovchinnikov Inst. of Bioorganic Chemistry RAS, Russia

ThSYC-37 17:00-17:15
High performance fiber plasmonic sensor based on hyperbolic metamaterials
Hu Shiqi, Chen Yu, Liu Guishi, Zhu Wenguo, Zheng Huadan, Chen Yaofei, Xiaoping Zheng, Dong Cao, Luo Yunhan, Chen Zhe; [1]Key Laboratory of Optoelectronic Information and Sensing Technologies of Guangdong Higher Education Institutes, Jinan Univ., [2]Department of Optoelectronic Engineering, Jinan Univ., [3]Rocketech Technology Corp. ltd., [4]Tsinghua Univ., China
We propose and investigate a plasmonic sensor based on a side-polished few-mode-fiber coated with a layered HMM, which is composed of the alternating layers of Ag and TiO2. The highest average sensitivity 5114.3 nm/RIU (RIU: refractive index unit) and the best average figure of merit of 182.0 RIU−1 at ρ=0.7 and Nbi= 3 are achieved.

ThSYC-38 17:15-17:30
Discovery of new luminescent materials using multi-channel parallel synthesis and laser heating strategy
Qian Liu, Jianding Yu, Zhehan Zheng, Xiaoke Xu, Zhenzhen Zhou; Shanghai Inst. of Ceramics CAS, China
This report focuses on an effective method or platform for fast discovery and optimization of inorganic phosphors by liquid-phase multi-channel parallel synthesis of micro/nano phosphors, including the solution injection method with in-situ mixing and drying functions for synthesizing micro/nano phosphor precursors, laser heating treatment, and luminescence property screening technologies, using multi-substituted YAG:Eu as an example.

SY: Section D. Photodynamic Processes in Biology and Medicine

09:00 - 11:00
Session Chair: *A. Krasnovsky, Bach Inst. of Biochemistry RAS, Russia*

ThSYD-04 09:00-09:30
In vitro combined effect of Doxorubicin and sulfonated zinc Phthalocyanine–mediated photodynamic therapy on MCF-7 breast cancer cells *(Invited paper)*
H. Abrahamse; Univ. of Johannesburg, South Africa
Findings from this study showed that combined treatment with doxorubicin and photodynamic therapy was more effective in inhibiting the proliferation and growth of MCF-7 cells. Overall, the results indicate that combination of smaller dose of doxorubicin with photodynamic therapy is a promising combined treatment strategy for breast carcinoma.

ThSYD-05 09:30-10:00
Infrared and visible fluorescence diagnosis for tracheobronchial malignancies *(Invited paper)*
G. Papayan, N. Kazakov, S. Goncharov, A. Strui, A. Akopov
A video endoscopy system intended for fluorescence-based imaging of the tracheobronchial tree in the visible (Vis) and near-infrared (NIR) regions of the spectrum is described.

ThSYD-06 10:00-10:30
Photodynamic therapy in the combined treatment of breast cancer intradermal metastases *(Invited paper)*
M. Gelfond, S. Kondratiev, E. Tkachenko, V. Semiglazov, T. Semiglazova, V. Ivanov, K. Usova, N. Brish; National Medical Research Center of Oncology of the Ministry of Health, Russia
Our experience with photodynamic therapy of intradermal metastases of breast cancer using a semiconductor matrix emitter has proven certain advantages of using this equipment.

ThSYD-07 10:30-11:00
Dynamics of patient-specific malignant cells death at photodynamic treatment in vitro *(Invited paper)*
A.A. Zhikhoreva[1], A.V. Belashov[1], N.A. Avdonkina[2], I.A. Baldueva[2], A.B. Danilova[2], M.L. Gelfond[2], T.L. Nekhaeva[2], I.V. Semenova[1], O.S. Vasyutinskii[1]; [1]Ioffe Inst.; [2]Petrov National Medical Research Center, Ministry of Health of Russia, Russia
We present experimental analysis of cell death dynamics at photodynamic treatment in vitro and reveal features specific for different tumor localizations and individual patients. The analysis is based on monitoring of post-treatment changes in cellular morphology being recorded by means of digital holographic microscopy.

SY: Section D. Photodynamic Processes in Biology and Medicine

11:30 - 13:30
Session Chair: *A. Krasnovsky, Bach Inst. of Biochemistry RAS, Russia*

ThSYD-08 11:30-12:00
Laser-spectroscopic methods, devices and tools for precise diagnosis, treatment and intraoperative navigation in oncology *(Invited paper)*
V.B. Loschenov; Prokhorov General Physics Inst. RAS, Russia
Laser spectroscopic methods, instruments and tools are among the most promising for non-invasive precision monitoring of vital parameters of biological tissue with a quantitative assessment. They are in particular demand when creating new clinical technologies for the removal and postoperative prevention of relapses of malignant tumors. This work was supported by RFBR, № 17-00-00159.
This research was supported by RFBR Grant(s) # 17-00-00159

ThSYD-09 12:00-12:30
Mechanisms of shungite nanocarbon interactions with biological molecules *(Invited paper)*
N.N. Rozhkova[1], A.S. Goryunov[2], S.S. Rozhkov[1]; [1]Inst. of Geology Karelian Research Center RAS, [2]Inst. of Biology Karelian Research Center RAS, Russia
Shungite carbon nanoparticles interaction with albumin has been studied in aqueous dispersion regarding structural-dynamic, thermodynamic, and hydrodynamic effects. Investigation of the effects and understanding of the fundamental mechanisms of interactions of graphene-based carbon, with biological molecules are of primary importance both with respect to the biomedical aspects concerning the regulation of binding and transportation of ligands by proteins.
This research was supported by RFBR Grant(s) # 18-29-19150_mk

ThSYD-10 12:30-13:00
Time-resolved microscopy and photo-mechanical action on bio-related objects *(Invited paper)*
G. Ferrini[1,2]; [1]Interdisciplinary Laboratories for Advanced Materials Physics (I-LAMP), Università Cattolica del Sacro Cuore, [2]Dipartimento di Matematica e Fisica, Università Cattolica del Sacro Cuore, Italy
The techniques to excite and detect mechanical transients in nanostructures using time-resolved microscopy are briefly reviewed. This research is of importance for photodynamic processes that exploit the photo-mechanical action directly on bio-objects or on nanostructures that have diagnostic or therapeutic interest in biology and medicine.

ThSYD-11 13:00-13:30
Experimental study of cell damage induced by ultrashort laser pulses at 1040nm in scanning nonlinear optical microscopy *(Invited paper)*
B. Talone[1], D. Viola[1], C. Camassa[1], E. Jacchetti[2], M. T. Raimondi[2], G. Cerullo[1], D. Polli[1]; [1]Department of Physics, Politecnico di Milano, [2]Department of Chemistry, Materials and Chemical Engineering, Politecnico di Milano, Italy
Experimental study on vital HeLa cells performed to establish the damage threshold induced by sub-200-fs laser pulses at 1040 nm wavelength and 80-MHz repetition rate for nonlinear optical microscopy applications. We analyzed its dependence on laser power, spot size on the sample, pixel dwell time and light exposure modality, with an in-depth analysis on the mechanism of photothermal damage.

SY: Section D. Photodynamic Processes in Biology and Medicine

14:30 - 16:30
Session Chair: *Natalia Rozhkova, Inst. of Geology Karelian Research Center RAS, Russia*

ThSYD-12 14:30-15:00
Oxygen activation in aerated solvents by red and infrared laser radiation: measurement of the absorption spectra of dissolved oxygen molecules *(Invited paper)*
A.A. Krasnovsky, A.S. Kozlov, A.S. Benditkis, S.E. Goncharov; Federal Center for Biotechnology, Bach Inst. of Biochemistry RAS, Russia
With a goal of modelling biological and therapeutic action of lasers, oxygen activation was studied in aerated organic solvents under irradiation by lasers in the wavelength range 600 – 1300 nm using chemical trapping and phosphorescence of singlet oxygen. Different mechanism of singlet oxygen production were revealed. The absorption spectra of dissolved oxygen were obtained.
This research was supported by RFBR Grant(s) # 19-04-00331

ThSYD-13 15:00-15:30
Visible light sensitized bactericidal structures based on titania nanoparticles and quantum dots *(Invited paper)*
A. Orlova[1], E. Kolesova[1], A. Makovetskaya[1], A.Dubavik[1], Y. Gun'ko[2], V. Maslov[1], V. Oleinikov[3], S. Sizova[3], O. Efremenkova[4]; [1]ITMO Univ., Russia; [2]TCD, Ireland; [3]Shemyakin–Ovchinnikov Inst. of Bioorganic Chemistry, Russia; [4]FSBI Gause Inst. of New Antibiotics, Russia
Hybrid structures based on Titania Nanoparticles and three types of CdSe Quantum Dots were formed. Luminescence of QDs and ROS generation of Titania NPs were studied. We show that hybrid structures based on 2.5 nm core CdSe QDs exposed by visible light inhibits the growth of Escherichia coli, Bacillus subtilis and Mycobacterium smegmatis, but not Staphylococcus aureus and Pseudomonas aeruginosa.

ThSYD-14 15:30-16:00
Photophysical aspects of corneal cross-linking. Challenges and prospects *(Invited paper)*
V.A. Serebryakov[1], E.V. Boiko[2,3], V.G. Maslov[4], M.V. Melekhova[2], G.V. Papayan[5,6], T.K. Krisko[1]; [1]Vavilov State Optical Inst.; [2]Fyodorov "Eye Microsurgery" Federal State Institution, St. Petersburg Branch;[3] Kirov Military Medical Academy of the Russian Ministry of Defense; [4]ITMO Univ.; [5]Pavlov First Saint Petersburg State Medical Univ.; [6]Almazov National Medical Research Center, Russia
The review report considers various aspects of cross-linking of the cornea, mainly concerning the photophysical processes occurring in it, including comparison of cross-linking with photodynamic therapy. This approach allowed us to conduct a deeper analysis of cross-linking processes, evaluate problems and justify (verify) the prospects for increasing efficiency and reducing the duration of the treatment procedure.

ThSYD-15 16:00-16:15
Application of digital holographic and fluorescence microscopy for investigation of live cells response to photodynamic treatment using Radachlorin photosensitizer
A.V. Belashov[1], A.A. Zhikhoreva[1], T.N. Belyaeva[2], E.S. Kornilova[2], I.V. Semenova[1], O. S. Vasyutinskii[1]; [1]Ioffe Institute, Russia; [2]Institute of Cytology RAS, Russia
In this paper we present analysis of living cells response to photodynamic treatment using Radachlorin photosensitizer. Its accumulation in cells was controlled using fluorescence microscopy. Digital holographic microscopy was applied for monitoring cells response to photodynamic treatment at different doses. The results obtained can be used for estimation of cells resistivity to intracellularly generated reactive oxygen species.

ThSYD-16 16:15-16:30
Nanodrug conjugate improves photodynamic action on lung cancer stem cells
A. Crous, H. Abrahamse; Univ. of Johannesburg, South Africa
Effects of a newly synthesized nanobioconjugate (NBC) composed of AuNPs, Ab (CD133 IgG) and PS, Al (III) Phthalocyanine Tetrasulfonic Acid (AlPcS4Cl) on lung CSCs have been evaluated

SY: Section D. Photodynamic Processes in Biology and Medicine

17:00 - 19:00
Session Chair: *Natalia Rozhkova, Inst. of Geology Karelian Research Center RAS, Russia*

ThSYD-17 17:00-17:30
Investigation of anisotropic relaxation in excited biomolecules in the pico- and subpicosecond time domain *(Invited paper)*
O.S. Vasyutinskii; Ioffe Inst., Russia
The results of experimental and theoretical studies of energy transfer processes in excited states of several important biologically relevant molecules under excitation with ultrashort laser pulses are presented. As shown, investigation of polarized molecular fluorescence decay and anisotropic transient signals allows for determination of new important information on energy transfer processes in excited molecules and on interaction with microenvironment.
This research was supported by RFBR Grant(s) # 18-03-00038a

ThSYD-18 17:30-17:45
Comparative study of the photocatalytic and bactericidal properties of coatings based on metal oxides nanoparticles
S.K. Evstropiev[1], I.V. Bagrov[2], A.N. Baranov[2], I.M. Belousova[2], K.V. Dukelskii[1,3,4], A.V. Karavaeva[5], V.M. Kiselev[2], N.V. Nikonorov[1]; [1]ITMO Univ., [2]Vavilov State Optical Inst., [3]Bonch-Bruevich St. Petersburg State Univ. of Telecommunications, [4]Vavilov State Optical Institutes, Research and Production Association, [5]St. Petersburg State Chemical-Pharmaceutical Academy, Russia
In this work a comparative study of the photocatalytic and bactericidal properties of coatings on a glass surface based on metal oxides nanoparticles, prepared by the polymer-salt method and using thermal evaporation are given.

ThSYD-19 17:45-18:00
Antibacterial effectiveness of polycationic photosensitizers based on synthetic bacteriochlorins in vivo and in vitro
E.V. Akhlyustina[1], Yu. S. Zhizhimova[2], N.I. Philipova[2], G.A. Meerovich[1,3], I.G. Tiganova[2], E.A. Makarova[4], E.A. Lukyanets[4], Yu.M. Romanova[2], V.B. Loschenov[1,3]; [1]National Research Nuclear Univ. MEPhI, [2]Gamaleya National Research Center of Epidemiology and Microbiology, [3]Prokhorov General Physics Inst. RAS, [4]Organic Intermediates and Dyes Inst., Russia
Photodynamic inactivation (PDI) is able to effectively destroy bacterial cells without developing resistance in response to treatment. The study of antibacterial properties of new photosensitizers (PS) based on polycationic synthetic bacteriochlorins showed their high efficiency in photodynamic inactivation of bacteria and biofilms P. aeruginosa. In animal model APDT with (3-PyBrE)4BCBr4 significantly reduced the time of wounds healing.

ThSYD-20 18:00-18:15
Polarized fluorescence in NADH in water/methanol solutions upon excitation with femtosecond laser pulses
I.A. Gorbunova[1], M.E. Sasin[1], N.O. Bezverkhnii[1], J. Rubayo-Soneira[2], O. S. Vasyutinskii[1]; [1]Ioffe Inst., Russia; [2]InSTEC, Univ. of Havana, Cuba
We studied polarized fluorescence in NADH in water-methanol solutions of various concentrations upon two-photon excitation with femtosecond laser pulses. Fluorescence lifetimes, pre-exponential weight coefficient ratio, rotational diffusion times, and anisotropies have been determined from experiment. The results obtained have been analyzed and compared with those reported earlier elsewhere.
This research was supported by RFBR Grant(s) # 18-53-34001

ThSYD-21 18:15-18:45
Synthesis of core-shell ternary quantum dots - porphyrin conjugates and its photodynamic therapy application *(Invited paper)*
S.O. Oluwafemi; Univ. of Johannesburg, South Africa
Porphyrins are photosensitisers used in photodynamic therapy (PDT) due to their tumour localisation and in situ singlet oxygen generation. However, their limited absorption and aggregation in an aqueous medium affect their effectiveness in PDT. In this presentation, synthesis of ternary quantum dots and its conjugation to porphyrin as an efficient way to overcome photosensitizer shortcoming will be discussed.

ThSYD-22 18:45-19:00
Dual-wavelength fluorescence imaging for photodynamic therapy planning and monitoring
A.V. Khilov[1], D.A. Kurakina[1], E.A. Sergeeva[1], M.A. Shakhova[1,2], A.G. Orlova[1], A.M. Mironycheva[2], A.S. Malygina[2], I.V. Turchin[1], I.L. Shlivko[2], M.Yu. Kirillin[1]; [1]Inst. of Applied Physics RAS, [2]Privolzhsky Research Medical Univ., Russia
We report on perspectives of dual-wavelength fluorescence imaging at 405 nm and 660 nm for PDT procedure assistance aimed at evaluation of chlorin-based photosensitizer accumulation depth for both topical administration and intravenous injection. The study includes Monte Carlo simulations, experiments on tissue phantoms and laboratory animals, and clinical monitoring.
This research was supported by RFBR Grant(s) # 17-15-01264П

SY: Section A. Advanced Laser Medical Systems and Technologies

TuSYA-p01

Thermo-mechanical mechanism of laser-assisted microstructure alteration in cartilaginous tissue

O.I. Baum, E.M. Kasianenko; Inst. of Photonic Technologies, FSRC "Crystallography and Photonics" RAS, Russia

The problem of laser-induced occurrence of thermal stress fields in biological tissues, pore formation and further regeneration have been investigated. Theoretical model predicting the laser mode allowed establishing optimal laser setting for avascular tissue form-correction and cell regeneration due to structure micro-modification have been constructed.

This research was supported by RFBR Grant(s) # 18-29-02124

TuSYA-p02

New laser technology for open-angle glaucoma treatment

O.I. Baum[1], E.M. Kasianenko[1], A.A. Gamidov[2], O.V. Khomchik[2], P.D. Gavrilina[3]; [1]Inst. Photonic Technologies of FSRC "Crystallography and Photonics" RAS, [2]Research Inst. of Eye Diseases, [3]Sechenov First Moscow State Medical Univ., Russia

A positive effect of laser exposure on biological tissue is achieved, as a rule, in a narrow range of laser parameters. In this investigation the theoretical model predicting the laser mode allowed establishing optimal laser setting for treatment of glaucoma with different initial intraocular pressure in glaucomatous eyes is presented.

This research was supported by RFBR Grant(s) # 20-02-00486 A

TuSYA-p03

Numerical modeling of heating of the skin of different phototypes of the dual-wavelengths copper vapor laser radiation

S.B. Topchiy[1], A.E. Pushkareva[2], S.V. Klyuchareva[3]; [1]Lebedev Physics Inst. RAS; [2]ITMO Univ.; [3]Mechnikov North-West State Medical Univ., Russia

The purpose of this study was to develop a computer simulation that demonstrates how the effect of dual-wavelengths CVL selective heating of photoactive chromophores will change for different skin phototypes. The change of the ratio at the CVL wavelengths allows for varying the degree of selective heating of the pigment and the vascular component associated with pigmentation processes

TuSYA-p04

The use of the multi-wave laser medical device "Livadia" for the treatment of inflammation of the epithelial pilonidal cyst in children and adults

O.V. Tikhonevich[1], A.A. Sirotkin[1], G.P. Kuzmin[1], N.E. Gorbatova[2], A.V. Brynsev[2], M.A. Dvornikova[2], A.G.Kuzmina[3], V.P. Kurilov[3]; [1]Prokhorov General Physics Inst. RAS, [2]Inst. of Emergency Children's Surgery and Traumatology, [3]Pushkino Regional Clinical Hospital named after prof. Rozanova, Russia

The multi-wave laser medical device "Livadia" for bactericidal and therapeutic effects on the affected areas of the body was developed at the A.M. Prokhorov Institute of General Physics RAS. The "Livadia"device has been successfully used for interoperative laser therapy and treatment of postoperative wound complications of epithelial pilonidal cysts in adults and children.

TuSYA-p05

Laser surgical apparatus for precision tissue dissection, with the possibility of controlled hemostasis

O.V .Tikhonevich[1], A.A .Sirotkin[1], G.P. Kuzmin[1], N.E. Gorbatova[2]; [1]Prokhorov General Physics Inst. RAS, [2]Inst. of Emergency Children's Surgery and Traumatology, Russia

In this work, we present a laser surgical apparatus for precision dissection of tissues, with the possibility of controlled hemostasis, without thermal damage to tissue structures adjacent to the operating area, and with simultaneous antibacterial effect on the pathogenic wound flora. The laser medical device contains two laser emitters with wavelengths of about 2.7-3 microns and 520-585 nm, respectively.

TuSYA-p06

Development of a laser medical device for the selective removal of pathological vascular structures

O.V. Tikhonevich[1], A.A. Sirotkin[1], N.E. Gorbatova[2], G.P. Kuzmin[1], M.V. Remennikova[3], D.A. Seleznev[4]; [1]Prokhorov General Physics Inst. RAS; [2]Inst. of Emergency Children's Surgery and Traumatology; [3]Perm Federal Research Center UB RASa; [4]Perm Scientific Production Instrument-Making Company, Russia

A laser medical device based on a system of laser diodes with a wavelength of 520-524 nm and a power of more than 3 W has been developed. A laser medical device is designed for selective photodestruction of vascular formations of the skin and subcutaneous tissue.

TuSYA-p07

Effect of high-power pulses of terahertz radiation on cell viability

D.S. Sitnikov[1,2], I.V. Ilina[1], V.A. Revkova[3], M.A. Konoplyannikov[3,4], V.A. Kalsin[3], V.P. Baklaushev[3]; [1]Joint Inst. for High Temperatures RAS, [2]Moscow Inst. of Physics and Technology, [3]Federal Research and Clinical Center of Specialized Medical Care and Medical Technologies of FMBA of Russia, [4]Inst. for Regenerative Medicine, Sechenov Univ., Russia

Here we present the results of studying the viability of human skin fibroblasts exposed to high-power pulses of THz radiation with peak intensity and electric field strength of 32 GW/cm^2 and 3.5 MV/cm for 90 minutes. Activation of the cascade of proapoptotic enzymes (not leading to cell apoptosis) and inhibition of the ROS action on cells were found.

This research was supported by RFBR Grant(s) # 19-02-00762

TuSYA-p09

Laser radiation - ultrasound converters with colloidal coating of the optical fiber distal tip by a single layer of transparent spheres

V. Kamensky, V. Kazakov, V. Bredikhin, A. Pikulin, N. Bityurin; Inst. of Applied Physics RAS, Russia

Optical-acoustic radiation converters on base of optical fibre microsphere coating is problem. 1. Use 0.96 μm spheres, fibre Ø 1 mm. Distilled water is medium. Laser: λ=1.064 μm; 300 ns pulses. 2. 200 μm glass spheres coating. Laser λ = 0.532 μm, impulse 15 ns. The media: water - ink solution α ≈ 100 cm-1 .

This research was supported by RFBR Grant(s) # 18-02-00806a

TuSYA-p10

Opto-thermal fiber guide converter for laser surgery

N.M. Bityurin[2], V.I. Bredikhin[2], V.A. Kamensky[2], O.S. Streltsova[1], Grebenkin[1], V.V. Elagin[1]; [1]Privolzhsky Research Medical Univ., [2]Inst. of Applied Physics RAS, Russia

High temperature opto-thermal fiber converter for laser surgery based on absorbing coating (SAC): Soft tissue, tumor; SAC laser animal surgery technique for the resection of tumors; Urinary stones partitioning; Calculus density stones were fragmented effectively; Temperature regimes, morphological, thermometric data suggest SAC safety for controlled fragmentation of urinary calculi.

This research was supported by RFBR Grant(s) # 18-02-00806a

TuSYA-p11

Optical conveyor for targeting delivery

Zhen Che[1], Yaoming Huang[1], Jianhui Yu[1], Xiaoping Zheng[4], Dong Cao[2], Zhe Chen[1,2,3]; [1]Jinan Univ.; [2]Rocketech Technology Corp. Ltd.; [3]SUNLUX IOT Technology (Guangdong) Inc.; [4]Tsinghua Univ., China

We demonstrated a cost-effective optical conveyor for the transverse confinement and the longitudinal targeting delivery of microparticles.

TuSYA-p12

Self-mixing laser interferometry in medical diagnostics

An.V. Skripal, S.Yu. Dobdin, A.V. Dzhafarov; Saratov State Univ., Russia

We have shown the possibility of using self-mixing laser systems to measure the parameters of eyeball movements, such as tremor and saccades. The possibility of using a self-mixing laser to determine the shape of the pulse wave of the human radial artery is shown. The characteristics of the eardrum oscillations in normal and sensorineural hearing loss were studied.

TuSYA-p13

High-power narrow-band laser for SEOP applications

A.G. Putilov[1,2], A.A. Antipov[1,2], A.E. Shepelev[1], A.V. Osipov[1,2]; [1]ILIT RAS - Branch of FSRC "Crystallography and Photonics" RAS; [2]Vladimir State Univ., Russia

Abstract — This paper consider the possibility of the high-power solid-state laser creating using dispersive elements in a cavity for the excitation of rubidium atoms and further realization of the Spin-Exchange Optical Pumping (SEOP) method resulting in the hyperpolarization of the Xenon atoms.

This research was supported by RFBR Grant(s) # 19-29-10022

WeSYA-p14

Mathematical model of weld formation during laser welding of biological tissues

D.I. Ryabkin[1], A.Y. Gerasimenko[1,2]; [1]National Research Univ. of Electronic Technology, [2]Sechenov First Moscow State Medical Univ., Russia

Mathematical model of weld formation during laser welding of biological tissues is proposed. The model allows to evaluate the weld depth depending on the solder component composition and the laser radiation power density. According to the proposed model, numerical calculation of the weld depth was carried out using solders based on bovine serum albumin, indocyanine green and single-walled carbon nanotubes

WeSYA-p15

Laser formation of nanocomposites with electrically conductive carbon nanotubes networks

N.A. Demidenko[1], N.G. Cherepanova[2], A.E. Semak[2], V.N. Bychkov[2], A.S. Komarchev[2], A.Yu. Gerasimenko[1,3]; [1]National Research Univ. of Electronic Technology; [2]Russian State Agrarian Univ. - Moscow Timiryazev Agricultural Academy; [3]Sechenov First Moscow State Medical Univ., Russia

Electrically conductive networks were formed by laser welding of carbon nanotubes in nanocomposite. An in vivo study of the biocompatibility showed that carbon nanotubes do not have a pathological effect on the morphology of living cells and tissues, also enhance the proliferation of fibroblasts and stimulate the growth of connective and muscle tissue.

WeSYA-p16

Characterization of nanoparticle emission during laser cladding with stainless steel powder

A. Nagy[1], Sz. Kugler[1], I. Kreisz[2], A. Czitrovszky[1]; [1]Wigner Research Centre for Physics, [2]Lasram Engineering Ltd., Hungary

Different measurement methods and instruments ware used to characterize the properties of the generated smoke while building-up a part from different stainless steel alloy powders with powder-based laser cladding technique. The generated smoke contains a considerable amount of ultrafine particles.

WeSYA-p17

Laser induced endogenous fluorescence of skin lipofuscin in patients suffering from keloid scars

I.A. Raznitsyna[1], V.V. Andreeva[2], A.A. Gerzhik[1], M.B. Makmatov-Rys[1], D.A. Rogatkin[1], D.A. Kulikov[1], A.M. Sipkin[2]; [1]Laboratory of Medical and Physics Research, Moscow Regional Research and Clinical Institute "MONIKI"; [2]Department of Facial-Maxilla Surgery, Moscow Regional Research and Clinical Institute "MONIKI", Russia

During investigation of endogenous fluorescence of different types of cicatricial deformities in vivo unexpected results on fluorescence of lipofuscin were obtained. Increased lipofuscin fluorescence was detected in both scar and intact tissues in patients suffering from the keloid scar.

WeSYA-p18

Laser spectrometry of living beings – a system of non-invasive express control methods, early diagnosis and remote monitoring of human elemental status and environmental safety

A.V.Agrafenin[1], A.A.Kuznetsov[2], N.V.Volkova[2]; [1]SciAps Russia Ltd, [2]Omsk State Transport Univ., Russia

Monitoring the bioelement status of living creatures allows us to assess the imbalance in the content of bioelements. Laser spectrometry has received new development due to the improvement of technical means, the emergence of new methods of quantitative analysis using virtual standards. An integrated monitoring approach using mobile spectral instruments is important for monitoring health and safety.

WeSYA-p19

Continuous phase-shifting holographic microscopy in turbid media

G.S. Kalenkov[1], S.G. Kalenkov[2]; [1]Inst. of Geosphere Dynamics RAS; [2]Moscow Polytechnic Univ., Russia

The principal possibility of holographic registration of diffraction fields of micro-objects that passes through a turbulent medium is shown.

TuSYA-p20

Comparison of the results of endovenous laser coagulation (EVLC) using 2-μm radiation and various types of fiber

S.A. Artemov, A.N. Belyaev, O.S. Bushukina, S.A. Khrushchalina, S.V. Kostin, A.A. Lyapin, P.A. Ryabochkina, A.D. Taratynova; National Research Mordovia State Univ., Russia

The results of in-vivo experiments on endovenous laser coagulation (EVLC) using 2-μm radiation and various types of fiber are presented. It was found that the use of a radial fiber with a cylindrical diffuser (forming thin ring) leads to deeper and irreversible damage to the vein compared to a radial fiber with a circular scattering diagram (forming thick ring).

This research was supported by RFBR Grant(s) # 18-29-20039

SY: Section B. Laser Interaction with Cells and Tissues: Clinical Imaging and Spectroscopy

TuSYB-p01

Two approaches in Monte Carlo simulation of laser light transport in turbid biological media

A.P. Tarasov, D.A. Rogatkin; Moscow Regional Research and Clinical Inst. "MONIKI", Russia

Two sets of Monte Carlo simulations of laser light transport in turbid biological media with two different absorption accounting approaches were compared. It was found that the classical approach, which suggests photon termination following the absorption event, is more preferable than another one, which implies photon weighing, at small source-detector distances.

TuSYB-p02

Acceleration of Monte Carlo simulation of light transport in tissues using disk-detector geometry in the backscattering problem

A.P. Tarasov; Moscow Regional Research and Clinical Inst. "MONIKI", Russia

A simple and effective method for acceleration of Monte Carlo simulations of light transport in tissues is considered in the backscattering geometry. It is proposed to replace a conventional square detector with a disk-shaped one. This is applicable when a turbid medium is azimuthally homogeneous with respect to the light source and effective at large source-detector separations.

TuSYB-p03

Comparative study of different types of fixed histological samples using digital holographic microscopy

A.A. Zhikhoreva, A.V. Belashov; Ioffe Inst., Russia

We present result of digital holographic microscopy for investigation of optical properties of various fixed histological samples. It was shown that various types of tissues introduce significantly different patterns of phase shift in the object wave. Further analysis of these patterns can be used for estimation of their optical properties which may be related with physiological characteristics of the tissues.

TuSYB-p04

Skin optical spectroscopy – diagnostics of cancerous and degenerative diseases

E. Borisova[1,2], Ts. Genova[1], V. Mircheva[1], S. Ilyov[1], L. Zakharieva[1], D. Ivanov[1], A. Gisbrecht[1], L. Avramov[1], I. Lihachova[3], A. Lihachovs[3], J. Spigulis[3], I. Bratchenko[4], O. Myakinin[4], V. Zakharov[4], I. Terziev[5], P.Troyanova[5]; [1]Inst. of Electronics, Bulgarian Academy of Sciences, Bulgaria; [2]Saratov State Univ., Russia; [3]Inst. of Atomic Physics and Spectroscopy, Univ. of Latvia, Latvia; [4]Samara National Research Univ., Russia; [5]University Hospital "Tsaritsa Yoanna – ISUL", Bulgaria

Fluorescence, diffuse-reflectance and Raman scattering spectroscopies are integrated in a common multispectral tool, to obtain original experimental data on spectral properties of cutaneous lesions, with subsequent development of algorithms of diagnostics and differentiation of skin pathologies. Cancerous and degenerative cutaneous lesions are investigated to obtain broad picture of spectral properties of skin pathologies leading to severe damages and health problems.

TuSYB-p05

Reconstruction of optical parameters for blood plasma pellets using pulse terahertz holography method

E.L. Odlyanitskiy[1], M.S. Kulya[1], Q. Cassar[2], I.A. Mustafin[3], V.N. Trukhin[3], D.V. Korolev[4], Y.V. Kononova[4], P. Mounaix[2], J.P. Guillet[2], N.V. Petrov[1], O.A. Smolyanskaya[1]; [1]ITMO Univ., Russia; [2]Univ. of Bordeaux, France; [3]Ioffe Inst., Russia; [4]Almazov National Medical Research Centre, Russia

This work describes the possibility for reconstructing the optical properties of a biological object using terahertz pulse time-domain holography method. Pellets made from sublimated blood plasma were used as samples. Eventually, we created a convenient model that based on experimentally measured THz fields. Using this model, it is possible to reconstruct spatial distributed and frequency-dependent optical characteristics.

This research was supported by RFBR Grant(s) # 17-00-00275, 17-00-00272

TuSYB-p06

Determination of egg yolk optical properties at various temperatures using modified integrating spheres method

T.K. Karpova[1], N.V. Kovalenko[1], G.A. Aloian[1], D.M. Mukhankov[2], O.A. Ryabushkin[1,2]; [1]Moscow Inst. of Physics and Technology., [2]Fryazino branch of Kotelnikov Inst. of Radio-engineering and Electronics RAS., Russia

A modification of integrating spheres method was proposed, allowing to measure temperature dependencies of biological tissues optical properties. Measurements of absorption coefficient, scattering coefficient and anisotropy factor of an egg yolk were conducted at different temperatures.

TuSYB-p07

Sensitivity of the laser Doppler flowmetry and incoherent optical flowmetry to low-frequency blood flow oscillations

D.G. Lapitan, D.A. Rogatkin; Moscow Regional Research and Clinical Inst., Russia

The sensitivity of the laser Doppler flowmetry (LDF) and incoherent optical flowmetry (IOF) to blood flow oscillations was studied experimentally. IOF is a method of measuring the perfusion index from a raw photoplethysmographic signal. It was shown that the IOF is approximately 2-10 times more sensitive than LDF.

TuSYB-p08

Design of the acousto-optical system for laser trapping of microscopic particles

M.A. Vinogradov[1], A.A. Yablokova[1,2], P.A. Nosov[1]; [1]Bauman Moscow State Technical Univ., [2]Scientific and Technological Center of Unique Instrumentation RAS, Russia

We address the design and mathematical modeling of acousto-optical (AO) system for laser trapping of microscopic particles. We present an approach to theoretical calculation of the shape, intensity and trajectory of the light trap formed by AO deflection system. Theoretical calculation are confirmed by modeling and experiments.

This research was supported by RFBR Grant(s) # 18-38-20155

TuSYB-p09

Reversible immobilization for synthesis of barcoding particles

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Integration of FACS and DropSeq depends on identifiable barcoding carriers. Here, we describe road to fabrication such carriers using DNA-chip technology and microfluidic chips. This include magnetization procedure for any particle core; design and comparison of microfluidic chips with various magnetic traps, suitable for reversible immobilization and subsequent photochemistry; and successful particle on-chip immobilization and release procedures.

TuSYB-p10

The laser radiation pressure on nanocapsules (the ability to move)

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The task of laser radiation pressure on hollow metal nanorods or carbon, which can be used as capsules for medicines is solved. It is possible to create a laser trap for targets with dimensions much smaller than the wavelength, in which can be placed on medication.

TuSYB-p11

Mobile laser device for express diagnostics of red blood cells size distribution

A.E. Lugovtsov[1], G.S. Kalenkov[2], A.E. Shtanko[3], V.D. Ustinov[1], P.S. Vinnikov[4], S.Yu. Nikitin[1], A.V. Priezzhev[1]; [1]Lomonosov Moscow State Univ.; [2]Inst. of Geosphere Dynamics; [3]MSTU "STANKIN"; [4]Moscow Polytechnic Univ., Russia

An express method, based on principles of laser diffractometry, for measuring the parameters of red blood cells size distribution, such as mean size and its dispersion, is proposed. The compact mobile device has been developed for registering diffraction patterns form blood smears and their automatic analysis.

This research was supported by RFBR Grant(s) # 17-29-03507ofi_m

TuSYB-p12

LED RGB transluminescence lighs sourse to improove cell migration imaging

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RGB LED light source for phase contrast optical microscopy is introduced. Light source construction based on multimedia projector components makes it obtainable, affordable and repeatable. RGB light source was composed with LED, aspheric condenser lenses and dichroic cube. Images obtained with inverted microscope and digital camera. LED drivers were developed by the authors.

TuSYB-p13

Low-coherence reflectometry of coarse-grained random media

E.V. Ushakova, D.A. Zimnyakov; Yuri Gagarin State Technical Univ. of Saratov, Inst. of Precision Mechanics and Control RAS, Russia

A technique of low-coherence reflectometry is applied to characterization of coarse-grained random media such as evolving foamed liquids. An approach to acquired data analysis is based on the phenomenological model taking into account the decay of the integrated acquired signal with the increase of the transport mean free path of light propagation in a probed medium.

This research was supported by RFBR Grant(s) # 18-29-06024

SY: Section C. Photonics and Nanobiotechnology

TuSYC-p02

Modeling the mass transfer of ophthalmic drugs in soft contact lenses and polymeric hydrogels using laser interferometry technique

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The work is devoted to the creation of a technique for estimating the parameters of diffusion processes of drugs in soft contact lenses. Analysis of the mass transfer dynamics was carried out using monitoring of the wavefront distortions of radiation passing through the sample by means of laser phase-shifting interferometry

TuSYC-p03

Multimodal Magnetic Metal-Organic Framework Nanoparticles for Bioimaging and Gene Knockdown

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Using hybrid nanomaterials with multimodal features allow designing advanced agents for targeted drug delivery and bioimaging. We constructed magnetic metal-organic framework nanoparticles optimized to transport small oligonucleotides and act as perspective nanoagents for fluorescent bioimaging and MRI-contrasting. The achieved combination of the optical features with high adsorption capacity is promising for construction of the novel types of theranostic systems.

This research was supported by RFBR Grant(s) # 19-33-70075

TuSYC-p04

Improve the accuracy temperature measurement of NaYF4:Er,Yb upconversion particle by calibration with refinement

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Upconversion particles NaYF4:Er,Yb have prospects for application as thermal sensors. A method of increasing the accuracy of particle temperature measurement is proposed. The temperature measurement error decreased from 2.6 to 0.8 °C.

TuSYC-p05

Eu-based phosphorescence lifetime polymer nanothermometer

J.R. Shakirova[1], N.N. Shevchenko[2], S.P. Tunik[1]; [1]St. Petersburg State Univ.; [2]Inst. of Macromolecular Compounds, Russia

In this work, we synthesized a thermoresponsive luminescent europium complex that exhibits dual emission due to a ligand and a chromophore. To exclude the quenching of emitter by water, we incorporated the complex into amine-functionalized polymer nanoparticles by nanoemulsion polymerization. Such a nanothermometer demonstrated the reversibility of lifetime in cycling experiments and the ability to determine the temperature in vitro.

TuSYC-p06

Precise quantitative analysis of cell targeting by particle-based agents using imaging flow cytometry and deep learning object detection

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The method based on convolutional neural networks usage is developed for evaluation of particle-cell interactions. The imaging flow cytometry was used for automatic mining of important cell-particle interaction information. The developed method expands capabilities of spot counting applications in existing imaging techniques and allows to quantify particle-cell and cell-cell interactions.

This research was supported by RFBR Grant(s) # 19-33-70075

TuSYC-p07

Induced fluorescence techniques for plant phenotyping

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A system for semi-automated plant phenotyping is being developed in Portugal within the framework of the INTERPHENO project from the EU Programme "Portugal 2020." As a part of this activity, we tested two induced fluorescence techniques based on the laser and flashlamp excitation to facilitate the recognition of plants and photosynthetic state assessment based on the emission spectra.

TuSYC-p08

The use of optical methods in the detection of nanostructures at different stages of fibrillation

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This work is devoted to development of optical methods for detecting fibrillar nanostructures. Comparison of physical parameters obtained with the use of nanoparticle tracking analysis and fluorescence spectroscopy allowed not only to characterize the aggregation process, but also to draw a conclusion regarding the applicability of these approaches for detecting various fibrillar nanostructures in bioliquids.

TuSYC-p09

Surface-enhanced Raman spectroscopy of urine and plasma: study of background signal

N. Markina, A.V. Markin; Saratov State Univ., Russia

The report is dedicated to the study of SERS spectra of urine and blood plasma. These spectra are responsible for formation of the background signal during SERS-based therapeutic drug monitoring. The influence of various factors on these spectra is also studied and the ways to achieve the control over their intensity are proposed.

TuSYC-p10

Multi-parameter label-free biosensing with self-assembled smart biolayers that transform each sensing channel into a multiplex channel

A.V. Pushkarev, E.N. Mochalova, A.G. Burenin, N.V. Guteneva, P.I. Nikitin; Prokhorov General Physics Inst. RAS, Russia

Smart biomolecular layers that self-assemble on a sensor chip and can logically analyze a presence of several different molecules in the microenvironment to generate a response are developed and demonstrated. In contrast to conventional sensor chips for label-free biosensors, analyzing in each channel only one parameter, the channel with smart layer can analyze several parameters simultaneously.

This research was supported by RFBR Grant(s) # 18-29-09169

TuSYC-p11

Development of fluorescent nanoparticles and investigation of their biodistribution in living laboratory animals

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Nanoparticles are very promising for drug delivery in vivo. However, the factors that affect their biodistribution are yet to be understood. Here, we investigated biodistribution and pharmacokinetics of various fluorescently labelled nano- and microparticles using optical bioimaging.

TuSYC-p12

Photomodification of gold nanostars under nanosecond laser pulses

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Gold nanostars with tunable plasmon resonance are a new type of gold nanoparticles used in laser-induced biomedical applications. We investigated the effect of nanosecond pulsed laser (1064 nm) on the photomodification of gold nanostars of various sizes using TEM and spectroscopy. Photomodification of gold nanostars strongly depends on the position of their plasmonic peak in the extinction spectrum.

TuSYC-p13

Photofragment angular momentum polarization in photolysis of planar molecules with polarized laser light: symmetry properties of the anisotropytransforming coefficients

B.V. Semak, A.A. Semenov, O.S. Vasyutinskii; Ioffe Inst., Russia

Symmetry properties of the anisotropy transforming coefficients describing spin and orbital angular momentum polarization of photofragments produced in photolysis of planar triatomic molecules with polarized laser light have been derived theoretically using the full quantum mechanical approach. The theoretical model was built that explains the results of recent experiments on ozone photolysis at 266 nm.

TuSYC-p14

Phosphorescent Pt(II)-peptide conjugates for cellular microscopy and neuroimaging

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Herein we report the synthesis, characterization of the structure, and photophysical properties of cyclometalated platinum(II) complexes [Pt(N^C)(PPh2(C6H4COOH))Cl] and their conjugates with blood-brain-barrier (BBB) penetrating peptide. Cell imaging and MTT cytotoxicity study of the conjugates was carried out on HeLa and ECV cell cultures. Neuroimaging experiments on Drosophila melanogaster reviled that the compounds penetrate BBB and distribute in the brain.

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TuSYC-p15

Influence of microenvironment on the optical properties of quantum dots based on InP/ZnS and CdSe/ZnS

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Optical properties of quantum dots based on InP and CdSe with organic shells were measured in different environment such as ions solutions and culture medium with serum. Several distinct patterns of luminescence lifetime changes were revealed depending on external factors applied. Besides, the luminescence lifetimes were investigated inside the cultured cells. The obtained data are important for correct biomedical applications.

TuSYC-p16

The evaluation of tumor vascularization as a prognostic factor of plasmonic phothothermal therapy efficiency

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The tumor vascularization in rats with transplanted cholangiocarcinoma was assessed by US power Doppler before plasmonic photothermal therapy (PPT). For PPT, the multiple intravenous injections of PEG-coated gold nanorods and irradiation by 808-nm NIR diode laser were used. We have shown that gold accumulation in tumor and PPT efficiency are associated with the degree of vascularization of a tumor.

TuSYC-p17

A facile synthesis, structural and triple-luminescence properties of a novel fluoroperovskite RbCaF3: Dy3+ phosphor for dosimetry and WLED applications

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Dysprosium activated Rubidium Calcium Fluoride phosphors were synthesized by solid state reaction method. Phase purity of the compound was analyzed by PXRD study. The Photoluminescence emission was obtained at 480 nm under the excitation of 388 nm and luminescence decay time was analysed. The thermoluminescence property of X-ray irradiated RbCaF3:0.6Dy3+ phosphor was analysed by TL reader and radioluminescence was recorded.

TuSYC-p18

Determination of the emitted particle characteristics of a dry powder inhaler using laser based optical measurement techniques

Sz. Kugler, A. Nagy, A. Czitrovszky; Wigner Research Centre for Physics, Hungary

The characteristics of particles emitted by a DPI depends on the pressure drop in the chamber determined by the inhalation parameters and the geometry of the device. Our aim was to study the effect of the breathing pattern and the presence of an upper airway on the MMAD. The lung deposition of the drug was determined with numerical simulations.

TuSYC-p19

Hybrid magnetic nanoparticles synthesized by the solvothermal method as promising agents for biomedical applications

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Magnetic nanoparticles and various hybrid magnetic nanostructures remain to be of great attention constituting an important class of promising functional compounds. Within the study, we carried out the spectrophotometric analysis of a wide range of core/shell nanoparticles obtained with the solvothermal synthesis in various media in relation to the plasmon properties of individual nanoparticles for their possible biomedical application.

TuSYC-p20

Biocompatible and highly luminescent quantum dots for bioimaging

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Methods for the synthesis of biocompatible and highly luminescent quantum dots are presented. Desirable spectral characteristics of quantum dots were achieved by fine tuning of reaction parameters. Quantum dots were functionalized with a number of biomolecules, synthesized materials were tested in vitro. Obtained results could be useful both in basic and applied research in which bioimaging methods are used.

This research was supported by RFBR Grant(s) # 19-33-51011

TuSYC-p21

pH-responsive iridium(III) complexes as potential probes in Phosphorescent Lifetime Imaging

Ju. Shakirova, V.A. Baigildin[1], S.P. Tunik[1]; St. Petersburg State Univ., Russia

Herein we present the synthesis of phosphorescent iridium(III) complexes with emission lifetime response to pH value in the physiologically important range as potential probes for in vitro and in vivo experiments in PLIM mode. To prevent the oxygen quenching of the phosphorescence and interaction with the biological environment the probes are covalently bonded to biocompatible polymer based on N-vinylformamide.

TuSYC-p22

Multifunctional magnetic particle-based nanocarriers with easily modifiable surface for in vivo transfection

A.V. Yaremenko[1,2], A. Ringaci[1,2], S.D. Zvereva[1], T.V. Yaremenko[3], A.A. Tamgin[3], D.A. Lifanov[1], V.R. Cherkasov[1,4], M.P. Nikitin[1,2]; [1]Moscow Inst. of Physics & Technology, [2]Shemyakin-Ovchinnikov Inst. of Bioorganic Chemistry RAS, [3]Sechenov Univ., [4]Prokhorov General Physics Inst. RAS, Russia

In this study we show a new multifunctional visible magnetic particle-based DNA nanocarrier for effective in vivo transfection. We demonstrate successful gene expression of luminescent protein in mouse lungs and spleen. The biodistribution of the nanocarriers was visualized by magnetic and fluorescent methods and signal from the nanoparticles were observed in lungs, spleen and liver.

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TuSYC-p23

Multimodal nanoparticles for simultaneous delivery of therapeutic agents of different nature

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Numerous metal-organic frameworks have proven to transport effectively a variety of molecules inside their pores. However, the sorption of high molecular weight drugs is limited by the small pore size. Here, we demonstrate the possibility for metal-organic frameworks use in simultaneous encapsulation of a drug and a nucleic acid molecule.

This research was supported by RFBR Grant(s) # 19-33-51011

TuSYC-p24

Multiparametric Characterization and Quantitative Detection of Extracellular Vesicles by a Combination of Optical and Magnetic Techniques

S.L. Znoyko[1], I. Nazarenko[2], L. Paniushkina2, E.B. Khomyakova[1], E.N. Mochalova1, E.G. Evtushenko3, V.N. Lavrenkova4, V.A. Bragina1, B.G. Gorshkov1; [1]Prokhorov General Physics Institute of the Russian Academy of Sciences, Russia; [2]Institute for Infection Prevention and Hospital Epidemiology Medical Center - University of Freiburg, Germany; [3]Lomonosov Moscow State University, Russia; [4]Federal Research and Clinical Center of Physical-Chemical Medicine of Federal Medical Biological Agency, Russia

Novel approaches are proposed for high-throughput multiparametric characterization and quantitative detection of extracellular vesicles (EVs) based on a combination of optical and magnetic techniques. One of them, intended for EVs visualization, employs the imaging flow cytometry with submicron magnetic particles. For quantitative detection of EVs, a magnetic lateral flow assay is developed using the same submicron magnetic particles as labels.

TuSYC-p25

Optically controlled design of bi-functional agents for development of competitive immunoassays of enhanced sensitivity

S.L. Znoyko[1], A.G. Burenin[1], V.A.Bragina[1], A.I. Nikitin[2], G.M. Sorokin[3], E.L. Kolychev[1]; [1]Prokhorov General Physics Institute of the Russian Academy of Sciences, Russia; [2]Volga branch of MADI, Russia; [3]Chuvash State University, Russia

Label-free approach is developed based on the spectral-correlation and spectral-phase interferometric methods for characterization and fine-tuning of bi-functional ligands, which can improve the limits of detection of immunoassays by several orders of magnitude. The concept was verified by development and optimization of an ultrasensitive test system for registration of thyroxine (a marker of thyroid diseases).

This research was supported by RFBR Grant(s) # 19-33-70075

TuSYC-p26

The influence of microwave radiation on the pore size in a bilayer lipid membrane

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Using the pore model of a bilayer lipid membrane, it was shown that the microwave action changes the pore size by acting on ion transport through the membrane.

TuSYC-p27

Implementation of optical pulse densitometry sensor

I.N. Kolokolnikov, I.I. Lavrenyuk, E.A. Savchenko, E.K. Nepomnyashchaya, E.N. Velichko; Peter the Great St. Petersburg Polytechnic Univ., Russia

Determining the rate of elimination of indocyanine green in the blood is the most informative way to evaluate liver function. It is proposed to use optical pulse densitometry as a method of study. The paper presents the development of a non-invasive optical pulse densitometry sensor for measuring light absorption by a tissue at a specific wavelength.

TuSYC-p28

Image processing system of biological liquids for medical diagnostics

M.A. Baranov, E.N. Velichko, E.A. Savchenko; Higher School of Applied Physics and Space Technologies, Inst. of Physics, Nanotechnology and Telecommunications, Peter the Great St. Petersburg Polytechnic Univ., Russia

In the work the image processing system for medical diagnostics in described. The existence of a correlation between some diseases and the geometric parameters of structures in biological films is proved. This article describes an image processing method for analyzing the geometric parameters of structures in films of biological fluids.

TuSYC-p29

Laser scattering technique for blood serum analysis

E.K. Nepomnyashchaya, E.N. Velichko, E.A. Savchenko; Higher School of Applied Physics and Space Technologies, Inst. of Physics, Nanotechnology and Telecommunications, Peter the Great St. Petersburg Polytechnic Univ., Russia

The paper is derived to development and approbation of laser correlation spectrometer for diagnostics. Main focus of this work is to investigate molecular sizes in blood serum of healthy and sick donors.

TuSYC-p30

Multimodal Nanostructures for Measuring Ultra-Low Concentrations of Analytes in Complex Mediums

V.A. Bragina, V.R. Cherkasov, A.V. Babenyshev, A.G. Burenin, S.V. Miziev, N.V. Guteneva; Prokhorov General Physics Inst. RAS, Russia

Highly-sensitive lateral flow assay based on multi-modal nanostructures has been developed for detection of staphylococcal enterotoxin B in complex matrices. For optimization of assay parameters, kinetic characterization of immunoreagents, selection of immobilization interfaces and nanoparticles, modified label-free optical biosensors were used. The developed assay is rapid, easy-to-use, compatible with affordable consumables and different sample volumes, does not require sample pretreatment.

TuSYC-p31

Copper nanostructures for surface-enhanced Raman spectroscopy: state-of-art, challenges, and perspectives

N.E. Markina; Saratov State Univ., Russia

This report summarizes the key information regarding to copper-based SERS-active materials (Cu-SERS substrates) and their applicability for SERS-based chemical analysis. The efficiency of Raman enhancement, chemical stability issues, and analytical performance of the Cu-SERS substrates are overviewed and compared with those of the noble-metal-based SERS substrates.

TuSYC-p32

Laser ablation and fragmentation of selenium nanoparticles for use in medicine, biology, and agriculture

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Selenium nanoparticles were obtained using laser ablation and fragmentation. Their elemental composition, dimensions, shape, optical properties, and a number of other physicochemical characteristics were studied. Scenarios of the use of selenium nanoparticles to prevent the development of oxidative stress in mammalian cells are considered. The possibilities of using the obtained nanoparticles as soil fertilizer are investigated.

This research was supported by RFBR Grant(s) # 19-02-00061_a, 18-52-70012 e-Asia_a

TuSYC-p33

Modes of Escherichia coli Dps interaction with DNA and it thermodynamic characteristics

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Here we show that Dps has a different affinity for the two DNA fragments taken from the dps gene regulatory region. We found by atomic force microscopy that Dps predominantly occupies thermodynamically unstable ends of linear double-stranded DNA fragments and has high affinity to the central part of the branched DNA molecule self-assembled from three single-stranded oligonucleotides.

This research was supported by RFBR Grant(s) # 18-52-70012

TuSYC-p34

Synthesis of fluorescent and magnetic liposomes and their application for optical detection of migrating cancer cells

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Simultaneous location and eradication of specific cells in vivo opens the way to novel approaches to study cancer. Herein, we introduce a novel optical approach based on the use of liposomes filled with magnetics and fluorescent dyes. Results of this study can be used to further our understanding of cancer emergence.

This research was supported by RFBR Grant(s) # 18-29-04065

TuSYC-p35

Novel magneto-optical sensors based on anisotropic magnetic nanomaterials for detecting biological agents

D.O. Novichikhin, A.G. Burenin, A.R. Alekbarova, A.V. Orlov; Prokhorov General Physics Inst. RAS, Russia

Biosensors are developed that use nanoparticles with direction-dependent magnetic properties detected optically in real time by a low-coherent interferometry. Antibody-functionalized one- and two-dimensional nanoparticles (nanorods and nanodiscs) were used as anisotropic materials. The biosensors form the signal due to synchronized detection of a shift of the interference spectrum during a periodic actuation of anisotropic particles by an external magnetic field.

This research was supported by RFBR Grant(s) # 18-33-20252

TuSYC-p36

Development of Rapid Multiparametric Methods of Molecular Biosensing for Early Diagnostics and Monitoring of Oncology Diseases

D.O. Novichikhin, A.G. Burenin, I.A. Bakhratov, P.I. Nikitin; Prokhorov General Physics Institute of the Russian Academy of Sciences, Russia

Rapid multiplex methods were proposed for simultaneous measurements of concentrations of a number of different molecular markers of cancer in clinical samples. Low coherent interferometry was used for controllable design of intermolecular interface layers. A unique combination of magnetic nanolabels, original high-sensitive electronic readers, and a variety of 3D porous solid phases for biochemical assays were employed.

This research was supported by RFBR Grant(s) # 18-29-09169

TuSYC-p37

Three-dimensional modular biosensor for express determination of several cardiac markers

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The feasibility of rapid multi-parametric biosensor for simultaneous detection of several cardiac markers in human whole blood, which is not inferior to the characteristics of approaches performed in laboratories and can be used by low-grade medical staff at patient's bedside or in the ambulance is shown. Immunoreagents that provide maximum sensitivity and specificity were selected with a label-free optical sensor.

TuSYC-p38

High-sensitive immunoanalytical platform based on iron oxide nanoparticles and magnetic beads containing composite nanomaterials

A.V. Orlov, A.R. Alekbarova, N.V. Guteneva, S.L. Znoyko; Prokhorov General Physics Institute of the Russian Academy of Sciences, Russia

Kinetic characteristics of the hard-magnetic particles containing composite nanomaterials and soft magnetic iron oxide particles were studied by the spectral-phase interferometry to achieve the maximum dynamic range and minimal non-specific binding in a novel bioanalytical platform. In the platform, the former particles are used as a mobile solid phase controlled by an external field, while the latter – as nanolabels.

This research was supported by RFBR Grant(s) # 18-33-20252

SY: Section D. Photodynamic Processes in Biology and Medicine

WeSYD-p01

Porphyrins' autofluorescence as possible marker of ultraviolet skin damage in mice

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In this study we investigated endogenous fluorescence of ICR mice's skin irradiated with different doses of ultraviolet B and obtained promising results. It was shown that fluorescence of porphyrins had been gradually increasing in different time points after the exposure and this parameter was in positive agreement with the dose of UV.

This research was supported by RFBR Grant(s) # 20-32-70134

WeSYD-p02

Ultrasensitive transient time-resolved monitoring of anisotropic relaxation in NADH with sub-picosecond resolution

Y.M. Beltukov, I.M. Gadzhiev, I.A. Gorbunova, M.E. Sasin, O.S. Vasyutinskii; Ioffe Inst., Russia

A novel ultrasensitive transient time-resolved monitoring method has been developed suitable for studying of fast anisotropic relaxation in electronic excited states of polyatomic and biologically relevant molecules under excitation with femtosecond laser pulses. The method was used for the study of anisotropic relaxation in the first electronic excited state of coenzyme NADH in solutions with various viscosity and polarity.

This research was supported by RFBR Grant(s) # 18-03-00038a

WeSYD-p03

On the photostability of complexes of amphiphilic water-soluble photosensitizers with albumin

I.V. Bagrov, I.M. Belousova, A.V. Dadeko, V.M. Kiselev, T.K. Krisko, T.D. Murav'eva, A.M. Starodubtsev; Vavilov State Optical Inst., Russia

Photostability of albumin complexes, Pluronic F-127 complexes and aqueous solutions of photoditazine and dimegin were investigated. Photodegradation rate of albumin complexes was about four times faster than that of other compositions under study due to desagregation of photosensitizers.

WeSYD-p04

Oxygen sensitive graphene-based carbon films

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An anomaly of the microwave conductivity of films containing graphene-lbased carbon was investigated. Desorption of oxygen was detected in the temperature range 290–360 K for carbon films on substrates coated with In2O3 and ITO

WeSYD-p05

Dynamics of PpIX accumulation in A549, HeLa and 3T3 cell lines.

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The synthesis and accumulation of PpIX, induced by 5-ALA in HeLa, A549 and 3T3 cells was studied using confocal fluorescence microscopy. The accumulation dynamics of PpIX in cells was determined from the kinetics of its fluorescence intensity. The PpIX synthesis rate was analyzed as function of 5-ALA concentration and incubation time.

WeSYD-p06

Enhancement of Raman signal by the use of BaTiO3 microspheres

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The Raman signal from Si and graphene is enhanced using BaTiO3 microspheres. It is shown that the Raman signal can be enhanced using BaTiO3 microspheres beyond that obtained by the highest numerical aperture objective available on a standard Raman microscope.

WeSYD-p07

Polarized fluorescense of FAD in water and water-methanol solutions.

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Time-resolved kinetics of polarized luminescence of FAD were studied in aqueous and water-methanol solutions. Polarization anisotropy, fluorescence lifetimes, and rotational diffusion times have been determined depending upon methanol concentration in solution.

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WeSYD-p08

Polarized fluorescense of alkyl derivatives of fluorescein, MitoFluo and C8-Fl, in solutions with liposomes.

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We present the study of interaction of fluorescein derivatives, MitoFluo and C8-Fl with two types of liposomes modeling cellular and mitochondrial membranes. Polarization anisotropy, fluorescence lifetimes, rotational diffusion times have been determined from time-resolved polarized fluorescence experiments. The analysis of the experimental results shows that both fluorescein derivatives interact with liposomes and MitoFluo embeds in liposomes more effectively than C8-Fl.

This research was supported by RFBR Grant(s) # 18-53-34001

SY: Section E. Nanophototheranostics

TuSYE-p01

Laser spectroscopic method for assessing the effectiveness of photodynamic therapy (controlled PDT)

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This work presents the developed method and equipment for assessing the effectiveness of treatment using PDT. The problem of spectral separation of laser radiation and fluorescence of 5-ALA-induced protoporphyrin IX or Chlorin e6 was solved by selecting a combination of optical filters. The results showed the effectiveness of the new approach and equipment for conducting controlled PDT.

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TuSYE-p02

Hybrid nanostructures for fluorescence diagnostics and photodynamic therapy using two-photon excitation

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The fluorescence diagnosis complexity of cholangiocellular cancer is associated with the parasitic autofluorescence presence of the hepatobiliary system components. Necessary change the red region of the spectrum to the near infrared region. Proposed to use hybrid nanostructures. When quantum nanoplates are excited by a two-photon laser, they transfer energy to the photosensitizer using fluorescence resonance energy transfer interaction.

TuSYE-p03

Tumorigenesis and metastasis scheme from photodynamic therapy perspective

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The effectiveness of photodynamic therapy of tumors can be increased if every specialist will understand the mechanisms behind tumorigenesis and metastasis. To make this process easier, the scheme of processes taking place in the tumor was made. This work was supported by RFBR, № 20-02-00928.

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TuSYE-p04

The approach to optimization parameters of aluminium phthalocyanine-based nanophotosensitizers for phototheranostic

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The use of crystalline nanoparticles of aluminium phthalocyanine (AlPc) as nanophotosensitizers for phototheranostic is a promising direction. The investigations of size dependence, absorption and fluorescence of AlPc nanoparticles on various particle production conditions were carried out, and optimal conditions for obtaining the most effective samples of initial solutions for their testing on cancer and immune cells were found.

TuSYE-p05

Nd3+-doped nanoparticles for visualization in the tissue depth

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Stable aqueous colloidal solutions of Nd3+: LaF3 nanoparticles with strong luminescence in the NIR and visible spectral ranges under NIR laser excitation were synthesized by hydrothermal microwave treatment. The results of their luminescence visualization under system-wide administration to laboratory animals with transplanted tumors are presented. The histological distribution of the nanoparticles is verified by laser upconversion microscopy.

TuSYE-p06

Raman spectroscopy for the development of a method for glial brain tumors diagnostics

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Reducing the frequency of relapses after surgical removal of glial tumors is a non-trivial task due to their infiltrative growth. Raman spectroscopy has the advantages of optical spectroscopy such as speed and non-invasiveness. With reference spectra database of those components that can be expressed in glial tumors, Raman scattering spectroscopy allows multivariate diagnosis of such tumors and their intraoperative demarcation.

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TuSYE-p07

Fluorescence diagnostics and photodynamic therapy of grain crops pathogenic fungi

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The studies show the dynamics of photosensitizers accumulation in various grain areas during germination and their photodynamic activity against pathogenic microflora (Fusarium, Bipolaris, Alternaria). The possibility of pathogenic microflora inactivation using aluminum phthalocyanine was shown.

TuSYE-p08

Laser-induced fluorescent diagnostics and photodynamic therapy of cervical neoplasms

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The paper presents the results of precise fluorescent diagnostics of cervical neoplasms at PDT using a photosensitizer, chlorin e6. The precise fluorescent diagnostics supposes the combined use of spectral and video fluorescent diagnostics of pathological and normal tissues. PDT was performed and controlled via photobleaching. The results of spectral fluorescent diagnostics well correlate with the results of video fluorescent diagnostics.

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