Integrated butt-coupled membrane laser for Indium Phosphide on Silicon platform

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Download date: 17. Jun. 2019
17th International Conference
“Laser Optics 2016”

Technical Program

Saint Petersburg, Russia
June 27 - July 1, 2016
On July 11, 2016, will be the 100th anniversary of the birth of Alexander Mikhailovich Prokhorov. Professor Prokhorov (1916-2002) was one of the founders of laser sciences, a Nobel prize winner, and for many years an Honorary Chair of the Laser Optics Conference. We dedicate the conference to his memory.
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THE 17TH INTERNATIONAL CONFERENCE «LASER OPTICS 2016»
IS TECHNICALLY CO-SPONSORED BY
IEEE Photonics Society
AND HOSTED BY:
Fund for Laser Physics
ITMO University
IPG Photonics Corporation
Russian Foundation for Basic Research
Institute PhOOLIOS
RC «Vavilov SOI»
The Union of Industrialists and Entrepreneurs (Employers) of St. Petersburg
We wish to thank the following for their contribution to the success of this conference:

- Laser Association
- Rozhdestvensky Optical Society
- Prokhorov General Physics Institute of RAS
- St. Petersburg Government
- NTO IRE-Polus
- The Ministry of Education and Science of Russian Federation
- The Ministry of Industry and Trade of the Russian Federation
- «Photonika» Magazine
-«RITM» Magazine
- Holiday Inn
- Holiday Inn St. Petersburg Moskovskiy Vorota

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NONLINEAR PHOTONICS: FUNDAMENTALS AND APPLICATIONS
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S.K. Turitsyn, Aston Univ., UK

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«LASER OPTICS 2016»
TOPICS FOR LO'2016

R1. SOLID-STATE LASERS
DPSSL • Ultrafast • Mid-IR • CW and pulsed • Compact sources • Emerging applications • Guided wave lasers • Fiber lasers (excluding high power) • Tunable lasers • Parametric amplifiers

R2. HIGH POWER LASERS
Advances in high-power gas and solid-state lasers • Fundamental issues in high-power laser science • High power laser architectures • Terawatt lasers, including fusion lasers • Novel optical materials for high power applications and systems • Thermal and thermo-optical effects in lasers and their mitigation • CO₂/CO lasers • Iodine lasers • Slab gas lasers • Chemical lasers • Excimer lasers • Extreme-UV light sources • Alkali vapor lasers

R3. SEMICONDUCTOR LASERS, MATERIALS AND APPLICATIONS
Quantum-well, wire, dash and dot lasers and devices • MID-IR and Quantum Cascade lasers • Ultrashort pulse lasers • VCSELs, VECSELs and superlattice structures • UV and Visible diode lasers and LEDs • Compact THz sources and applications • Silicon photonics • Optical coherent tomography • Multiphoton imaging • Novel semiconductor-based devices and emerging applications

R4. LASER BEAM CONTROL
Wavefront correction • Adaptive optics • Phase conjugation • Dynamic holography • Laser cavities • Stabilization and control of laser beam direction • Laser imaging • Coherent and non-coherent summation of laser beams • Singular laser optics • Optical limiting • Optical and laser elements based on nanostructured materials • Optics and electrooptics of liquid crystals

R5. SUPER-INTENSE LIGHT FIELDS AND ULTRA-FAST PROCESSES
Generation of high-power, super short pulses • Problems of «Fast Ignition» for the ICF • Laser plasma X-ray sources • Fast particle generation and acceleration by laser pulses • Femtosecond laser technology and applications • Physics of ultrafast phenomena • Ultrafast devices and measurements

R6. LASERS FOR SATELLITE RANGING SYSTEMS, SPACE GEODESY, AND GLOBAL NAVIGATION
Advanced picosecond lasers for satellite laser ranging • High power solid-state lasers for space junk monitoring • Atmospheric effects on laser ranging • Laser ranging retroreflector systems • Single-electron photodetectors • Laser radiation processing • Time transfer via one-way laser ranging

R7. LASERS IN ENVIRONMENTAL MONITORING
Laser remote sensing technologies and methods • Lidar techniques and measurements for atmospheric remote sensing • Oil spill and ocean monitoring • Urban remote sensing • Laser sensing for geology • Remote sensing for agriculture and ecosystems • Space-based lidar for global observations • Laser applications in biophotonics

R8. NONLINEAR PHOTONICS: FUNDAMENTALS AND APPLICATIONS
Nonlinear optical devices, including microresonators, waveguides, and PT-symmetric systems • Multimode light propagation • Self-focusing, collapse dynamics and applications • Conservative and dissipative optical solitons, oscillons • Vortex solitons and optical angular momentum • Supercontinuum generation • Fiber optics and telecommunications

R9. OPTICAL NANOMATERIALS
Modeling of nanostructures • Advanced methods of nanosynthesis structure • One-dimensional growth of semiconductor nanowires • Wide band gap nanostructures • Epitaxial quantum dots and related structures • Nanostructures for single photon devices • Nanostructures for THz radiation • Nanostructures for solar cells • Microcavities and photonic crystals • Hybrid nanostructures with pre-defined properties

R10. FREE ELECTRON LASERS
X-ray and other free electron lasers (FELs) • Theory of FEL radiation • Linear electron accelerators • Undulators • Optics at photon-beam transport systems • Electron- and photon-beam diagnostics • Photon detectors • Data acquisition systems • Experimental stations and science at FELs
S1. 8TH INTERNATIONAL SYMPOSIUM
ON HIGH-POWER FIBER LASERS AND THEIR APPLICATIONS

High power fiber lasers for material processing applications • Cutting and welding with kW fiber lasers • Fiber laser cladding, sintering, heat treatment and additive technology • Fiber lasers for automotive applications • Mid power fiber laser applications • Pipe and thick section welding • Marking and engraving • Mid infra-red, 2 to 3 micron fiber lasers, processing including • Cutting and welding of plastics • Visible, UV and ultrafast fiber lasers and applications • Hybrid lasers • Life Sciences, medical, surgical, food production, agricultural pest and herbal control applications of fiber lasers • New materials and parts for fiber lasers: fibers, crystals, glasses, optics, nonlinear elements, etc.

S2. 4TH INTERNATIONAL SYMPOSIUM
«LASERS IN MEDICINE AND BIOPHOTONICS»

New medical applications and advanced laser medical systems for ophthalmology, dermatology, urology, endoscopic and microsurgery, dentistry, and other specialties autofluorescence and photodynamic diagnosis • Optical coherence tomography and diffuse optical imaging • New developments in non-invasive optical technologies, laser microscopy and spectroscopy of tissues • 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 • Analytical biophotonics • Novel sensing principles, devices and instrumentation for medical diagnostics • Nanomaterials and nanosystems for diagnostics and therapy
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«LASER OPTICS 2016»
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<td>PETROV-VODKIN 1 P. 48</td>
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11.00-11.30    COFFEE BREAK

11.30-13.30    POSTER SESSION                                      | MOSKOVSKY CONGRESS HALL                      | R3, R7                                       |
|               | R1 SOLID-STATE LASERS VI                             |                                               | STENBERG P. 46                               |
|               | R2 HIGH POWER LASERS V                              |                                               | PETROV-VODKIN 1 P. 48                        |
|               | R4 LASER BEAM CONTROL IV                            |                                               | DEYNEKA P. 49                                |
|               | R8 NONLINEAR SURFACES, WAVEGUIDES AND CAVITIES      |                                               | PUDOVKIN P. 52                               |

13.30-15.00    LUNCH BREAK

15.00-17.00    POSTER SESSION                                      | MOSKOVSKY CONGRESS HALL                      | R2, R4                                       |
|               | R1 SOLID-STATE LASERS VII                            |                                               | STENBERG P. 47                               |
|               | R5 SUPER-INTENSE LIGHT FIELDS AND ULTRA-FAST PROCESSES III |                                               | DEYNEKA P. 50                               |
|               | R8 NONLINEAR FREQUENCY CONVERSION                    |                                               | PUDOVKIN P. 52                               |

17.00-17.30    COFFEE BREAK

17.30-19.30    POSTER SESSION                                      | MOSKOVSKY CONGRESS HALL                      | R2, R4                                       |
|               | R5 SUPER-INTENSE LIGHT FIELDS AND ULTRA-FAST PROCESSES IV |                                               | DEYNEKA P. 50                               |
|               | R8 NONLINEARITY OF SOLIDS, GASES AND PLASMAS         |                                               | PUDOVKIN P. 53                               |

FRIDAY, 1 JULY

10.00-17.00   A2 NEWLED CONSORTIUM MEETING
|               | MUNTS                                               |

SIDE-EVENT WORKSHOPS:

**A1. Advanced laser technology and equipment in industrial applications**
- Official Language: Russian
- Brik Room, floor 3
- June 29, 2016
- 09:00 - 17:00
- Registration: 08:30 – 09:00
- **Chair:** Nikolay N. Evtikhiev, NTO “IRE-Polus”, Russia
- **Moderator:** Sergey N. Smirnov, Lasertech Ltd., Russia

**A2. NEWLED consortium meeting (by invitation only)**
- Official Language: English
- Munts Room, floor 3
- June 30 and July 1, 2016
- 10:00 - 17:00
- **Chair:** Edik Rafailov, Aston University, UK
- **Sponsor:** FP7 NEWLED Project
### THURSDAY, 30 JUNE

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**COFFEE BREAK**

11.00-11.30

**LUNCH BREAK**

13.30-15.00

**COFFEE BREAK**

17.00-17.30

### FRIDAY, 1 JULY

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**SID-EVENT WORKSHOPS:**


Official Language: Russian
Levinson Hall, floor 2
June 28, 2016
17:30 – 19:00

Chair: Ivan A. Shcherbakov, Prokhorov General Physics Inst. of RAS, Russia

**Tu** = Tuesday,
**We** = Wednesday,
**Th** = Thursday,
**Fr** = Friday.
FIRST FLOOR

Moskovsky Congress Hall

Stairs to 2 floor

WC

Lifts

Hotel lobby

Hotel Entrance

Stairs to 2 floor

« LASER OPTICS 2016 »
JUNE 27 - JULY 1, ST. PETERSBURG, RUSSIA
3D Laser printing of nanoparticles and living cells
Boris Chichkov
Laser Zentrum Hannover e.V., Germany
11:20-11:55
Laser printing can be used for printing very small and delicate objects like nanoparticles and living cells. Nowadays, 3D printers can be bought for less than 500 Euro. They are able to print three-dimensional structures from thermoplastic and other materials. Here we report on laser printing of nanoparticles and living cells.
We demonstrate a simple printing method allowing the generation and arrangement of spherical metal and dielectric nanoparticles in a very precise manner. For example, the printed silicon nanoparticles have a predefined size and are characterized by unique optical properties. With sizes in the range of 100-200 nm in diameter they exhibit pronounced electric and magnetic dipole resonances within the visible spectral range. Fabrication, characterization, and applications of the generated nanoparticle arrays will be discussed.
In a series of publications on laser printing of living cells we proved that cells are not harmed by the printing process. The differentiation behavior and potential of laser printed stem cells are not affected. Stem cells can be printed in defined patterns and then differentiated within these patterns towards bone, cartilage or adipose tissue. With specific multi-cellular cell structures, studies of cell-cell and cell-environment interactions can be performed. Furthermore, fibroblast and keratinocyte cells have been printed layer-by-layer to form 3D skin tissue constructs. The skin tissue formation has been proven by visualizing intercellular junctions and verifying their functionality.
The presented laser printing techniques are promising for a wide range of applications in nanophotonics and tissue engineering.

Why we need to replace the transistor, and what would be the newly required material properties?
Eli Yablonovitch
University of California, United States
11:55-12:30
In contemplating the headlong rush toward miniaturization represented by Moore's Law, it is tempting to think only of the progression toward molecular sized components. There is a second aspect of Moore’s Law that is sometimes overlooked. Owing to miniaturization, the energy efficiency of information processing has steadily improved. But there is an inefficiency for internal communications in a chip. It is caused by the difference in voltage scale between the wires and the transistor switches. Transistors are thermally activated, leading to a required voltage >>kT/q. Wires are long, and they have a low impedance, allowing them to operate efficiently even at a few millivolts. Thus the main Figure-of-Merit for future transistors is low operating voltage or sensitivity, NOT mobility.
The challenge then is to replace transistors with a new low-voltage switch that is better matched to the wires. I will present the new material quantum level properties, which are being explored by the NSF Science & Technology Center for Energy Efficient Electronics Science.
Applications of plasmonic and dielectric nanoantennas in nanophotonics
Stefan A. Maier
Imperial College London, UK
12:30-13:05
Optical nanoantennas based on metallic nanostructures enable the controlled focusing of light from the far field to highly confined volumes below the diffraction limit, and furthermore form the basis of implementations of metamaterials and metasurfaces operating in the optical regime of the spectrum.
Upon excitation of the plasmon oscillation, parts of the energy get dissipated via electron/hole pair formation, leading ultimately to dissipation into phonon modes. Here, we show how the vibrational frequencies of these modes can be controlled on the nanoscale, at the level of an individual nanoantenna. This is achieved via pinning certain parts of the antenna stronger to the substrate, utilizing oxide bar layers. Comprehensive finite element modelling combined with degenerate fs pump probe spectroscopy allows us to determine the ratio of the amplitudes of the underlying vibrational normal mode, demonstrating the tailoring. We believe that this work could be the start of a new avenue for control over electromagnetic - acoustic coupling in optical metasurfaces.
We further demonstrate the mapping of plasmonic hot spots using super-resolution far-field fluorescence spectroscopy, including a de-coupling of enhanced absorption and emission processes. The crucial role of the latter in determining the position of the emitter with respect to the antenna will be elucidated. Finally, we will present applications of dielectric nanoantennas for surface-enhanced spectroscopies, including antennas operating via localized surface phonon-polariton modes.

Wave control with space-time manipulations
Mathias Fink
Institut Langevin, ESPCI Paris Tech, France
13:05-13:40
Time-reversal processing is based on Huygens principles and on wavefield manipulation on spatial boundaries. It provided an elegant way to back propagate a wave field towards its initial source allowing to create, through any complex medium, a wave pattern of any required shape restricted only by diffraction limits.
Here we want to revisit these approaches by introducing another point of view, the one that Loschmidt proposed in his famous argument to create a time-reversal experiment by inversing instantaneously all velocities of the particles in a gas. The extension of this concept to wave will be discussed through the concept of time boundaries manipulation. Experiments, conducted with water waves, validating this approach will be presented. We show that sudden changes of the medium properties generate instant wave sources that emerge instantaneously from the entire space at the time disruption. The time-reversed waves originate from these “Cauchy sources” which are the counterpart of Huygens virtual sources on a time boundary. It allows us to revisit the holographic method and introduce a new approach for wave control in complex media.
In the second part of this talk, we will discussed another approach to manipulate a wave field in reverberating medium by introducing tunable metasurfaces as spatial boundaries and we will emphasis this concept for microwaves.

We report on the generation of high-energy few-optical-cycle pulses in mid-infrared spectral region via self-compression in transparent dielectrics and filaments as well as via four wave parametric amplification in gas-filled hollow waveguides.

TuR1-09 12:15-12:30
NIR photoluminescence of Bi+ impurity center in RbY2Cl7 ternary chloride crystal
1 - Inst. of Laser Physics SB RAS, 2 - Inst. of Electrophysics UB RAS, 3 - Kotel'nikov Inst. of Radio Engineering and Electronics RAS, 4 - Inst. of Automation and Electrometry SB RAS, 5 - Inst. of Inorganic Chemistry SB RAS, Russia

Intense long-lived NIR photoluminescence, centered at 920 nm was observed from the single crystalline specimens of RbY2Cl7 ternary chloride, containing Bi+ impurity centers. This crystal phase can be crystallized from the stoichiometric Lewis acidic melt, which promotes the formation of Bi+ ion in sufficient concentration.

TuR1-10 12:30-12:45
Optical properties and high-efficiency lasing of Nd:YAG and Ho:YAG ceramics
S.M. Vatnik, I.A. Vedin, V.V. Osipov, K.E. Luk'yashin, R.N. Maksimov
1 - Semenov Inst. of Chemical Physics RAS, 2 - State Scientific-Research and Design Inst. of Rare-Metal Industry «Giredmet», Russia

We report on optical properties and high-efficiency lasing of YAG ceramics synthesized at IREE (Fryazino) and IEP (Ekaterinburg). The best slope efficiency is to be 36% for 1% Nd:YAG ceramics and 40% for 1% Ho:YAG ceramics, in the latter case the emission was centered at 2090 nm. Internal losses in domestic ceramics prove to be a few percents per centimeter.

TuR1-11 12:45-13:00
The 2-µm waveband laser system based on Tm:YLF and Ho:YAG crystals with diode pumping

The experimental investigation results of the continuous-wave Tm:YLF laser based on the one cylindrical active element with the dual end pumping of the laser diode modules are represented. The σ- and π-polarized generation is obtained with the total pumping power up to 185 W.

TuR1-12 13:00-13:15
Efficient 10-J pulsed Fe:ZnSe laser at 4100 nm

Energies of over 10 J and efficiencies of over 44% have been demonstrated in single-shot operation of liquid nitrogen cooled single-crystalline Fe:ZnSe laser at 4100-nm wavelength.

TuR1-13 13:15-13:30
Multipass pump scheme for passively Q-switched eye-safe Er:YAG DPSSL
VM. Polyakov, VA. Buchenko, A.V. Kovalev, V.V. Vizitin, A.A. Mak, ITMO Univ, Russia

We discuss an efficient Er:YAG DPSSL with passive Q-switch and analyze Er:YAG spectroscopic properties for efficient performance. The multipass pump scheme and multipass lasing scheme are discussed.
R3. SEMICONDUCTOR LASERS, MATERIALS AND APPLICATIONS

TuR3-01 Invited
09:00-09:30
Semiconductor laser based optical frequency combs - applications in communications and signal processing
P. Deilyett, S. Bhoslapur, A. Klee, E. Sarailou, K. Bagnell, CREATe, The College of Optics & Photonics; Univ. of Central Florida; United States
Optical frequency combs from mode-locked lasers are developed and used for realizing unique functionality for applications in ultra-wide bandwidth communication and signal processing.

TuR3-02 09:30-09:45
Novel approach for transverse mode engineering in edge-emitting semiconductor lasers
N.Yu. Gordeev1,2, A.S. Poyusov1,2, Yu.M. Sherryakov2,3, S.A. Mintaorov2,3, N.A. Kalyuzhny2,3, M.M. Kulagina2, A.E. Zhukov1, M.V. Maximov1,3 - 1 - Submicron Heterostructures for Microelectronics, Research Engineering Center RAS, 2 - Ioffe Inst, 3 - St. Petersburg Academic Univ, Russia
We review our novel approach based on coupled large optical cavity (CLOC) structures for effective suppression of high-order transverse modes in edge-emitting lasers with broadened waveguides. We discuss the main principles of the CLOC laser concept and present our recent numerical and experimental results of the laser operation.

TuR3-03 Invited
09:45-10:15
Wavelength stabilized high-power diode lasers – design, manufacturing and applications
B. Sumpf, Ferdinand-Braun Inst., Germany
Wavelength stabilized high-power diode lasers are requested light sources in the field of laser based sensor systems. They are used as pump lasers for non-linear frequency conversion, e.g. second harmonic generation, to pump solid state f-laser devices applied for diagnostic purposes in life sciences and they are applied directly as light sources for absorption or Raman spectroscopy. This paper presents recent developments concerning distributed Bragg reflector (DBR) ridge waveguide (RW) diode lasers for vibrational spectroscopy and high brightness DBR-tapered lasers for non-linear optics. The manufacturing and the electro-optical, spectral, and beam parameters of these devices will be presented together with a compact handheld Raman probe using an implemented dualwavelength DBR-RW diode laser for Shifted Excitation Raman Difference Spectroscopy (SERDS).

TuR3-04 10:15-10:30
Integrated butt-coupled membrane laser for Indium Phosphide on Silicon platform
In this work we present the design and technology development for an integrated butt-coupled membrane laser in the IMOS (Indium Phosphide Membrane on Silicon) platform. Laser is expected to have a small footprint (less than 50 µm²), 1 mA threshold current and a direct modulation frequency of 10 GHz.

TuR3-05 Invited
10:30-11:00
Modulation response of double tunneling-injection quantum dot lasers
LV Asryan, Virginia Polytechnic Institute and State Univ., United States
The upper limit for the modulation bandwidth in a double tunneling-injection (DTI) quantum dot (QD) laser is discussed. While the maximum bandwidth is the same in DTI and conventional QD lasers, the optimum dc current, at which it is obtained, is lower in a DTI laser. Different factors limiting the modulation bandwidth in a DTI QD laser are also discussed.
- Coffee Break -

TuR3-06 Invited
11:30-12:00
Integrated mode locked laser systems in semiconductor photonic integrated circuits
E. Berne, V. Moskalenko, S. Latkovskii, M. Llorens-Revull, K. Williams; Eindhoven Univ. of Technology, Netherlands
E.A. Avrutin1, B.S. Ryvkin2,3; 1 - Univ. of York, United Kingdom, 2 - Univ. of Oulu, Finland, 3 - Ioffe Inst, Russia
The performance of integrated planar waveguide mode locked lasers can be enhanced using the available photonic integration platform technology in indium-phosphide. Extended cavity mode locked oscillators including DBR mirrors and phase modulators can be realized at telecom wavelengths to improve performance and control over the device. Integrated pulse shapers and special amplifiers can be used to improve the output properties further.

TuR3-07 12:00-12:15
Mode-locking and Q-switching in 1.06 µm two-sectional QW lasers due to Stark effect
M.S. Buyolo1,2, I.M. Godzihiyev1,2, N.D. Itinskaya1, A.A. Usikova1, V.N. Nevedomskiy3, A.Yu. Egorov1, E.P. Portnoi1
In two section lasers with 3 QWs passive mode-locking and Q-switching are realized. Frequency rate in mode-locking is 75 GHz with time-bandwidth product 0.49. The bleaching mechanism is induced by photocurrent in absorber at high reverse biases.

TuR3-08 Invited
12:15-12:45
High-energy picosecond optical pulse generation with asymmetric-waveguide diode lasers
E.A. Avrutin1, B.S. Ryvkin2,3, J.T. Kostamoavaara1, A.A. Usikova1, V.N. Nevedomskiy3, A.Yu. Egorov1, E.P. Portnoi1
We report recent progress and discuss important issues in the design of gain-switched and combined gain/Q-switched asymmetric waveguide lasers with a large effective spot size for applications ranging from optical range finding (with a prototype system developed) to nonlinear optics. The role of the active layer material, the waveguide design, and the use of saturable absorber in the cavity are discussed.

TuR3-09 12:45-13:00
Laser-thyrists as a source of high-power laser pulses with a pulse width of 1-100 ns
A.A. Podaskin1, O.S. Soboleva1, V.V. Zolotarev1, D.A. Veselov1, N.A. Pikhitin1, I.S. Tarasov2, T.A. Bagaev2, M.A. Ladugin2, A.A. Marmalyuk2, V.A. Simakov2, S.O. Silchenko2, A.A. Usikova1, V.N. Nevedomskiy3, A.Yu. Egorov1, E.P. Portnoi1
A low-voltage ALGaAs/GaAs laser-thyristor heterostucture has been fabricated in order to have a compact source of high-power laser pulses at 900nm wavelength. Peak powers/pulse width of 55 W/100 ns and 8 W/1000 ns from 20µm aperture can be achieved.

TuR3-10 Invited
13:00-13:30
Frequency combs from InAs/InP quantum dash based mode-locked lasers for multi-terabit/s data transmission
A. Ramdane1, V. Panapakkam1, Q. Gaimard1, K. Merghem1, G. Aubin1, N. Chimot2, E. Bente, V. Moskalenko, S. Latkovskii, M. Llorens-Revull, K. Williams; Eindhoven Univ. of Technology, Netherlands
InAs/InP quantum dash based mode locked lasers are particularly suited for frequency comb generation. Multi-terabit/s data transmission has been achieved using one single chip.
- Lunch Break -
28 JUNE, TUESDAY

TECHNICAL SESSION

TuR3-11 Invited
15:00-15:30
Dislocations in LD and LED semiconductor heterostructures
A.E. Romanov1, 2, J.S. Speck2, 1 - ITMO Univ., Russia, 2 - Ioffe Inst. Russia, 3 - UCSB, United States

We discuss misfit dislocations (MDs) and threading dislocations (TDs) in lattice-mismatched semiconductor heteroepitaxial layers, which are the key structural elements of light-emitting diodes (LEDs) and laser diodes (LDs). Novel approaches to modelling MD formation and TD reduction are considered. The behavior of dislocations in conventional III-V semiconductor compounds as well in polar and semipolar III-nitride heterostructures are reviewed in detail.

TuR3-12 Invited
15:30-16:00
The most important issues in technology of AlGaN-based laser diodes and in array
M. Leszczynski, TopCaN and Inst. of High Pressure Physics UNIPRESS, Poland

Despite the bright commercial future of nitride LDs, there is a number of technological issues which are being solved, and some of them will be discussed in the presentation.

TuR3-13
16:00-16:15
Fractional order of poling period for broadly tunable second harmonic generation
K.A. Fedorova1, 2, G.S. Sokolovskii1, I.O. Bakshiev2, A.A. Lishchitz1, E.A. Rafailov1, 3 - Ioffe Inst., Russia, 2 - Stepanov Inst. of Physics NASB, Belarus

We demonstrate the possibility of using a fractional order of poling period of nonlinear crystal waveguides for tunable second harmonic generation. This approach allows for an extension of wavelength coverage in the visible spectral region by frequency doubling in a single nonlinear crystal waveguide.

TuR3-14 Invited
16:15-16:45
True yellow II-VI/GaAs optically pumped laser structures for microchip laser diode converters
S.V. Sorokin1, 2, I.V. Sedova1, V.V. Gronin2, I.V. Ivanov2, L.P. Vainshtok1, A.G. Vainilovich1, G.P. Yablonski1, 2 - Ioffe Inst. Russia, 2 - Stepanov Inst. of Physics NASB, Belarus

We report on recent progress in developing true-yellow (570-590 nm) low-threshold (on for microchip laser diode converters.

TuR3-15
16:45-17:00
Infrared, green, and blue-violet pulsed lasers based on semiconductor structures pumped by low-energy electron beam
M.M. Zverev1, N.A. Gamov1, E.V. Zhidanova1, V.B. Studionov1, I.V. Sedova1, V.V. Sorokin1, V.V. Gronin1, I.V. Ivanov2, M.A. Ladugut1, A. Padalitsa1, A.V. Mazalov1, V. Kureshov2, A.A. Marmalyuk1, 2 - Moscow Technological Univ. MIREA, 2 - Ioffe Inst., 3 - RDI Polyus, Russia

Ultimate parameters of infrared, visible and blue-violet electron-beam-pumped lasers and laser arrays based on II-VI, III-V and III-N semiconductor heterostructures, obtained at electron energy below -10eV are discussed.

- Coffee Break -

TuR3-16 Invited
17:30-18:00
Monolithic high-index contrast grating VCSELs
M. Gelski1, M. Marciniak1, M. Denis2, J.A. Lott1, T. Czyszarowski1, 2 - Lodz Univ. of Technology, Poland, 2 - Technical Univ. Berlin, Germany

A new and radically simplified construction of the vertical-cavity surface-emitting laser (VCSEL) with monolithic high-index contrast grating will be investigated. Instead of hundreds of epitaxial layers as in conventional VCSELs, the proposed design consists of a thin active zone capturing and recombining the carriers positioned between two monolithic cladding layers of p-doped and n-doped material. In these semiconductor lasers the optical feedback is provided by one or two planar monolithic subwavelength gratings etched into the cladding layers on either side of the optical cavity.

TuR3-17
18:00-18:15
VCSEL polarization control by rhombohedral selectively-oxidized current aperture
M.A. Bobrov1, N.A. Maleev1, A.A. Blokhin1, A.G. Kuzmenkov1, A.P. Vasil’ev1, 2 - Ioffe Inst., Russia, 3 - UCSB, United States

The new approach for single-mode (SM) VCSEL polarization control based on rhombohedral selectively-oxidized current aperture combined with intracavity contacts is discussed. MBE-grown VCSELs with aperture size of about 2.5 micron demonstrate lasing at 845-852 nm with SM output power exceeds 1.5 mW, SMSR higher than 30 dB, and orthogonal polarization suppression ratio higher than 20 dB for temperature of 20-80°C.

TuR3-18 Invited
18:15-18:45
Progress in high-power VCSELs: from material science to applications
M. Guina; Tampere Univ. of Technology, Finland

The presentation is focused on reviewing the major recent steps in the development of VCSEL technology. Emphasis is put on advances concerning power scaling, thermal management, and wavelength coverage. Ultimately, an outline of emerging applications in medicine and atom physics, is presented.

TuR3-19
18:45-19:00
1.3 μm InAs quantum dot semiconductor disk laser
S.A. Blokhin1, M.A. Bobrov1, A.A. Blokhin1, A.G. Kuzmenkov1, A.P. Vasil’ev1, N.A. Maleev1, V.V. Dudellev1, K.K. Sobolev1, G.S. Sokolovskii1, A. Rantamaski1, O. Okhotnikov1, 2 - Ioffe Inst., Russia, 2 - Peter the Great St.Petersburg Polytechnic Univ., Russia, 3 - Tampere Univ. of Technology, Finland

We report an InAs/InGaAs quantum dot-based optically pumped vertical-cavity disk laser with a 1.3 μm emission at 25°C. The laser device was grown by liquid phase epitaxy, including the InAs quantum dot active layer, a set of quantum well cladding layers and a tunnel injection barrier. The device operates in the CW mode with optical powers exceeding 70 mW at 1.3 μm. A fibre-coupled 808 nm laser diode and V-cavity configuration were used. Continuous wave output power over 200 mW is obtained at 7-15°C, which is the highest reported for such type of surface-emitting laser in this wavelength range.

TuR3-20
19:00-19:15
A serially-connected two-chip VCSEL for dual-wavelength emission
F. Zhang1, M. Gafdar1, C. Möller2, W. Stolz2, M. Koch1, A. Rahimi-Imani1, 2 - Philipps-Univ. Marburg, Germany, 2 - NASP III/V GmbH, Germany

We present a compact and flexible cavity design for high intracavity powers in dual-wavelength vertical-external-cavity surface-emitting lasers (VECSELs), by serially connecting two different gain chips in one cavity. Such device generates linearly polarized dual-wavelength emission with up to 640 W intracavity power at 10 nm wavelength spacing, which is tunable via a changing of the cavity angles on the chips. Furthermore, in this cavity, type-I second harmonic generation and sum-frequency generation have been performed in a LiNbO3 crystal.

TuR3-21
19:15-19:30
Self-mode-locked semiconductor disk laser
A. Rahimi-Imani1, M. Gafdar1, M. Vaupel1, C. Möller2, F. Zhang1, D. Al-Nakdali1, K.A. Fedorova2, W. Stolz1, E.U. Rafailov1, M. Koch1, 2 - Philipps-Univ. Marburg, Germany, 2 - Aston Univ. United Kingdom, 3 - NASP III/V GmbH, Germany

In the last decade, vertical-external-cavity surface-emitting lasers (VECSELs) have become promising sources of ultrashort laser pulses. While the mode-locked operation has been strongly relying on costly semiconductor saturable-absorber mirrors for many years, new techniques have been found for pulse formation. Mode-locking VECSELs are nowadays not only achievable by using a variety of saturable absorbers, but also by using a saturable-absorber-free technique referred to as self-mode-locking (SML), which is to be highlighted here.
R6. LASERS FOR SATELLITE RANGING SYSTEMS, SPACE GEODESY, AND GLOBAL NAVIGATION

Location: Deyneka Room, floor 2, 15:00 – 17:00
Lasers for Satellite Ranging Systems, Space Geodesy, and Global Navigation I
Session Chair: Vladimir P. Vasiliev, OJSC «RPC «Precision Systems and Instruments», Russia

TuR6-01 Invited 15:00-15:30
New one-way and two-way precision radio-laser ranging systems to increase the accuracy of global space geometry and navigation systems
M.A. Sadovnikov, A.A. Chubykin, V.D. Shargorodskiy, OJSC «RPC «Precision Systems and Instruments», Russia
New laser technologies for collecting sub-millimeter accuracy data to promote ephemeris-time support for global navigation and space geodesy are presented. The ways to use laser ranging systems to perform lunar ranging and space debris monitoring are reviewed. Technical specifications of high-accuracy measuring systems are given.

TuR6-02 Invited 15:30-16:00
High brightness Q-switched Nd:YAG lasers for plasma diagnostics and long distance ranging
A.F. Kornev, ITMO Univ., Russia
Results of developments and studies of high brightness Q-switched Nd:YAG lasers. Output energy of the lasers is up to 4 J at 1064 nm, 2.5 J at 532 nm, 1 J at 946 nm, pulse repetition rate up to 330 Hz and beam divergence near to diffraction limited. 6 J@200 Hz and 12 J@300 MHz multichannel laser systems were developed.

TuR6-03 Invited 16:00-16:30
High-energy, high repetition rate regenerative amplifiers at 2 μm
U. Griebner, L. von Grafenstein, M. Bock, T. Elsaesser; Max Born Inst., Germany
Picosecond Ho:YLF regenerative amplifiers near 1 kHz repetition rate are reported. Stable operation regimes are identified, delivering up to 16 mJ picosecond pulses at 2051 nm, with energy fluctuations of the pulse train as low as 1% rms.

TuR6-04 16:30-16:45
Russian Lunar Laser Rangefinder with Millimeter Accuracy
I.A. Grechukhin1, E.A. Grishin1, O.A. Nlev1, A.F. Kornev2, A.A. Mak3, M.A. Sadovnikov4, V.D. Shargorodskiy1; 1 - OJSC «RPC «Precision Systems and Instruments», 2 - ITMO Univ., Russia
Laser rangefinder being created by JC «RPC «PSI» will allow ranging to mid-orbit spacecrafts which consists of corner reflectors with the controlled camber of a single dihedral angle for generating a double-lobe pattern and thus compensating for the velocity aberration. It is shown that the circular retroreflector system has a number of advantages over the existing ones.

TuR6-05 16:45-17:00
100 ps 360 mJ 200 Hz Nd:YAG laser for the Lunar Laser Ranging
R.V. Balmanashov, Y.V. Katsev, A.F. Kornev, I.G. Kuchma, D.O. Oborotov; ITMO Univ., Russia
We developed high-power diode-pumped Nd:YAG 1.064 μm laser with pulse duration of 100 ps, energy of 360 mJ, pulse repetition rate of 200 Hz and divergence of laser radiation at the level 1.3 of diffraction limit. 72% efficiency of second harmonic generation of the laser output was obtained.

- Coffee Break -
R8. NONLINEAR PHOTONICS: FUNDAMENTALS AND APPLICATIONS

Nonlinear Fibers and Photonic Crystals

Session Chair: Boris A. Malomed, Tel Aviv Univ., Israel

TuR8-01 Invited
09:00-09:30
Space-time dynamics of nonlinear multimode fibers
K. Krupa1, A. Tonello1, A. Barthelemé1, V. Couderc1, B.M. Shalaby2, A. Bendahmane1, G. Millot1, S. Wabnitz1, 1 - Univ. de Limoges, France, 2 - Tanta Univ., Egypt, 3 - Univ. de Bourgogne Franche-Comté, France, 4 - Univ. Brescia, and INO-CNR, Italy

The spatio-temporal dynamics of multimode waves in optical fibers leads to novel possibilities to shape the frequency and spatial content of laser beams.

TuR8-02 Invited
09:30-10:00
Micrometre-scale reconfigurable photonic circuits and buffers at the fibre surface
M. Sumetsky1, A.V. Dmitriev1, N.A. Toropov1, 1 - Aston Univ., United Kingdom, 2 - ITMO Univ., Russia

Recent experimental and theoretical results on microscopic reconfigurable photonic circuits and buffers introduced at the fiber surface are reviewed.

TuR8-03 10:00-10:15
Self-pulsating nonlinear systems via dissipative parametric instability
A.M. Perego1, N. Tarasov1,2, D.V. Chunkin1,3, S.K. Turitsyn1,2, K. Staliunas1,2, 1 - Aston Inst. of Photonic Technologies, Aston Univ., United Kingdom, 2 - Univ. Politecnica de Catalunya, Spain, 3 - Inst. of Computational Technologies SB RAS, Russia, 4 - Novosibirsk State Univ. State, Russia, 5 - Inst. Catalana de Recerca i Estudis Avançats, Spain

The recently discovered dissipative parametric instability is presented in the framework of the universal complex Ginzburg-Landau equation. The pattern formation associated with the instability is discussed in connection to the relevant applications in nonlinear photonics especially as a new tool for pulsed lasers design.

TuR8-04 Generation in visible range using second harmonic of random distributed feedback fiber laser
E.I. Donskova1, S.I. Kabukov1, I.D. Volnik1, S.A. Babkin1, 1 - Inst. of Automation and Electrometry, 2 - Novosibirsk State Univ, Russia

Frequency doubling of radiation generated by random distributed feedback (RDFB) Raman fiber laser (RFL) in MgO:PPLN crystal is studied experimentally for the first time. Second harmonic generation (SHG) power is compared for conventional and RDFB RFL configurations. The comparison shows, that higher SHG power (more than 100 mW at 654 nm) is generated with RDFB RFLs.

TuR8-05 Broad green generation using adiabatically chirped chi(2) nonlinear photonic crystals
H.-J. Lee, C.-M. Lai2, W.-S. Tsai3, A.-H. Kung4, L.-H. Peng5, 1 - National Taiwan Univ., 2 - Ming Chuan Univ, 3 - National Chi Nan Univ, 4 - Academia Sinica and National Tsing Hua Univ, China

Broad green generation from 500 to 565nm was observed on chirped chi(2) nonlinear photonic crystals made of periodically-poled lithium tantalate (PPLT) with single pass up-conversion efficiency ~10%. This was ascribed to simultaneous multi-wavelength SHG and SFG due to nonlinear interaction of (signal, idler) waves in the adiabatically chirped PPLT.

TuR8-06 Towards three octave-spanning mid-IR supercontinuum generation in chalcogenide fibers with two zero dispersion wavelengths
E.A. Anashkina1, V.S. Shyraev2, G.E. Snopatin2, A.V. Kim3, 1 - Inst. of Applied Physics, 2 - Inst. of Chemistry of High-Purity Substances, 3 - Inst. of Automation and Electrometry, 4 - Novosibirsk State Univ., 2 - Inst. of Chemistry of High-Purity Substances SB RAS, Russia

We have numerically demonstrated mid-IR supercontinuum generation spanning more than three octaves in all-solid chalcogenide glass fibers with two zero dispersion wavelengths pumped by 50-pJ femtosecond pulses at 2 microns. We manufactured the proper step-index fibers with As39.4S60.6 cladding having various core diameters and theoretically studied wavelength conversion up to 8 microns.

- Coffee Break -

TuR8-07 Invited
11:30-12:00
Statistics of rare events: errors in optical fiber communication systems
I.R. Gabitov1,2, F. Kueppers3, M. Shkarayev1, 1 - Skolkovo Inst. of Science and Technology, Russia, 2 - Unic. of Arizona, United States (on leave), 3 - Technische Univ. Darmstadt, Germany

The waveguide bundles and two dimensional waveguide arrays in the case of the electromagnetic wave propagating along the waveguide only are discussed. The waveguide array consists of alternating waveguides of positive and negative refraction indices. It is shown the features of the spectrum are dependent on number of waveguides per cell.

TuR8-08 Invited
12:00-12:30
Towards generation of multicolor dissipative solitons in telecom range
A.E. Bednyakova1, D.S. Kharenkova1, E.V. Pudlov1, M.P. Fedorov2, A.A. Apolonski2, S.A. Babkin1, S.K. Turitsyn1, 1 - Novosibirsk State Univ, Russia, 2 - Inst. of Computational Technologies SB RAS, Russia, 3 - Inst. of Automation and Electrometry SB RAS, Russia, 4 - Ludwig-Maximilians-Univ. Muenchen and Max-Planck-Instit. fuer Quantenoptik, Germany, 5 - Aston Univ., United Kingdom

All-fiber cavity for synchronous generation of conventional and Raman dissipative solitons in the telecom spectral range is designed. Through extensive numerical modelling we demonstrate 2-wavelength complex with 10 nJ energy and ~200 fs duration after compression. A comparison with the experimental results will be presented.

TuR8-09 Interaction between weak and nonlinear optical waves in fibers in the vicinity of zero-dispersion point
I. Cherenkov1, R. Driben1, A.V. Yulin1, 1 - ITMO Univ., Russia, 2 - Univ. of Paderborn, Germany

We study interaction of weak dispersive waves with broad class of nonlinear waves including dark solitons and second-order solitons. We show a possibility to control nonlinear waves with weak probe signals, polychromatic frequency conversion of weak dispersive waves, and demonstrate a way to emulate classical optical devices like Fabry-Perot and Bragg resonators.

TuR8-10 Steering of solitons by resonant dispersive waves
A.V. Yulin, 1 - ITMO Univ., Russia

It is shown that the effect of Cherenkov radiation can be inverted and the solitons can be pumped by the synchronous dispersive waves of low intensity. This effect is analogous to the effect of the acceleration of moving charges by resonant electromagnetic waves. The importance of mutual resonant interactions between the solitons and the dispersive waves for supercontinuum generation is discussed.

TuR8-11 Three-photon spontaneous downconversion in highly nonlinear germania-silica optical fiber waveguides
S.Y. Yudinov, K.G. Katamadze1, N.A. Borshchevskaia1, A.A. Sysolyatin1, M.V. Fedorov2, S.P. Kulik1,2, M.Yu. Salganskii1, A.S. Belanov1, 1 - Prokhorov General Physics Inst. 2 - Lomonosov Moscow State Univ., 3 - Inst. of Chemistry of High-Purity Substances, 4 - Moscow State Univ. of Information Technologies, Radioengineering and Electronics, Russia

Three-photon spontaneous parametric downconversion (TPSPDC) is a challenging problem in nonlinear quantum optics. A highly doped germania-silica optical fiber is a good candidate for the appropriate nonlinear medium, because of the big interaction length and tight field confinement. A principal condition for TPSPDC is the exact phase-matching between the pump and signal fiber modes.

- Lunch Break -
R8. NONLINEAR PHOTONICS: FUNDAMENTALS AND APPLICATIONS

TuR8-13 Invited 15:00-15:30

Soliton fission and fusion in dispersion oscillating fiber and correlation properties of the pulses
L. Mel'nikov, Gagan Sarotov State Technical Univ., Saratov Branch of Kotel'nikov Inst. of Radioengineering and Electronics RAS, Russia

Comprehensive solitons dynamics in the fiber with periodically oscillating group velocity dispersion is demonstrated. Soliton fission and recently described solitons fusion are explained using the solitons spectra of inverse scattering problem solution. The fusion and fusion and collision of discrete spectral parameters of the solitons demonstrate collisions (anti-crossing) behavior during the pulse propagation along the fiber. The resulting pulses after fission remain coupled and this coupling exists in spite of long temporal or longitudinal distance between the pulses. Possible scenarios of collisions are discussed and correlation properties of the pulses are investigated.

TuR8-14 15:30-15:45

Dissipative Faraday instability mode-locking in a Raman fiber laser
N. Turaov, A.M. Perego, V.D. Churkin, K. Staliunas, S.K. Turyshev, A. Univ, United Kingdom, 2 - Inst. of Computational Technologies SB RAS, Russia, 3 - Inst. Catalana de Recerca i Estudis Avançats, Spain

There is a new type of parametric instability that was recently theoretically predicted - dissipative Faraday instability. In this work we experimentally demonstrate this new type of instability by using a recently achieving mode-locking in a simple configuration. The results not only open the possibilities for new designs of mode-locked lasers, but extend beyond the field of laser physics.

TuR8-15 15:45-16:00

Generation of frequency combs in nonlinear SNAP fiber resonators
S.V. Suchkov, M. Sumetsky, A.A. Sukhorukov, 1 - Australian National Univ, Australia, 2 - Univ, United Kingdom

We suggest Surface Nanoscale Axial Photonic resonators for generation of frequency combs. We derive model equations, which describe propagation of whispering gallery modes in the nonlinear SNAP resonators. Our simulations show that by appropriate variation of fiber radius along the millimeter long SNAP resonator, we can obtain a frequency comb, comparable to frequency combs generated by ring resonators of cm radius.

TuR8-16 16:00-16:15

Mid-IR ultrashort Raman solitons and red-shifted dispersive waves in suspended-core tellurite fiber
E.A. Anashkina, A.V. Andrianov, V.V. Dorofeev, A.V. Kim, 1 - Inst. of Applied Physics RAS, 2 - Moscow Inst. of Physics and Technology, Russia

We have demonstrated numerically the possibility to obtain ultrashort laser pulses in the range beyond 3 microns due to soliton self-frequency shift and red-shifted dispersive wave generation in a suspended-core fiber made of specially synthesized high-refractive-index glass pumped by a standard fs pump laser source at 2 microns.

TuR8-17 16:15-16:30

Broadband femtosecond fiber laser with ultrahigh repetition rate in the telecommunication range
A.V. Andrianov, V.V. Dorofeev, M. Yu, Konchev, M. Myronov, A.V. Kim, 1 - Inst. of Applied Physics RAS, 2 - University, United Kingdom

A new variant of the fiber laser for generation of ultrashort pulse bunches and sequences with repetition rate in the range of 8-260 GHz, which combines a nonlinear amplifying loop mirror and a comb spectral filter for stabilization of the pulse separation, was demonstrated. We showed that a well-ordered and equidistant structure of the pulse sequence is maintained on a nanosecond timescale.

TuR8-18 16:30-16:45

Femtosecond pulse propagation in the negative dispersion hollow-core revolver fiber

For the first time femtosecond pulse propagation has been numerically and experimentally studied in the hollow-core revolver fiber with a non-capped cylindrical capillaries-based cladding, fabricated for high-power ultra-short pulse delivery in the telecom band near 1.55 μm.

TuR8-19 16:45-17:00

Short cavity Brillouin random laser
S.M. Popov, O.V. Butov, Yu.K. Chamorovskiy, P. Megret', I.O. Zolotovskii, A.A. Foladov, 1 - Inst. of Radio Engineering and Electronics RAS, Russia, 2 - Univ. of Mons, Belgium, 3 - Ulyanov State Univ, Russia, 4 - Ioffe Inst, Russia

We report on random lasing realized with 100-m-long Rayleigh fiber fabricated with multiple reflection centers inserted in the fiber core and uniformly distributed along the fiber length. Extended fluctuation-free conditions of the oscillators traces highlights powerful behavior typical for lasing.

TuR8-20 17:30-17:45

Differential high-resolution stimulated CW Raman spectroscopy of hydrogen in a hollow-core fiber
P.G. Westergaard, M. Lassen, J.C. Petersen, Danish Fundamental Metrology, Denmark

We demonstrate sensitive high-resolution stimulated Raman measurements of hydrogen using a hollowcore photonic crystal fiber (H-PCF). The Raman transition is pumped by a narrow linewidth (~50 KHz) 1064 nm fiber CW laser. The probe light is produced by a homebuilt CW optical parametric oscillator (OPO), tunable from around 800 nm to 1300 nm.

TuR8-22 Invited 18:00-18:30

On-chip nonlinear generation and quantum tomography of entangled photons
A.A. Sukhorukov, Australian National Univ, Australia

We present the theoretical concepts and experimental results on the generation and characterization of photon-pair states with reconfigurable quantum entanglement in integrated nonlinear photonic structures.

TuR8-23 18:30-18:45

One-way quantum key distribution scheme
A.V. Dupinskii, V.V. Ustinchik, V.V. Kurochkin, 1 - Russian Quantum Center, 2 - Moscow Inst. of Physics and Technology, Russia

We report the quantum key distribution (QKD) demonstration over a standard optical singlemode fiber, implementing the BB84 phase-coding protocol via two-pass optical scheme. To achieve the goals we report we used self-developed electronics.

TuR8-24 18:45-19:00

Testing of quantum key distribution system with real optic-fiber communication line
A.V. Losev, A.V. Miller, A.S. Sokolov, A.A. Kanapin, V.V. Kurochkin, Russian Quantum Center, Russia

We report the quantum key distribution (QKD) demonstration over a standard optical singlemode fiber, implementing the BB84 phase-coding protocol via two-pass optical scheme. To achieve the goals we report we used self-developed electronics.

TuR8-25 19:00-19:15

Development and characteristics measurement of single photon detectors, based on InGaAs/InP avalanche photodiodes, designed for quantum communication lines
S.V. Zaitev, A.V. Miller, A.V. Losev, V.V. Kurochkin, V.V. Kurochkin, 1 - FemtoVision Company, 2 - Russian Quantum Center, Russia

The detector, which is used further, designed for single photon detection of 1550nm wavelength, was developed as part of the project: «Creating a quantum device prototype for secure data transmission». The detector is based on the InGaAs/InP avalanche photodiodes, which are used in this study. The report contains discussions of the detectors construction, its structural and functional schemes, and certain working features in Geiger mode and free-running mode, with a delay timer after every registered pulse, and without it.

TuR8-26 Invited 19:15-19:45

The brave new world of ultrafast optics in the mid-infrared

Our studies reveal unique properties of midinfrared filaments, where the generation of powerful midinfrared supercontinuum is accompanied by unusual scenarios of optical harmonic generation, giving rise to remarkably broad frequency range. Stretching light from visible to the midinfrared, filamentation-assisted pulse compression in the gas phase is shown to enable the generation of sub-10fs few-cycle pulses in the mid-infrared. Generation of low-energy and even single-cycle midinfrared field waveforms with peak powers ranging from a few megawatts to hundreds of gigawatts has been demonstrated within a broad range of central wavelengths.
Self-catalyzed growth of GaAs nanowires on silicon by MBE growth and optical properties of GaN nanowires on silicon substrate.

TuR9-02 Invited

Semiconductor nanostructures for lasers and optoelectronics applications

Ch. Jagodish; Australian National Univ., Australia

In this talk I will discuss about the synthesis of nanostructures and their characterization and device fabrication and testing. Role of plasmonic cavities in improving the quantum efficiency of nanostructures will be discussed. Strengths and weaknesses of each of these nanostructures will be presented and future perspective will be provided.

TuR9-03 Invited

Growth of organized III-V nanostructures for quantum technology and energy applications

A. Fontcuberta i Morral, Laboratory of Semiconductor Materials, Inst. of Materials, Ecole Polytechnique Fédérale de Lausanne, Switzerland

Nanowires are filamentary crystals with a tailored diameter ranging from few to ~100 nm. The special geometry and reduced dimensions of these nanowires results in interesting optical and electrical properties and provides a great potential for many applications of the XXI century. In this talk we will first review the growth mechanisms of Ga-assisted growth of GaAs nanowires by molecular beam epitaxy. We will follow by elucidating the photonic properties of single nanowires standing and lying on a substrate to show how they can be used for quantum science and technology and energy harvesting applications.

TuR9-04

Self-catalyzed growth of GaAs nanowires on silicon by HVPE

Zh. Dong1,2, Ya. Andre1,2, V. Dubrovskii1,2, C. Bougerol2, G. Monier1,2, R. Ramdani1,2, A. Trassoudaine1,2,8, Ch. Leroux9,10, D. Castelluci1,2, E. Gil1,2,3; 1 - Inst. Pascal, France, 2 - CNRS, UMR 6600, France, 3 - Ioffe Inst., Russia, 4 - St. Petersburg Academic Univ., Russia, 5 - Ioffe Inst., Russia, 6 - Univ. Grenoble Alpes, France, 7 - CNRS, Inst. Néel, France, 8 - Univ. d’Auvergne, France, 9 - Univ. du Sud Toulon-Var, France, 10 - CNRS, UMR 6249, France

We report on the first self-catalyzed growth of GaAs nanowires on patterned and non-patterned silicon (111) wafers by hydride vapour phase epitaxy (HVPE) with a record elongation rate of 30 μm/h. The crystalline structure was analyzed using high resolution transmission electron microscopy (HRTEM). Self-catalyzed growth proceeds under gallium rich conditions at low-temperature (600° C). Nanowires exhibit cylindrical rod-like shape morphology with a mean diameter of 50 nm and are randomly distributed.

TuR9-05

MBE growth and optical properties of GaN nanowires on SiC/Si(111) substrate

R.R. Reznik1,2, K.P. Kotlyar2, I.V. Ilkiv1,2, I.P. Soshnikov1, S.A. Kukushkin6, A.V. Osipov6, A.V. Uskov1,2, I.V. Smetanin1, I.E. Protsenko1, J.B. Khurgin3, M. Buret4, A. Bouhelier4; 1 - Inst. Pascal, France, 2 - CNRS, UMR 6600, France, 3 - Ioffe Inst., Russia, 4 - ITMO Univ., Russia, 5 - St. Petersburg Academic Univ., 3 - Ioffe Inst., Russia, 4 - Inst. for Analytical Instrumentation RAS, 5 - St. Petersburg State Univ., 6 - Inst. of Problems of Mechanical Engineering RAS, Russia

The fundamental possibility of the growth of GaN nanowires by molecular-beam epitaxy on a silicon substrate with nanoscale buffer layer of silicon carbide has been demonstrated for the first time. Morphological and spectral properties of the resulting system have been studied and compared properties of GaN nanowires on silicon substrate.

- Coffee Break -
A. Povolotckaia, A. Povolotskiy, A. Manshina; 1 - Stoletov Vladimir State Univ., present the design, capabilities, scope of operation and installation schedule. At its core is an optical parametric amplifier optimized for 800nm emission. We burst-mode, emitting milli-Joule class few-cycle pulses at MHz repetition rates. Future experiments at the European XFEL. Like the XFEL, the laser operates in continuous-wave mode-locking.

We present a versatile and flexible ultrafast optical laser setup, developed for almost all the technical and scientific disciplines that are shaping our daily life. The setup is under construction in Germany. The facility will generate new knowledge in almost all the technical and scientific disciplines that are shaping our daily life.

In this work a method for the laser formation of C-Au-Ag clusters and complexes on the surface of an optically transparent media is discussed. In this work a method for the laser formation of C-Au-Ag clusters and complexes on the surface of an optically transparent media is discussed.

We have experimentally studied saturation behavior of Single-Walled Carbon Nanotube-based saturable absorbers at different temperatures and SWCNT concentrations in the carboxymethylcellulose polymer matrix and related it to the mode-locked erbium-doped fiber laser performance.

High-sensitivity side-coupled symmetric-shaft-shape crystal sensor arrays
Zh. Fu, J. Zhou, L. Huang, F. Sun, H. Tian; Beijing Univ. of Posts and Telecommunications, China

High-sensitivity side-coupled symmetric-shaft-shape crystal sensor arrays (SSPhCSAs) consisting of four cavities side-coupled to a W1 waveguide are designed. The sensitivities of the four sensor units are from 178 to 398 nm/RIU.

TuR9-12 Laser formation of the metal-carbon islands thin films for optical application

In this work a method for the laser formation of C-Au-Ag clusters and complexes on the surface of an optically transparent media is discussed.

TuR9-13 Saturation parameters studies of carbon nanotube-based thin-film saturable absorbers for erbium fiber laser mode-locking

We have experimentally studied saturation behavior of Single-Walled Carbon Nanotube-based saturable absorbers at different temperatures and SWCNT concentrations in the carboxymethylcellulose polymer matrix and related it to the mode-locked erbium-doped fiber laser performance.

TuR9-14 Novel hybrid materials based on various oxyquinoline organic phosphour compounds and oxyfluoride glass
M.E. Anurova, C.V. Ermaoleva, O.V. Petronova, A.V. Khamyakov, A.A. Akkuzina, R.I. Avetisov, I.C. Avetisov; Mendeleev Univ. of Chemical Technology, Russia

Novel luminous organic-inorganic hybrid materials were synthesized by high temperature reaction between metalorganic phosphors and glass. In the present research we used a lead fluoroborate glass as an inorganic matrix and various luminous oxyquinoline complexes as organic active agent.

TuR9-15 Laser correlation spectroscopy and nonlinear magnetooptic response of structures formed by nanoparticles in magnetic fluid

Investigations of the agglomeration process in liquid nanostructured materials (magnetic fluids) and its effect on their optical properties are presented.

TuR9-16 Laser correlation spectroscopy and nonlinear magnetooptic response of structures formed by nanoparticles in magnetic fluid

Investigations of the agglomeration process in liquid nanostructured materials (magnetic fluids) and its effect on their optical properties are presented.
**R10. FREE ELECTRON LASERS**

**TuR10-04** Invited 11:30-12:00

**The FERMI free-electron lasers**
Luca Giannesi; Elettra-Sincrotrone Trieste S.C.p.A., ENEA C.R. Frascati, Italy

The injection of an external seed to initiate the FEL amplification in a free electron laser is a concept initially introduced to improve the source spectral brightness. In the framework of the 4th generation light sources, FERMI was built with this unique distinguishing feature. We will provide an overview of the main recent developments seeded FEL facility.

**TuR10-05**

**Tunable ultrafast laser system for seeded XUV FEL**
P. Cinguarra, M.B. Danailov, A. Demidovich, G. Kuri, I. Nikolov, P. Sigalotti; Elettra – Sincrotrone Trieste, Italy

Description of an ultrafast Ti:Sa based laser system used for seeding an FEL facility and for pump-probe experiments.

**TuR10-06**

**Temporal characterization of FEL pulses**
R. Ivanov, S. Düsterer, G. Brenner, S. Dzierzkoptycki; Deutsches Elektronen-Synchrotron DESY, Germany

We used a terahertz (THz) field driven streak camera with capabilities to deliver the pulse duration and the arrival time information with around 10 fs resolution for each single XUV FEL pulse at FLASH. The setup was operated simultaneously with an alternative method to determine the FEL pulse duration based on spectral measurements. A comparison will be shown.

**TuR10-07** Invited 12:30-13:00

**Novosibirsk high-power THz FEL facility**

Novosibirsk free electron laser (FEL) facility contains three FELs operating in the wavelength range 8 – 240 micron at average power up to 0.5 kW and peak power about 1 MW. Radiation users works at 6 user stations performing biological, chemical, physical and medical research.

**TuR10-08**

**Analytical approximate methods in optimization of optical systems for free-electron lasers**
V.V. Kubarev; Budker Inst. of Nuclear Physics RAS, Novosibirsk State Univ, Russia

Analytical approximate methods in optimization of various optical resonators and transport beamlines for free-electron laser (FEL) were presented. Small signal gain, losses, optimal output coupling, and output FEL power are written as simple clear analytical functional of geometrical parameters of the FELs optical systems.

- Lunch Break -

**TuR10-09** Invited 15:00-15:30

**Solid state spectroscopy with THz free electron lasers**
M. Helm; Helmholtz-Zentrum Dresden-Rossendorf, Germany

Some applications of infrared and THz free electron lasers in solid state spectroscopy are discussed. In particular, nonlinear experiments on semiconductor quantum well excitons and pump-probe studies on carrier relaxation in graphene are presented.

**TuR10-10** Invited 15:30-16:00

**Science frontiers @ FERMI**
C. Masciovecchia; Elettra – Sincrotrone Trieste, Italy (will be presented by M. Danailov; Elettra – Sincrotrone Trieste, Italy)

The most recent light sources, extreme ultraviolet (EUV) and X-ray free electron lasers (FELs), have extended tabletop laser experiments to shorter wavelengths, adding element and chemical state specificity by exciting and probing electronic transitions from core levels. Through their unique properties, combining femtosecond X-ray pulses with coherence and enormous peak brightness, the FELs have enabled studies of a broad class of dynamic phenomena in matter that crosses many scientific disciplines and have led to major breakthroughs in the last few years.

**TuR10-11** Invited 16:00-16:30

**Time-resolved X-ray spectroscopy with free-electron lasers**
W. Wurth; Univ. of Hamburg, DESY Photon Science, Germany

We present the results and prospects for time-resolved photoelectron spectroscopy and time-resolved resonant inelastic X-ray scattering. We discuss on free electron lasers FLASH and European XFEL and their application to X-ray spectroscopy techniques.

**TuR10-12** Invited 16:30-17:00

**Imaging single cells in a beam of live cyanobacteria with an X-ray laser**
G. van der Schot, T. Ekeberg, J. Hajdu; Uppsala Univ., Sweden

Femtosecond diffractive imaging with X-ray free-electron lasers (XFELs) has the potential to achieve sub-nanometer resolution on micron-sized living cells. We developed an injection method that can image millions of living cells per day. We show that it is indeed possible to record scattered signal beyond 4 nm resolution. Detector saturation limited our image reconstructions to 76 nm.

**TuR10-13**

**Reduction of graphene oxide films by soft UV irradiation**

We have studied the UV reduction process of thin graphene oxide films, deposited on silicon substrate from ethanol suspension. Chemical structure of obtained material was analyzed by XPS method. TEM images showed holes formation during reduction process, that are connected into network. Films with observed structure have great variety of possible future applications, such as gas-sensors and different organic/nanorganic nanoocompites.
The plane cavity Nd:YAG master oscillator (MO) was passively Q-switched. The amplifier consisted of Nd:YAG active media in a ring cavity with two passes and polarization decoupling. The MO/PA system was used as a source for a space-based altimeter-roll stabilizer to control spacecraft landing process. The polarizer decoupler finite contrast leads to the parasitic lasing effect which acts as a seeding signal for the MO causing instabilities in the system output.

End pumped CW Nd:YAG amplifier for low power stable single-frequency laser was built and investigated. High extraction efficiency ~30% in double-pass amplifier is achieved due to high small-signal gain provided with longitudinal pumping. Pumping of amplifier is near uniformly distributed along 2 laser rods with low concentration using two-lens relay between them in order to decrease end overheating.

In this work the minimization of gain narrowing in Yb doped all-in-fiber crystal was investigated. Spectral filtering technique using fiber Bragg grating filter with desired transmission spectrum was demonstrated.

We present results of experimental investigation of chirped pulse amplification in a single and double-pass Yb:YAG crystal amplifier seeded with fiber laser pulses of 480 ps FWHM and ~350 mW average power at 100 kHz. High brightness fiber coupled laser diodes of 50 W power at 940 nm were used in a single and dual end-pumping geometry.

Since the thermo-optical distortions have a significant impact on the output characteristics of the laser, it is necessary to their detailed study. Investigation method of thermo-optical distortions in solid-state lasers was developed and presented. The method can be easily used for research of small diameter active elements.

Laser oscillator based on Cr2+:CdSe single crystal pumped by repetitively-pulsed Tm3+:Lu2O3:Ce3+ ceramics lasers was created and investigated. Repetitively-pulsed oscillations at the wavelength of 2.92 μm with bandwidth of 80 nm were demonstrated. The output power was up to 3W at 15-30 kHz repetition rate with the pulse duration of ~40-300 ns in the good-quality beam.

In eye-safe ring optical parametric oscillator based on KTIOPO4 crystal the crystal placed first in the path of pump radiation is subjected to the strongest thermal distortion caused by idler absorption. For the 10-Hz 35-mJ OPO, thermally induced lenses generate an increase in the signal beam divergence by 10% and moderate decrease in the signal energy.

Compact laser schematics for generation of stable subnanosecond pulses with energy up to 1J. The study was to develop high-power stable Nd:YAG master oscillator for MOPA laser system. Output power of 4.5 W was achieved with 30 W of pump power for wide range of Q-switched lasing repetition rate. 15ns@300Hz lasing of 10 ns pulses was achieved after optimization.

The amplification of transform-limited pulses in media with homogeneously broadened line. We propose the model of the amplification of the transform-limited pulses in a homogeneously broadened medium. The model provides the information about the output characteristics of an unchirped pulse after passing through an active homogeneously broadened medium and about the population inversion inside the medium at some time.

A parametric amplification unit based on nonlinear borate crystals for multiterawatt femtosecond laser system. The calculation of parametric amplification unit based on nonlinear borate crystals for multiterawatt femtosecond laser system has been carried out. A gaussian gain profile with ~20% dip near the center is proposed to optimize the amplified signal spectral shape. Optimal parameters of the noncollinear type 1 BBÖ-based parametric amplifier were established.
R9. OPTICAL NANOMATERIALS

TuR9-p01 Precision UV vacuum spectral reflectivity test system
Y. Jiang, Sh. Xu, Engineering Univ. of CAEP, China
The optical reflectance of the remote sensing instrument must be calibrated in vacuum conditions before being launched. The system to test the reflectivity of less than 280 millimeter diameter optical element in vacuum is constructed and consist of a light source, the Seya-Namioka vacuum visible monochromator, the sample room as the main structural and electronic system components. The monochromator's work band is from 160 nm to 780 nm, spectral resolution is 0.5 nm. Dual optical compensation method is used to eliminate the source of time drift, improve the measurement accuracy with phase-locked weak signal amplification method. To ensure the precision detection, the phase-sensitive detector function can be adjustable. The output value is not more than 10 mV before each measurement, so it can be ensured that the stability of the measured radiation spectrum is less than 1 percent. The reflectivity test results show that the wavelength accuracy is 0.1 nm, and the wavelength repeatability is 0.035 nm, it high-precision measurement of optical components under vacuum body can be achieved.

TuR9-p02 THz waveguide in asymmetric graphene-SiC hyperbolic metamaterial
O.N. Kozina1, L.A. Melnikov2, A.S. Zotkina3, I.S. Nefedov2, 1 - Kotel’nikov Inst. of Radioengineering and Electronics RAS, Saratov Branch, Russia, 2 - Gagarin State Technical Univ, Russia, 3 - Aalto Univ, Finland
Investigation of the THz radiation propagation in hyperbolic graphene-semiconductor metamaterial is presented. Anisotropy of the hyperbolic media slab was taken into account. The 4x4 Berreman matrix method was adopted for arbitrary orientation of optical axis according to slab boundary.

TuR9-p03 Laser-assisted deposition of the bimetal thin films with pre-defined optical and electrical properties
S. Khotrova1, A. Antipov1, S. Arakelian1, V. Kucheren1, A. Ozgur2, T. Vartanyan1, 1 - Kotel’nikov Inst. of Radioengineering and Electronics RAS, 2 - Max-Planck-Institut fuer Festkuerperforschung Stuttgart, Germany
In this work, we investigated the influence of morphology (particle diameter in the colloid, the distance between the deposited particles, the number of layers etc.) on the optical and electrical properties of the deposited thin film of bimetallic clusters.

TuR9-p04 Search of optimal conditions of Nd:Y2O3 nanopowder synthesis by using a powerful fiber ytterbium laser
G.S. Evtushenko1, V.V. Lisnensk1, V.V. Osipov1, V.V. Platonov1, A.V. Podkory1, A.V. Spirina1, E.V. Trukhanov1, M.V. Trubel2, K.V. Fedorov2, 1 - Inst. of Electrophysics UB RAS, 2 - Zvezda Inst. of Atmospheric Optics SB RAS, 3 - National Research Tomsk Polytechnic Univ., Russia
We investigated the evaporation of the 1%Nd:Y2O3 with the help of 600W fiber laser and the synthesis by this method 1%Nd:Y2O3 nanopowder. It is shown that in microwave 200Km/s substance from the target is removed only by evaporation, but then also begins the spray droplets. These data helped to increase the productivity of this powder and its output with 15g/h to 23g/h and from 9wt.% to 30 wt.%, respectively.

TuR9-p05 The influence of the dipole-dipole interaction on the radiative properties of point-like impurity centers in Fabry-Perot microcavity
A.S. Kurupets, I.M. Sokolov1, Peter the Great St. Petersburg Polytechnic Univ, Russia
We analyze the role of the dipole-dipole interaction between point-like impurity centers inside a Fabry-Perot microcavity on its radiative characteristics. The spontaneous decay dynamics is calculated and cooperative effects are analyzed. The results are compared with the case of absence of the cavity and the difference is discussed.

TuR9-p06 Light-matter coupling in nonideal array of coupled microresonators with quantum dots
V.V. Rumyantsev1, 2, A.A. Polohin1, Yu.P. Shaman3, 1 - Kotel’nikov Inst. of Radioengineering and Electronics RAS, Russia, 2 - Mediterranean Inst. of Fundamental Physics, Italy, 3 - National Research Univ. of Electronic Technology, Russia
A numerical model is developed for a defect-containing lattice of microcavities branch polaritons as well as their densities of states are evaluated. The results are compared with the case of absence of the cavity and the difference is discussed.

TuR9-p07 Temperature dependent optical properties of the titanium nitride broadband perfect absorber
J. Wang, M. Zhu, J. Shao, Shanghai Inst. of Optics and Fine Mechanics CAS, China
The temperature dependence of the absorber based on the titanium nitride and titanium dioxide layer is investigated by finite difference time domain simulation. It is shown the absorption is larger than 0.98 from 550nm to 715nm. The intensity of absorption will reduce and the peak will be blue-shift when the temperature is increased from 18°C to 325°C.

TuR9-p08 Matrix photoreceiver based on carbon nanotubes for control laser radiation
E.V. Blagov1, A.A. Polohin2, A.A. Gerasimenko1, A.A. Polov1, Yu.P. Shaman1, 1 - National Research Unive of Electronic Technology, 2 - Inst. of Nanotechnology of Microelectronics and Photonics, Russia, 3 - Kotel’nikov Inst. of Radon-engineering and Electronics RAS, 4 - Scientific-Manufacturing Complex «Technological Centre», Russia
This work is aimed at the development of the new matrix photoreceiver. Photoreceiver is a matrix of 16 sensitive elements and each has 10000 sensitive area with synthesized carbon nanotubes. The parameters of matrix photoreceiver based on carbon nanotubes, such as working wavelength range, performance and sensibility were studied.

TuR9-p09 IR and Raman spectroscopy of biocomposite with carbon nanotubes
A.A. Polonich1, L.P. Ichkidze2, A.A. Polav1, Yu.P. Shamar1, A.A. Gurasyenko1, 1 - National Research Unive of Electronic Technology, 2 - Inst. of Nanotechnology of Microelectronics and Photonics RAS, 3 - Scientific-Manufacturing Complex «Technological Centre»/Laboratory of perspective processes, Russia
This work is aimed at spectral research of composite based on simplewall carbon nanotubes in matrix of bovine serum albumin (biocomposites). Biocomposites

TuR1-p18 High power and high repetition rate picosecond Nd:LuVO4 laser
X. Liang, P Gao; Shanghai Inst. of Optics and Fine Mechanics CAS, China
We developed a high average power and high repetition rate picosecond laser based on crystal of Nd:LuVO4. The Maximum average power of 28 W is obtained at the repetition rate of 58 MHz. With a cavity dumping technique, the pulse energy is scaling up to 40.7 μJ at 300 kHz, and the shortest pulse duration is 6.0ps.

TuR1-p19 Two microns Y2O3:Tm ceramic laser upon diode pumping
A.N. Chabushkin1, 2, A.A. Polov1, Yu.L. Kopylov1, V.V. Balashov1, K.V. Lupikhin1, 1 - Ogarev Mordovia State Univ., 2 - Kotel’nikov Inst. of Radioengineering and Electronics RAS, Russia
We demonstrate laser experiments of thulium-doped Y2O3 ceramics. The continuous-wave laser have been obtained for Y2O3:Tm ceramics at 1.95 μm and 2.05 μm pumped by a diode laser emitting at 808 nm.

TuR1-p16 Diode-pumped continuous wave Tm:KLu(WO4)2 and Tm:KY(WO4)2 microchip lasers
O.P. Deminovich1, S.V. Kurichik2, N.V. Glubed Photochemistry and Laser Res, Russia, 3 - Kotel’nikov Inst. of Inorganic Chemistry SB RAS, Russia
Laser performance of Tm+ doped KLu(WO4)2 and KY(WO4)2 crystals was investigated in a microchip cavity configuration with fiber coupled laser diode as a pump source. The highest output power of 1013 mW with 51 % slope efficiency was obtained for Tm:KY(WO4)2 crystal. Using Tm:KLu(WO4)2 crystal output power of 912 mW and slope efficiency of 38 % were achieved.
TuR9-p10 15:00-19:00
The copper nanostructures produced by in situ laser synthesis reveal catalytic activity
T.S. Stepanova, A.V. Khomyakov; Mendeleev Univ. of Chemical Technology, Russia
The laser-induced metal deposition technique attracts a great interest not only due to its application in microelectronics and manufacturing of electronic sensors but also due to its possible implementation for in situ laser synthesis of nanostructured metal catalysts directly in the reaction mixture. The synthesized nano-sized metal structures may take part in organic catalysis using solvent as a reaction medium.

TuR9-p11 15:00-19:00
The nanostructured membrane investigation by optical methods
A.A. Mikhaylova1, A.V. Prikhodko2, O.I. Konkor2, N.N. Rozhkova1; 1 - Inst. of Geology Karelian Research Centre RAS, 2 - Peter the Great St. Petersburg Polytechnic Univ., 3 - Ioffe Inst., Russia
The known technology for producing fullerene membrane was applied to the natural carbon material. The basic structural elements of shungite carbon have been identified in the prepared nanostructured sample by optical methods.

TuR9-p12 15:00-19:00
The electric-dipole transitions in an emitter
K.K. Pukhov, General Physics Inst. RAS, Russia
Here we present the theoretical study of the electric-dipole emission rate modification of the luminescence centers inside and outside of the subwavelength core-shell nanoparticles.

TuR9-p13 15:00-19:00
Quantum dots luminescence in the photonic crystal fibers modified with polymer layers
S.A. Pidenko, S.D. Bondarenko, A.A. Chibrova1, A.A. Shulavtsov2, N.A. Burmistrova1, Y.S. Skibina1, I.Y. Goryacheva1; 1 - Saratov National Research State Univ., 2 - SPU Nanostructured Glass Technology Ltd, 3 - Saratov National Research State Univ., 5 - St.Petersburg State Univ., Russia
The luminescence of the quantum dots of different colors glow in the samples of photonic crystal fibers modified with self-organizing layers of polyvinylamine was studied. The fluorescence decay lifetime of dye in asbestos is longer that in chrysotile asbestos. As a result of increased toxic gas production in chemical industry and its influence on human health an effective detection of CO2, NO, NO2, NH3, and other gases are studied. The fluorescence decay lifetime of dye in asbestos is longer that in chrysotile asbestos. As a result of increased toxic gas production in chemical industry and its influence on human health an effective detection of CO2, NO, NO2, NH3, and other gases are studied.

TuR9-p14 15:00-19:00
NO2 gas sensor based on Au-tZnPc-OH Langmuir-Blodgett glassy film
D.M. Krivchesky1, A.V. Zasedatelev1, A.Yu. Tolbin1, T.V. Dubinina2, V.I. Krasovskii3, A.B. Karpova1; 1 - National Research Nuclear Univ. «MEPhI», 2 - Lomonosov Moscow State Univ., 3 - NITIOM Vavilov State Optical Inst., Russia
As a result of increased toxic gas production in chemical industry and its influence on human health an effective detection of CO2, NO2, NOH3, and other gases becomes a crucial task in environmental safety. The most spread gas sensors are based on thin films, but these films have some drawbacks, such as low selectivity and high power consumption. In contrast, optical sensors are potentially more selectable and have fast response time. Optical gas sensors based on organic thin films can operate at room temperatures without external thermal stabilization. Among promising starting compounds for NO2 gas detection phthalocyanines (Pc) have found good application due to their thermal and chemical stability, as well as low production costs.

TuR9-p15 15:00-19:00
Eu3+-doped transparent lead fluoroborate glass-ceramics
T.S. Stepanova, E.V. Zhukova, A.V. Khomyakov, O.B. Petrova; Mendeleev Univ. of Chemical Technology, Russia
Lead fluoroborate glasses doped with Eu3+ were synthesized. Glass-ceramics were made by heat-treatment. In a glass-ceramic the rare-earths ions were located in fluoride crystal nanoparticles distributed in a borate glass. The changes in structural, mechanical and optical properties of the glass-ceramic were revealed in comparison with the initial glasses. Structural, optical and spectral properties of Pb1-xEuxF2+x polycrystalline were investigated.

TuR9-p16 15:00-19:00
Yb3+-doped glasses and glass ceramics based on Bi2O3 and GeO2 in different proportions
T.V. Stepanova, A.V. Khomyakov; Mendeleev Univ. of Chemical Technology, Russia
The glass ceramics was produced by heat-treatment of xBi2O3-(1-x)GeO2 glasses doped with Yb3+. Both glasses and glass ceramics were researched by X-ray diffraction analysis, optical and luminescence spectroscopy methods. The glass ceramics contain xBi2O3-(1-x)GeO2 crystals or Bi2GeO5+Bi4Ge3O12 phases according to initial oxides ratio. It's shown that spectral properties depend on only Yb3+ ions concentration and do not affected by glass matrix.

TuR9-p17 15:00-19:00
Synthesis condition influence on stability of metal-organic phosphor based on 8-hydroxyquinoline
A.V. Akhutina, A.V. Khomyakov, R.E. Avetisov, I.Ch. Avetissov; Mendeleev Univ. of Chemical Technology, Russia
8-Hydroxyquinoline (8-Hq) powders were synthesized under controlled 8-Hq partial pressure. It was showed that the ph-Hq increase resulted to changes in the photoluminescence characteristics and the life-time of the 8-Hq phosphor.

TuR9-p18 15:00-19:00
Synthesis and study of efficient up-conversion luminophores based M1-x-yYbxEryF2+x+y (M = Ca, Ba) for biomedical applications
M.N. Mayakova1, E.O. Soloylova1, R.G. Vahrenev1, S.V. Kuznetsova1, D.V. Pominova1; 1 - Prokhorov General Physics Inst. RAS, 2 - Mendeleev Univ. of Chemical Technology, 3 - Lomonosov Moscow State Univ., Russia
Tris(8-hydroxyquinolino) aluminum (Alq3) powders were synthesized under controlled 8-Hq partial pressure. It was shown that the ph-Hq increase resulted to changes in the photoluminescence characteristics and the life-time of the Alq3 phosphor.

TuR9-p19 15:00-19:00
New type of nanocomposite material for SERS
N.V. Mititea, A.I. Myadykovskiy, S.E. Syvakokhivskyi, A.A. Tepano, A.D. Gartman, T.V. Murzina; Lomonosov Moscow State Univ., Russia
We experimentally observe effects of second harmonic generation, nonlinear absorption in porous quartz with metallic nanoparticles in order to find a possibility to make a new device for SERS-experiments.

TuR9-p20 15:00-19:00
The obtaining and deposition of silicon nanoparticles: size control, luminescence in visible spectra
A. Osipov1, A. Kucherik1, S. Katroosky2, A. Elyukh2, B. Chichkov2; 1 - Stoloka Vladimiri State Univ., Russia, 2 - Laser Zentrum Hannover e.V, Germany
In this work we have used a CW-laser ablation for nanoparticle synthesis. Laser ablation allow to control particle sizes according to the irradiation parameters. For the particle deposition we have used the nanosonde laser. This method of deposition allows to sediment the silicon clusters very precisely.

TuR9-p21 15:00-19:00
Optical properties of cyanine dyes in the nanoporuous chrysotile asbestos
A.A. Starovoytov1, V.I. Belotatski2, Yu.A. Kumzerova1, A.Yu. Sysoev1; 1 - ITMO Univ., 2 - Ioffe Inst., Russia
The optical properties of the cyanine dye in nanotubes of the chrysotile asbestos are studied. The fluorescence decay lifetime of dye is longer that in films, due to hindrance of stereoisomerization in the excited state. Observed linear dichroism and fluorescence anisotropy indicate that embedded dye molecules are well-isolated monomer oriented predominantly along asbestos nanotubes.

TuR9-p22 15:00-19:00
Novel transparent glass-ceramics based on CoLi(Al,Ga)5O8 nanocrystals for passive Q-switching of Er lasers
O.S. Dymshtis1, A.A. Zhilin1, P. Alesskeeva, M.Ya. Tsenter1, А.М. Малыреч1, K.V. Yumashev2, V.V. Vitkin3, P.A. Loiko1, N.A. Skoptsov1, K.V. Bogdanov1, I.V. Gladunov1; 1 - NITIOM Vavilov State Optical Inst., Russia, 2 - Belarusian National Technical Univ., Belarus, 3 - ITMO Univ., Russia
Transparent glass-ceramics of the lithium gallium aluminosilicate system based on cobalt-doped Li(Al,Ga)5O8 spinel nanosized crystals were developed. Their structure and optical properties were evaluated. Passive Q-switching of an Er, Yb:glass laser with 1 mJ/45 ns pulses at ~1.54 µm is realized.

TuR9-p23 15:00-19:00
Photodesorption of Rb atoms from glass and sapphire surfaces
A.A. Akkuzina1, A.V. Pazgalev2, T.A. Vartanyan1; 1 - ITMO Univ., 2 - Ioffe Inst., Russia
We presents results of ours researches and calculations of dependence between kinetic energy of desorbed atoms and desorb pulse wavelength.

TuR9-p24 15:00-19:00
Glass-ceramics with Yb,Tm:YNbO4 nanocrystals: novel NIR-to-NIR upconversion phosphor
E.V. Vileshkova1, P.A. Loiko1, O.S. Dymshtis1, A.A. Zhilin1, P. Alesskeeva1, M.Ya. Tsenter1, K.V. Yumashev1, I.V. Gladunov1; 1 - NITIOM Vavilov State Optical Inst., Russia, 2 - Belarusian National Technical Univ., Belarus, 3 - ITMO Univ., Russia
Transparent lithium aluminosilicate glass-ceramics containing nanosized (8-15 nm) crystals of rare-earth orthoironobates, Yb,Tm:YNbO4, and β-quartz solid solutions are synthesized. Under the near-IR excitation by an InGaAs diode, these demonstrate intense near-IR upconversion luminescence at ~800 nm. The efficiency of Yb3+ to Tm3+ energy transfer is ~90%.
A compact high repetition rate eye-safe laser for atmosphere lidar was developed. The device is Nd:YAG laser with KTP OPO, wavelength is 1.57 μm, Q-switched pulse energy is 1.1 mJ and pulse duration is 10 ns. The laser rod and laser diodes are conductive cooled. The 100 Hz operation with good beam quality is demonstrated.
Session Chair: Vladimir E. Yashin, Vavilov State Optical Inst., Russia

**New generation of ultra-high peak and average power laser systems with thin disk Ti:sapphire amplifiers**

V. Chuykov1, H. Cao1, R.S. Nagymihaly1, M. Kalashnikov2, K. Osyv1, 1 - EL-Hu Nktf., Hungary, 2 - Max-Born-Inst., Germany

New technology utilized the combination Extraction During Pumping (EDP) method and thin disc amplifiers (EDP-TD) applied to PW-level Ti:Sapphire laser systems for increasing of the repetition rate will be presented. Proof-of-principle experiment results, when EDP-TD final amplifier was inserted in to 100TW/10Hz laser system will be discussed.

**Ab initio calculations of transition dipole moments of (O2)2 complex**

A.A. Pershin1,2, A.M. Mebel3, M.V. Zagidullin1,2, A.S. Insapov1, V.N. Azyazov1,2, Lebedev Physical Inst. of RAS, Russia

Theoretical studies of collision induced emission of singlet oxygen molecules in the visible range have been performed. The experimental results were rationalized in terms of ab initio calculations of the ground and excited potential energy and transition dipole moment surfaces of singlet electronic states of the (O2)2 dimer, which were utilized to compute rate constants.

**Impact of water vapor concentration on O2(a) yield in CO2 laser systems**

V. Smirnov, O. Mokhun, L. Glebova, O. Mokhun, R. Vasilyev, A.L. Glebov, L.B. Glebov, OptiGrate Corp, United States

We report on an all-fiber integrated laser oscillator with a maximum output of 2kW operating at 1080nm. The laser oscillator is single-end pumped by 976nm and 915nm laser diodes. It can overcome the relatively lower mode instability threshold while maintaining the relatively higher stimulated Raman scattering threshold. The influence of the pump power ratio on the maximum output power is also investigated.

**Volume Bragg Gratings (VBGs) in photo-thermo-refractive glass have outstanding properties in 2-micron spectral region providing extremely high spectral and angular selectivity, diffraction efficiency up to 99.99%**

This paper reviews recent VBG technology developments as well as various results on VBG applications that can lead to major improvements of fiber, solid-state, and diode laser system performance in 2-micron spectral range.

**High average power diode pumped solid state laser**

Y. Gao, Y. Wang, A. Chan, M. Dawson, B. Greene; EOS Space Systems Pty Ltd, Australia

A completely diode pumped high energy system capable of generating pulse energy 4.7J, beam quality M2~3, pulse width 10~20ns, repetition rate 100~200Hz has been developed. It is a fully automated multi-stage system consisting a pulsed single frequency oscillator, pre-amplifiers, power-amplifiers, and SBS cell. The system has been in service for almost 2 years with excellent performance and reliability.
Brillouin and Raman scattering in silicon and silicon nitride photonics integrated circuits
R. Boets; Ghent Univ., Belgium
Silicon photonics has gained considerable momentum as a platform for the on-chip integration of advanced photonics functions on the basis of CMOS-technology, especially in the fields of telecom and datacom. Here we report on the use of this platform for photon-phonon interaction in nanophotonic silicon or silicon nitride waveguides. We discuss the first demonstration of Brillouin gain in silicon waveguides as well as Raman spectroscopy taking advantage of silicon nitride photonics circuits.

WeR3-23
AFM visualization of half-disk WGM laser modes
P.A. Alekseev1, M.S. Dunavetskyi2, A.M. Manakov3, V.V. Dulevsky1, G.S. Sokolovskii1, A. Baranov4, R. Teissier4; 1 - Ioffe Inst., Russia, 2 - ITMO Univ., Russia, 3 - Peter the Great St. Petersburg Polytechnic Univ., Russia, 4 - Inst. d'Electronique du Sud, France
By means of atomic force microscopy (AFM) the spatial mapping of the laser intensity was performed on the cleavage of the whispering gallery modes (WGM) half-disk laser. The study was carried out in the near- and far-field regime. It showed a strong spatial divergence of different modes in the laser.

WeR3-24 Invited
Compact external cavity laser with photonic crystal cavity reflector
L. O’Faolain1, A.A. Liles2, A.P. Bakoz2, A.A. Gonzalez-Fernandez3, S.P. Hegarty2, 1 - Univ. of Glasgow, United Kingdom, 2 - Peter the Great St. Petersburg Polytechnic Univ., Russia, 3 - Aston Univ., United Kingdom
We investigate the applicability of use of Laguerre-Gaussian laser beams for optical biopsy. In current presentation a Monte Carlo based numerical simulation of complex vector light beams propagating that undergoing anisotropic scattering in turbid tissue-like scattering media will be presented in comparison with the plane wave light beams. Several basic phenomena associated with the anisotropic scattering of the vector light beams in turbid media are discussed, including the mutual influence of light's polarization and its directional awareness during the multiply scattering.

WeR3-25
Photonic crystal reflector laser
A.P. Bakoz1, A.A. Liles2, J.C. O’Farrel1, S.P. Hegarty2; 1 - Cork Inst. of Technology, Ireland, 2 - Tyndall National Inst., Ireland, 3 - Univ. of Oulu, Finland, 4 - Peter the Great St. Petersburg Polytechnic Univ., Russia
We report on conical refraction (CR) experiments with low-coherent light sources such as light-emitting diodes (LEDs) that demonstrated different CR patterns. Variation of the pinhole size from 25 to 100 μm reduced the spatial coherence of the LED radiation and resulted in disappearance of the dark Poggendorf ring. We describe our plans to reach TRL 5 by 2017. The laser system includes a low-noise oscillator followed by a power amplifier. The oscillator is a low-mass, compact 10 mW External Cavity Laser, consisting of a semiconductor laser coupled to an optical cavity, built by the laser vendor Redfern Integrated Optics. The amplifier is a diode-pumped Yb fiber with 2.5 W output, built at Goddard. We will show noise and reliability data for the full laser system, and describe our plans to reach TRL 5 by 2017.

WeR3-29
Development of a US laser system for the gravitational wave mission LISA
J. Camp, K. Numata; NASA Goddard Space Flight Center, United States
A highly stable and robust laser system is a key component of the space-based, Gravitational Wave mission LISA architecture. In this talk I will describe our plans to demonstrate a TRL 5 LISA laser system at Goddard Space Flight Center by 2017. The laser system includes a low-noise oscillator followed by a power amplifier. The oscillator is a low-mass, compact 10 mW External Cavity Laser, consisting of a semiconductor laser coupled to an optical cavity, built by the laser vendor Redfern Integrated Optics. The amplifier is a diode-pumped Yb fiber with 2.5 W output, built at Goddard. We will show noise and reliability data for the full laser system, and describe our plans to reach TRL 5 by 2017.

WeR3-26 Invited
Photonic crystal surface emitting lasers – coherent arrays and external feedback
R.J.E. Taylor1, G. Li2, P. Ivanov3, D.T.D. Childs4, B.I. Stevens5, N. Babazadeh6; 1 - Univ. of Oulu, Finland, 2 - Univ. of Tokyo, Japan, 3 - Univ. of Sheffield, United Kingdom
We investigate the applicability of use of Laguerre-Gaussian laser beams for optical biopsy. In current presentation a Monte Carlo based numerical simulation of complex vector light beams propagating that undergoing anisotropic scattering in turbid tissue-like scattering media will be presented in comparison with the plane wave light beams. Several basic phenomena associated with the anisotropic scattering of the vector light beams in turbid media are discussed, including the mutual influence of light's polarization and its directional awareness during the multiply scattering.

R3. SEMICONDUCTOR LASERS, MATERIALS AND APPLICATIONS

Location: Deyneka Room, floor 2, 9:00 – 11:00
Location: Deyneka Room, floor 2, 11:30 – 13:30

Coffee Break
Lunch Break
WeR3-32 Invited
15:00-15:30
Interband Cascade Lasers for sensing
K.A. Fedorova1,2, A.A. Gorodetsky1,2, R. Weih1; 1 - Univ. Würzburg, Germany, 2 - Univ. of St Andrews, United Kingdom

The Interband Cascade Laser (ICL) combines the interband transition as in a conventional diode laser with the cascading scheme of a Quantum Cascade Laser. ICLs allow for an external quantum efficiency greater than which is enabled because of the special band alignment of GaInSb/AIAs/InAs-interfaces that separates hole and electron injector and internally feed each cascade with carriers. This makes ICLs a unique with great design flexibility. By changing the InAs layer thickness of the typically used W-shaped quantum well (W-QW) the emission wavelength can be tuned within the entire mid infrared region which is known as the fingerprint region of a variety of industrially relevant molecules. We present our progress achieved in the field of ICL device research.

WeR3-33
15:30-15:45
Broadly tunable dual-wavelength InAs/GaAs quantum-dot laser for THz generation
A.N. Klochkov1,2, S.S. Pushkarev1; 1 - Inst. of Ultrahigh Frequency Semiconductor Electronics RAS, 2 - Moscow State Univ., Russia

We demonstrate an ultra-compact, room-temperature, continuous-wave, broadly-tunable dual-wavelength InAs/GaAs quantum-dot external-cavity diode laser in the spectral region between 1150nm and 1301nm with maximum output power of 280mW. This laser source, generating two modes with tunable difference-frequency (300GHz-30THz) has a great potential to replace commercially used bulky lasers for THz generation in photomixer devices.

WeR3-34 Invited
15:45-16:15
Generation of intense sub-100 fs pulses from Yb-doped solid-state lasers based on nanostructured semiconductor saturable absorbers
A. Major; Univ. of Manitoba, Canada

Results on dual action of semiconductor saturable absorber and Kerr-lens mode locking of Yb-ion doped solid-state lasers will be reported. Using both quantum-dot and quantum-well nanostructured semiconductor saturable absorbers, the developed approach enabled demonstration of record high performance of Yb:KGW and Yb:CALGO lasers among other Yb-ion materials in sub-100-fs regime with peak powers ranging from >100 kW to >1 MW.

WeR3-35
16:15-16:30
Generation of THz radiation in epitaxial InGaAs films on InP substrates of various crystallographic orientations
G.B. Galiev1, G.H. Kitaeva1, E.A. Klamo1, V.V. Karnikov1, K.A. Kuznetsov1, A.N. Klochkov1, S.S. Pushkarev1; 1 - Inst. of Ultrahigh Frequency Semiconductor Electronics RAS, 2 - Moscow State Univ., Russia

We study the THz wave generation by the time-domain spectroscopy method in low-temperature grown InGaAs layers on InP substrates with crystallographic orientations (100) and (411). It was found that the THz wave generation is 3-5 times more effective in the case of (411)A InP substrates as compared to the (100) substrates. In samples grown at high pressure of As4 generation of THz waves is more effective at low-frequency range less than 200 GHz.

WeR3-36
16:30-16:45
Wavelength-swept laser based on semiconductor optical amplifier for dynamic optical fiber sensors
M. Yong Jeon, J. Woo Park, M. Ock Ko; Chungnam National Univ., Republic of Korea

We report two kinds of wavelength-swept lasers based on semiconductor optical amplifier for dynamic optical fiber sensors. The wavelength-swept laser has a linear relationship that exists between wavelength and time. As an application using the wavelength-swept laser for dynamic optical fiber sensors, we measure a dynamic modulation frequency of the applied electric field using a nematic liquid crystal cell. The amplitude modulation frequency is measured up to 2.5 kHz.
WeR4-01 Invited Measurements of the second hyperpolarizability and nuclear rotational response of liquids and gases D.J. Hagan, M. Reichert, F. Zhao, E.W. Van Stryland, Univ. of Central Florida, United States
A beam deflection technique is used to separate the bound-electronic and molecular rotational components of nonlinear refractive transients of molecular gases. Coherent rotational revivals from air and carbon disulfide (CS2) vapor are identified. Dephasing rates, rotational and centrifugal distortion constants of each species are measured. Polarization-resolved studies allow unambiguous measurement of the bound-electronic nonlinear refractive index of air and second hyperpolarizability of CS2. Agreement between gas and liquid phase second hyperpolarizability measurements is found using the Lorentz-Lorenz local field correction.

WeR4-02 Invited Ultrafast modulators of light beams based on pristine or modified single-wall carbon nanotubes E.D. Obraztsova1, N.R. Arutyunyan1, P.A. Obraztsov1, E.P. Khartonovova2, D.-I. Liu3; 1 - Prokhorov General Physics Inst. RAS, Russia, 2 - National Taiwan Univ. of Science and Technology, Taiwan
In this work a procedure for formation of homogeneous thermostable composites “polyimide + single-wall carbon nanotubes” has been developed. With such composite (used as a saturable absorber) the mode-locking regime was realized in Yb fiber laser.

WeR4-03 Invited Two-dimensional semiconductors for nonlinear optical modulation J. Wang, Shanghai Inst. of Optics and Fine Mechanics CAS, China
Realized that the sizable and thickness-dependent bandgap offers transition metal dichalcogenides (TMDCs) a huge potential in the development of photonic devices with high performance and unique functions, we studied extensively the ultrafast NLO property of a range of TMDCs. TMDCs with high-quality layered nanosheets were prepared using liquid-phase-exfoliation technique. Ultrafast saturable absorption, two-photon absorption were observed from the 2D nanostructures.

WeR4-04 Invited Spectral shift of the transparency line of a semiconductor multilayer resonator under pulsed laser radiation A.A. Ryzhov1, E.I. Gacheva1, S.Yu. Mironov1, I.M. Belousov2, G.E. Tsyrlin3, A.K. Poteomkin1, V.V. Zelenogorsky1, A.V. Andrianov1, E.N. Borisov1, D.V. Venediktov1, V.Yu. Venediktov1,2, V.A. Ryzhov1,2, M.V. Balabas1, S.A. Pulkin1, E.N. Borisov1, D.V. Venediktov1, V.Yu. Venediktov1,2; 1 - St. Petersburg State Electrotechnical Institute “LETI”, Russia; 2 – St. Petersburg State Electrotechnical University, Russia
Multilayer microresonators are of interest as low-threshold nonlinear optical devices. Such a resonator for near IR in the form of GaAs/AlAs heterostructure was fabricated and tested. The spectral shift of its transparency line accompanied by the transmittance peak reduction was experimentally observed as a function of the laser pulse energy. Optical limiting characteristic of the resonator was measured as well.

WeR4-05 Invited Enhancement of optical limiting by polymer doping of aqueous nano-carbon suspensions A.V. Sokolov1, I.M. Kislyakov2, S.A. Povarov2, S.S. Polyanskaya2; 1 - ITMO Univ, Russia, 2 - Vavilov State Optical Inst, Russia, 3 - Univ. of Massachusetts Boston, United States
We report on augmenting materials for optical limiting of laser power radiation by introduction of polymers into nano-carbon aqueous suspensions, the throughput being controllable healing of the solid optical material and higher bleaching resistibility of the fluid state.

WeR4-06 Invited Holographic recording of relief-free infrared diffusive optics based on semiconductor nanomaterials S.G. Krivoshyakov1, ANTEOS, Inc., United States
A broad technology platform for holographic recording of various infrared diffusive optical elements in semiconductor materials for application in spectral devices, telecom components and lasers is described. The room temperature process of photo-modification of the material refractive index at low light intensity is applied to fabrication of the infrared diffusive optics based on polycrystalline ZnSe and single-crystal GaAs semiconductor materials.

WeR4-07 Invited Interference comb-spectroscopy with increasing sensitivity S.A. Pulkin1, E.N. Borisov1, D.V. Venediktov1, V.Yu. Venediktov1,2, M.V. Balabas1, S. Saveleva1, S.V. Uvarova1, J.N. Strel’nikov1, V. Arnautov1, V. Shevtsov1, O. Trefyak1, A. Khazanov1, M. Krivoshlykov; ANTEOS, Inc., United States
The wide spectrum from comb – generator of femtosecond laser was applied for illuminating of Michelson interferometer with atomic vapor. The method of holographic interferometry with increasing sensitivity using phase modulator was applied for treatment of digital hologram.

WeR4-08 Invited Digital correction of distortions in holographic interferometer A.A. Severuygin1, S.A. Pulkin1, I.M. Tursunov1, D.V. Venediktov1, V.Yu. Venediktov1,2; 1 - St. Petersburg State Electrotechnical University, 2 – St. Petersburg State University, 3 – ITMO Univ, Russia
The paper considers the use of holographic interferometer for hologram recording with correction of distortions. This is done with spatially combined interferograms using matrix spatial light modulator and digital image processing of the interferograms recorded by CMOS camera.

WeR4-09 Invited 3D ellipsoidal beam shaping in laser drivers for photoinjectors E.I. Gacheva1, S. Yu. Miranov1, A.K. Poteomkin1, V.V. Zelenogorsky1, A.V. Andrianov1, A.A. Ryzhov1, M. Krivoshlykov; ANTEOS, Inc., United States
Ellipsoidal laser pulses with central wavelength of 1030 nm and duration of 40 ps were obtained. It is expected that after conversion into the fourth harmonic this will reduce appreciably emittance of the electron beam, injected by the laser.

WeR4-10 Invited Direction measurement by means of dynamic goniometer method Yu.V. Filatov1, E.D. Bohkman, P.A. Ivanov, R.A. Larichev, P.A. Pavlov, St. Petersburg State Electrotechnical University, Russia
The angle measurement system intended for measuring angles between some directions set in the space by reflectors is presented in the report. The system operates by continuous rotation of platform with the autocollimating null-indicator. The angle measurements are provided by the ring laser or the holographic optical encoder.

WeR4-11 Invited The influence of rotation on the parameters of the whispering gallery modes resonator Yu.V. Filatov1, E.V. Shalymov1, V.Yu. Venediktov1,2; 1 - St. Petersburg State Electrotechnical University, 2 - St. Petersburg State University, Russia
The review of the various effects arising in resonators of whispering gallery modes is provided in the paper.
WeR5-01 Invited
Science with a petawatt laser
L. Rosa, Centro de Láseres Pulsados, Spain
What kind of new science can be done with a petawatt laser? There are some applications as particle acceleration, extreme plasmas, or basic QED analysis. But each of them depends on many laser parameters, much more than just an outrageous laser peak power. Probably it is the time to begin to design ad hoc lasers for each of the applications.

WeR5-02 New generation of ultra-high power laser systems for super-intense light fields
V. Chvykov1, M. Kalashnikov2, K. Osovy1; 1 - ELI-Hu Kft., Hungary, 2 - Max-Born-Inst., Germany
Super-intense light field can be produced combining three properties inherent to the laser light which are the high energy, short pulse duration and sharp focusing. Our report will be devoted all of them, namely higher energy extraction and shortening of the pulse duration of the final large aperture amplifiers and utilization of the adaptive optics for wave front compensation.

WeR5-03 Beam combining with nonlinear frequency conversion for petawatt class laser systems
S.A. Frolov1, V.I. Trunov; Inst. of Laser Physics SB RAS, Russia
Beam combining with nonlinear frequency conversion for noncollinear second harmonic generation for high energy pump beams and multibeam pumped parametric amplification are investigated theoretically. Prospects of creation of high repetition rate petawatt class laser system with parametric amplification stages are discussed. Parasitic wave mixing effects are analyzed with numerical simulation.

WeR5-04 Characterization of TW-power UV sub-picosecond pulses produced at GARPUN-MTW Ti:Sapphire/KrF laser facility for target irradiation experiments
V.D. Zvyarkin, A.A. Ionin, A.O. Levchenko, D.V. Mokrousova, L.V. Seleznov, A.V. Shutov, E.S. Sunchugashewa, N.N. Ustinovskii; Lebedev Physical Inst. RAS, Russia
Initial experiments on targets irradiation by sub-picosecond UV pulses with peak intensity ~ 2·10^16 W/cm^2 at GARPUN-MTW Ti:Sapphire / KrF laser facility are reported.

WeR5-05 Femtosecond Raman lasers with double pulse pumping
N.V. Didenko1, A.V. Konyashchenko1, P.V. Kostryukov1, L.L. Losev1, V.S. Panuk1, S.Yu. Teryakov1, V.N. Malchakov1, S.I. Chizhikov1, K.B. Yushkov1; 1 - Lebedev Physical Inst., 2 - Max-Planck-Institut für Kernphysik, Germany
We present our experimental research on femtosecond Raman lasers pumped by two orthogonally polarized chirped pulses. It was developed technique for generation of femtosecond Stokes pulses with duration closed to pump one. The shortest 40 fs Stokes pulses were generated at stimulated Raman scattering in hydrogen.

WeR5-06 Invited
Compression of powerful femtosecond pulses after compressor
V.N. Grinberg, S.Yu. Mironov, I.V. Yakovlev; Inst. of Applied Physics RAS, Russia
Spectrum broadening by self-phase modulation (SPM) may be used for increasing PW-class laser pulse power. The influence of high-order spectral phase on SPM and compression of intensity pulses will be discussed. The results of compression of sub-PW pulses of the PEARL laser will be presented.

WeR5-07 Invited
Ultra-bright gamma-ray beams from Compton scattering of an electron beam in an intense laser field
G. Sarri1, D.J. Corvan1, M. Zepf1, A. Di Piazza1, C.H. Keitel2; 1 - The Queen's Univ. of Belfast, United Kingdom, 2 - Max-Planck-Inst. für Kernphysik, Germany
We report on experimental results concerning the generation of ultra-bright multi-MeV gamma-ray beams following non-linear Thomson scattering of a laser-driven ultra-relativistic electron beam in the field of a high intensity laser. The short duration (~20 fs), narrow divergence (~2-3 mrad), and small source size (~30 microns) make this compact source the brightest ever generated in the multi-MeV regime.
WeR7-01 Invited
Application of tunable diode laser absorption spectroscopy in planetary studies, on lander board for planned missions to Moon, Mars and Venus
I.J. Vinogradov1, V.V. Barke1, V.A. Kazakov2, Yu.V. Lebedev3, A.V. Rodin2, O.Z. Roste4, G.V. Benderov5, A.Yu. Klimchuk6, V.M. Semenov7, A.A. Zakharonova2, A.V. Kalyuzhnyi2, A.I. Nadezhdinskii4, Ya.Ya. Ponurovskiy4, V.V. Spindorov2, J. Cousin5, G. Durry5, L. Joly5; 1 ‑ Space Research Inst. RAS, Russia, 2 ‑ Moscow Inst. of Physics and Technology, Russia, 3 ‑ The Univ. Centre in Svalbard, Norway, 4 ‑ Concern 1 ‑ Prokhorov General Physics Inst. RAS, Russia, 2 ‑ National Univ. of Science and Technology MISiS, Russia, 3 ‑ Inst. Fresnel UMR 7299, France
In a couple of years, researchers of IKI RAS, together with colleagues from MIPT, GPI RAS, and from GSMA team (University of Reims, France) are developing TDLAS instruments for carrying out in situ measurements for several future space missions to our neighbor planets. In the report, we discuss TDLAS instrument adaptation to actual lander probes, scheduled for research missions to Moon, Mars and Venus.

WeR7-02 Invited
Ozone high resolution spectroscopy using FTIR and TDL techniques for atmospheric research
C. Janssen1, C. Boursier1, H. Elhandaloussi2, P. Jesseck3, M. Minassie1-2-3, Y. Té4, T. Zanon5, 1 ‑ LERMA‑IPSL, Sorbonne Univ., Observatoire de Paris, PSL Research Univ., France, 2 ‑ COPAC ApS, Denmark, 3 ‑ Univ. of Liège, Belgium, 4 ‑ IFPEN, France, 5 ‑ Mi công nghệ, Việt Nam
The paper describes some recent experience in United Statesge of lidars for the investigation of stratospheric aerosol and trace gas. To identify the impact of the application of the basic laws of chip and microlasers performance, are assuming a more and more important role among system requirements. The project is planned to continue the experimental study aimed at identifying the impact of the application of the basic laws of chip and microlasers as radiators on the linear-angular characteristics of existing measurement systems.

WeR7-03 Carbon monoxide concentration measurement on the base of GaAsSb heterolaser
Ya. Lebiadok1, D. Kabanau1, Yu. Yakovlev1, A. Imenkov2; 1 ‑ SSPA “Optics, Instrumentation, Laser Systems”, ITMO Univ., Russia, 2 ‑ Great St. Petersburg Polytechnic Univ., Russia
The method of detection of carbon monoxide on the base of diode laser with GaAsSb quantum active layer and its characteristics are discussed in the report.

WeR7-04 Ice thickness measurements by Raman & Rayleigh scattering technique
S.M. Pershin1, V.N. Lednev2, R.N. Yulmetov2, A.F. Bunkin1, M.Ya. Grishin1; 1 ‑ Prokhorov General Physics Inst. RAS, Russia, 2 ‑ National Univ. of Science and Technology MISiS, Russia, 3 ‑ Inst. Fresnel UMR 7299, France
An efficient technique for ice thickness measurements by Raman & Rayleigh scattering is suggested. The elastic scattering is used for air-to-sample borders indication but fails to detect floating ice border. The Raman spectroscopy is used to detect interfaces between transparent materials such as ice-water interface. This approach is a promising express and non-invasive technique for remote thickness measurements in field experiments.

WeR7-05 Raman lidar measurements of the alkane molecules concentration
V.G. Shemanin1, V.E. Privvalov1; 1 ‑ Novorossiysk Polytechnic Inst., KubSTU, 2 ‑ Peter The Great St. Petersburg Polytechnic Univ, Russia
This paper is about the accounting of the laser line and apparatus function widths in the Raman lidar equation for the hydrocarbon molecules sensing in the atmosphere and an assessment of the relative error of such a concentration measurements of the relative error of such a concentration measurements. The isobutane was used as an example. All of these results show that the laser line width and the of the Raman lidar instrumental function width leads to increase the relative error of the concentration measurements for the studied molecules in the atmosphere in all the ranging distance.

WeR7-06 Coordinate measuring systems based on solid chip and microlasers
A.S. Grishankin1, D. N. Redka2; 1 ‑ ITMO Univ., Russia, 2 ‑ St. Petersburg Electrotechnical Univ., Russia
According to the current great interest concerning Large-Scale Metrology applications in many different fields of manufacturing industry, technologies and techniques for dimensional metrology are similarly shown a significant improvement. Ease-of-use, logistic and economic aspects, as well as metrological performance, are assuming a more and more important role among system requirements. The project is planned to continue the experimental study aimed at identifying the impact of the application of the basic laws of chip and microlasers as radiators on the linear-angular characteristics of existing measurement systems.

WeR7-07 Invited
Monitoring of aerosol loading in the middle atmosphere using Siberian – Far Eastern lidar network
A.A. Cheremisin, Irkutsk State Univ. of Railway Engineering, Krasnoyarsk Railway Inst., Siberian Federal Univ, Russia
A network of stratospheric lidar stations operates in Siberia and Far East: Tomsk, Yakutsk, Kamchatka. The lidar in itself is a powerful tool for atmospheric aerosol investigation. Meanwhile, it is a very fruitful to analyze the lidar data along with the global satellite data and the aerosol particles motion simulation results.

WeR7-08 A selective and highly sensitive MIR photoacoustic sensor for trace gas monitoring
M. Lassen1, L. Lomard2, D. Batsleer-Harder1, Y. Feng3, J.-F. Focant4, A. Peremans2, J. C. Petersen1; 1 ‑ Danish Fundamental Metrology, Denmark, 2 ‑ Laserspec BVBA, Belgium, 3 ‑ COPAC ApS, Denmark, 4 ‑ Univ. of Liège, Belgium
A highly sensitive, and selective photoacoustic (PA) sensor pumped by a single-mode mid-infrared (MIR) ns pulsed optical parametric oscillator (OPO) has been developed. The sensor has a wide tuning range covering absorption bands for a large number of molecules. The potential sensor applications include climate, environmental, and industrial monitoring and monitoring of exhaled breath for medical diagnostics. The sensor has been validated by monitoring acetone, formaldehyde, butane, propane, methanol, nitrogen dioxide, and methane.

WeR7-09 Conception of underwater femtosecond lidar
V.A.Semenova, V.G.Bespalov, A.P.Zhevlakov, ITMO Univ., Russia
We introduce a concept of underwater lidar based on compact Yb-doped high energy femtosecond fiber laser. It is assumed that simultaneous registration of scattered supercontinuum radiation, conical emission and fluorescence from filament in water may allow obtaining information about media pollution as well as about oil and gas presence.

WeR7-10 Laser techniques for monitoring physical processes in water under substantial refraction conditions
I.L. Raskovanaya, I.N. Pavlov, B.S. Rinkevichyus, A.V. Tolkaichev, A.V. Vedyashchina, National Research Univ. «MPEI», Russia
Techniques are suggested for the laser visualization and quantitative monitoring of physical processes occurring in water featuring substantial refractive index gradients. Methods are worked out for solving inverse refraction problems with a view to reconstructing temperature, pressure, and aqueous solution concentration fields and surface reliefs of water films.

WeR7-11 Remote water temperature measurements quantifying Raman OH-band spectra
M.Ya. Grishin1, V.N. Lednev2, S.M. Pershin1; 1 ‑ Prokhorov General Physics Inst. RAS, 2 ‑ National Univ. of Science and Technology MISiS, Russia
Raman spectroscopy is an ideal tool for subsurface water temperature measurements. This approach is based on temperature dependence of Raman OH-band spectra and scattering technique for medical diagnostics. The sensor has been validated by monitoring acetone, formaldehyde, butane, propane, methanol, nitrogen dioxide, and methane.

WeR7-12 Simulation and processing techniques for lidar data
V.G. Goryanov1-2, A.A. Bazhkov3, V.L. Cherekov1, A.V. Vislaev1, Y.A. Goldin1; 1 ‑ Peter the Great St. Petersburg Polytechnic Univ, 2 ‑ JSC Giproneft, 3 ‑ Shreiskh Inst. of Oceanology, Russia
The paper describes some recent experience in United Statesge of lidars for the monitoring of hydrosphere. An example of a present-day lidar system is given, along with several methods for simulation and processing of lidar data.
WeR8-27  Invited

Nonlinear refractive index for crystals in terahertz spectral range
S.A. Babotin, A.A. Drazdin, K. Dolgaleva, R.W. Boyd; 1 - ITMO Univ., Russia, 2 - Univ. of Ottawa, Canada

We develop a simple analytical model for calculating the vibrational contribution to the nonlinear refractive index of a crystal at terahertz frequencies in terms of known crystalline parameters such as the coefficient of thermal expansion, atomic density of the vibrational modes, and the atomic force constants with laser focusing. We discuss the experimental and theoretical results of the study of the non-linear refractive index of crystals and the possibility of using it for the development of the new generation of the optical devices.

WeR8-28  Invited

Interaction of intense laser pulses

We present the results of experimental and theoretical study of interaction of intense femtosecond laser pulses with gas cluster beam aimed to the generation of terahertz (THz) and X-ray emission. Clusters were produced by partial condensation of gas molecules during the expansion through a conical nozzle into vacuum-pure argon, mixtures CF2Cl2+He, Ar+He etc. We analyze the use of two laser pulse excitation schemes in our experiments, single- and two-color geometries (fundamental frequency mixed with its second harmonic) for the generation of high power terahertz (THz) radiation.

WeR8-29

A method for nonlinear-optical calibration of the terahertz wave spectral brightness
G.Eh. Kitaeva, V.V. Kornienko, Yu.A. Mityagin, A.N. Penin; 1 - Lomonosov Moscow State Univ., 2 - Lebedev Physical Inst. RAS, Russia

Experimental results are presented for the detection of 0.2 THz radiation from a frequency-doubled impact ionization avalanche transit-time (IMPATT) diode. A unique methodology is discussed for standard-less measurement of the terahertz wave spectral brightness. The method is based on the use of spontaneous parametric down-conversion of light under the nonlinear-optical detection of terahertz wave radiation.

WeR8-30

Polarization of THz radiation generated during two-color filamentation of arbitrarily polarized laser pulses
V.A. Andreaeva, A.V. Borodin, M.N. Esaulkov, N.A. Panin, P.M. Solyankin, V.A. Makarov, D.E. Shchipol, A.P. Shkurinov, O.G. Kosarevo, S.L. Chin; 1 - Lomonosov Moscow State Univ., 2 - Inst. on Laser and Information Technologies RAS, Russia, 3 - Univ. Laval, Canada

We examined experimentally and theoretically polarization of THz radiation generated during dual-color co-propagation of femtosecond laser pulses in gases. We reveal that THz radiation polarization is predominantly defined by the generation of the nonlinear photocurrent in the self-induced laser plasma and remains relatively stable with respect to the change of the initial polarization angle between the 800 and 400 nm fields.

WeR8-31

Optimization of the laser plasma source of terahertz radiation and interferometric study of its spatio-temporal field distribution
A.A. Ushakov, P.A. Chizhov, R.V. Volkov, R.W. Bukin, S.V. Garnov, A.B. Savelev; 1 - Prokhorov General Physics Inst. RAS, 2 - Lomonosov Moscow State Univ., 3 - International Laser Center, Lomonosov Moscow State Univ., Russia

We studied the efficiency of terahertz radiation generation induced by focusing two-color femtosecond laser pulses in the air with different polarization state of the pump fields. We present a new measurement technique for the detection of the spatio-temporal THz electric field strength distribution in an electro-optic crystal using optical interferometry.

WeR8-32

Femtosecond supercontinuum generation and superfilamentation in liquids and supercritical fluids
V.N. Bragatskikh, M.R. Dutchenko, I.L. Mareev, N.V. Minsky, F.V. Petokin, A.V. Rogulskaya; Lomonosov Moscow State Univ., Russia

We present the first time report a generation of multi octave supercontinuum in supercritical CO2 and He by 0.6 m (1200 nm) femtosecond (200 fs) laser pulse. In supercritical CO2 it ranges from 330 to 1900 nm and have a plateau-like behavior in the range 1400-1900 nm, besides 50% of energy is transferred to the first Stokes component. The increase of laser energy and focusing lens numerical diameter in laser pulse with a number of maxima is in azimuthal direction, rotating with constant angular velocity without deformations (a solid-like structure).

WeR8-33  Invited

Topological solitons in partially PT-symmetric potentials
Y.V. Kartashov, V.V. Konotop, L. Torner; 1 - ICGO-The Inst. of Photonics Sciences, Spain, 2 - Inst. of Spectroscopy, Russia, 3 - Univ. of Lisbon, Portugal

We introduce partially-parity-time-symmetric azimuthal potentials composed from individual PT-symmetric cells located on a ring, where two azimuthal directions are nonequivalent. Such non-conservative ratchet-like structures support rich families of stable vortex solitons whose properties depend not only on modulus, but also on sign of their topological charge.

WeR8-34  Invited

New results for spontaneous symmetry breaking in nonlinear optics and matter waves
B.A. Malomed, Tel Aviv Univ, Israel

The presentation will give an overview of recent theoretical results which reveal new features of the spontaneous symmetry breaking (SSB) effect. It is produced by the interplay of the symmetry of an underlying potential, which traps optical or matter waves, and self-focusing nonlinearity.

WeR8-35

Population inversion gratings: creation and control with few-cycle non-overlapping optical pulses
R.M. Arkhipov, M.V. Arkhipov, I. Babushkin, N.N. Rosanov; 1 - ITMO Univ., Russia, 2 - St. Petersburg State Univ, Russia, 3 - Max Born Inst., Germany, 4 - Leibniz Univ Hannover, Germany, 5 - Vavilov State Optical Inst., Russia

We consider theoretically and experimentally a possibility of controlling and competition of population inversion gratings in two-level resonant medium coherently interacting with few-cycle light pulses. It is shown that it is possible to create, erase, and modify the spatial period of such gratings.

WeR8-36

Formation of localized states of electromagnetic radiation in dynamic cavities
N.N. Rosanov, E.G. Fedorov; 1 - Vavilov State Optical Inst., Russia, 2 - ITMO Univ., Russia, 3 - Ioffe Inst., Russia, 4 - Technion-Israel Inst. of Technology, Israel

Presented are results of numerical simulation of parametric generation of single and multiple uni- and bipolar radiation pulses in a cavity with oscillating mirrors characterized by Lorentz-type frequency dispersion of reflection coefficient, in terms of classical electrodynamics.

WeR8-37

Interaction of spatial and temporal cavity solitons in mode-locked lasers and passive cavities
D.V. Turavev, A.G. Vladimirov, S.V. Zelik; 1 - Imperial College London, United Kingdom, 2 - Lobachevsky Univ. of Nizhny Novgorod, Russia, 3 - Weierstrass Inst., Germany, 4 - Univ. of Surrey, United Kingdom

We study interaction of well-separated localized structures of light in the presence of periodic perturbations. Oscillating localized structures were found to emit weakly decaying dispersive waves leading to a strong enhancement of the intensity and formation of new types of bound states. We discuss the applicability of our analytical results to the interpretation of experimental and numerical data reported earlier.

WeR8-38

Self-induced transparency coherent mode-locking in lasers
R.M. Arkhipov, M.V. Arkhipov, I. Babushkin, N.N. Rosanov; 1 - ITMO Univ., Russia, 2 - St. Petersburg State Univ, Russia, 3 - Max Born Inst., Germany, 4 - Leibniz Univ Hannover, Germany, 5 - Vavilov State Optical Inst., Russia

Coherent mode-locking (CML) is based on intracavity self-induced transparency phenomena and allows generating single-cycle laser pulses. We propose a new technique based on McCall and Hahn area theorem, allowing to predict the main features of CML regimes, study theoretically the possibility of single-cycle optical pulse generation and provide experimental study of mode-locked regimes in laser with a coherent absorber.

WeR8-39

Rotating three-dimensional vortex dissipative optical soliton
N.A. Veretenenko, N.N. Rosanov, S.V. Fedorov; 1 - Vavilov State Optical Inst., 2 - ITMO Univ., Russia, 3 - Ioffe Inst, Russia

We present a new type of three-dimensional dissipative vortex soliton in homogeneous medium with nonlinear gain and absorption. The soliton has a fixed torus-like intensity distribution with a number of maxima in azimuthal direction, rotating with constant angular velocity without deformations (a solid-like structure).

- Coffee Break -
Evolution of Cr4+, Cr3+ and Cr2+ contents in Cr:Mg2SiO4 crystals during those oxidizing annealing
K.A. Subbotin1, V.V. Slavkina1, D.A. Lit1, O.N. Lis1, E.V. Zharkov1; 1 - Prokhorov General Physics Inst. RAS, Russia
The evolution of Cr4+, Cr3+ and Cr2+ contents in Cr:Mg2SiO4 crystals during those prolonged high-temperature oxidizing annealing have been studied. The concentration of Cr4+ increases by factor of 1,5–2,5, whereas the parasitic Cr2+ ions practically disappear during such annealing. Therefore this post-growth treatment of Cr:Mg2SiO4 crystals considerably enhances their spectroscopic properties as the active laser media.

Quantum cutting of UV emission in Yb doped NaGd(MoO4)2 and NaLa(MoO4)2 crystals
K.A. Subbotin, Yu.N. Osipova, D.A. Lit, D.A. Nikolaev, E.V. Zharkov, I.A. Scherbakov; Prokhorov General Physics Inst. RAS, Russia
The efficient 1 μm Yb luminescence in Scheelite-like molybdate Yb:NaGd(MoO4)2 and Yb:NaLa(MoO4)2 single crystals was found at UV excitation. The character of dependence of Yb luminescence intensity on its content in the samples at UV-excitation indicates that the mechanism of cooperative down-conversion (quantum cutting) switches on at high Yb concentrations. It can be used for increase the efficiency of photovoltaic cells at crystalline silicon.

Spectroscopic properties of UV active media Ce3+:LiCa1-xSrxA1F6
A.A. Shaveliev, A.S. Nizamutdinov, V.V. Semashko, M.A. Marisov, Kazan Federal Univ., Russia
Optical absorption spectroscopy studies have shown that mixed crystals Ce6+:LiCa0.2Sr0.8AlF6 grown by Bridgeman technique exhibit more than 3 times higher absorption coefficient compared to Ce6+:LiCaAlF6 sample. An important result is based on the fact that this enhancement was achieved for two types of Ce6+ centers in a multisite LiCa6Sr8Ca2Al16F66 system.

Investigations of a highly efficient and compact diode-pumped Yb:KYW laser
S.A. Kuznetsov1, V.S. Pivtsov2; 1 - Inst. of Laser Physics SB RAS, Russia, 2 - Novosibirsk State Technical Academy, Russia
Record high differential efficiency (53.2%) and full optical efficiency (48%) for a multimode diode-pumped Yb:KYW laser have been achieved. Preliminary results of investigations with a distributed Bragg reflector tapered diode laser (DBR TDL) pumping have been obtained. The characteristics of the laser and methods for improving its efficiency are discussed.

The diode-pumped Nd:SmReO4 self-Raman-parametric laser generation of shortened 300-picosecond pulses without any mode-locking device
S.N. Smetanin1, M. Jelinek1, V. Kubec1, H. Jelinekova1, I. Livi1, A.S. Shurygin2, M.N. Erskov3; 1 - Prokhorov General Physics Inst. RAS, Russia, 2 - Czech Technical University, Prague, 3 - Russian RAS, Russia
The diode-pumped Nd:SmReO4 self-Raman-parametric laser generation of shortened 300-ps pulse with the increased pulse energy of up to 1 μJ without any mode-locking device is experimentally demonstrated and theoretically studied.

Light-induced periodic structures and their characteristics in crystals CaF2-LuF3 activated by Ce3+ and Yb3+ ions
N.F. Rakhimov, A.S. Nizamutdinov, V.V. Semashko, M.A. Marisov, S.A. Shnaidman; Kazan Federal Univ., Russia
Here we discuss the opportunity of using Ce-doped fluoride-type crystals as basis in crystals CaF2-LuF3 activated by Ce3+ and Yb3+ ions for high efficiency laser sources.
Q-switch Er:YLF-laser generation control through dual-wave diode pumping

The results of investigations of multivalve generation of dual-wavelength diode pumped Q-switch Er:YLF-laser are presented. The analysis of 3um range laser generation spectrum using the mathematical model based on rate equations was implemented. The theoretical optimization of power and time parameters of dual-wavelength diode pumping for achievement of selective lasing on wavelengths 2.66, 2.71, 2.81um was carried out.

Polarization instability in Nd:YAG laser with linearly polarized pump

We propose a model of a bipolarized solid-state laser, taking into consideration real positions of active Nd³⁺ centers in the unit cells of yttrium aluminum garnet, which adequately describes the basic features of the gain anisotropy effect induced by linearly polarized pump radiation observed in experiment. The model predicts a new type of instability arising due to two competing pump channels.

The research of dispersion mirrors for ultrafast laser system

One of the key techniques of generating ultrafast pulse is the perfect management of different dispersions. Three types of dispersion mirrors, broadband chirped mirror, high dispersion mirror, and low dispersion mirror, are discussed for different dispersion requirements.

Q-switched 946 nm Nd:YAG laser with cavity dumping

946 nm Nd:YAG end-pumped Q-switched master oscillator with a pulse duration of 3 ns, repetition rate 50 Hz was developed. The problem of obtaining a short pulse associated with a high saturation energy Es = 5.7 J/cm², resolved by using the cavity dumping. The lasing energy was up to 5 mJ.

Principles of influence on the spectral properties of solid-state laser with loop cavity

Principles of spectral narrowing of radiation of laser with loop cavity due to phase conjugation phenomenon are discussed. The gain gratings in active media results in competition in longitudinal modes and spectral selectivity.
Passively mode-locked fiber laser at 1μm with tungsten
disulphide absorber
Yu. Song, H. Guoyu, K. Li, Zh. Dou; Beijing Univ. of Technology, China

A passively yb-doped mode-locked fiber laser around 1μm with an WS2 film SA is demonstrated. The stable mode-locking was obtained with a pulse width of 2.5 ns. The 3-dB bandwidth was 1.1nm at 1030.3 nm and the repetition rate was 2.84 MHz. At the maximum pump power of 350 mW, the average output power was 8.02 mW, corresponding to pulse energy of 2.82 nJ.

Calculation of optimal parameters of the laser radiation in metal ablation by femtosecond pulses
R.V. Davydov, V.I. Antonov; Peter the Great St. Petersburg Polytechnic Univ, Russia

In this paper a mathematical model for femtosecond laser ablation of metals is proposed, based on standard two-temperature model connected with 1D hydrodynamic equations. A good agreement for numerical results of simulation ablation of several metals with experiment shows that this model can be employed in choosing laser parameters for better accuracy in nanoparticles production by this method.

Passively mode-locked fiber laser trapping
Yu. Jin1,2, L. Huang1, Yu. Jiang1; 1 - Inst. of Genetics and Developmental Biology, CAS, 2 - South China Normal Univ, China

A phenomenon called “trap split” has been found when gold nanoparticles were trapped by femtosecond laser pulses, and the trap split was demonstrated strongly dependent on the polarization, energy and wavelength of the laser pulses. The 3-dimension distribution of trap split and its mechanism were systematically investigated in this work.

Measurement of spatial characteristics of internal modifications by means of optical delay in cases of femtosecond micromachining of materials
D.V. Ganin1,2, K.E. Lapshin1, F.Z. Obidin1, S.K. Vartapetov1; 1 - Physics Instrumentation Center, Prokhorov General Physics Inst. RAS, 2 - National Research Nuclear Univ. «MEPHI», Russia

The paper presents the results of direct managing of spatial characteristics of the modifications in the case of focusing of femtosecond laser pulses in a bulk of material. Managing performed by inserting optical delay into different parts of the focused beam.

Direct femtosecond-pulse inscription of fiber Bragg gratings with special characteristics for sensing and laser applications
A.A. Wolf1, A.V. Dostovalov1,2, A.V. Perygin1, M.I. Skvortsov1, S.S. Yakushin1, S.A. Babin1; 1 - Inst. of Automation and Electrometry SB RAS, 2 - Novosibirsk State University, Russia

The paper presents the results on inscription of long (up to 100 nm) fiber Bragg gratings with point-by-point technique and phase-shifted gratings inscription with continuous core-scanning technique by femtosecond laser pulses.

Electron acceleration in vacuum by optimized nonlinearly chirped laser pulse
M. Akhyan1, M.R. Pandari1, F. Jahangiri1, A.R. Niknam2, R. Massoudi1, Shahid Behesti Uniex, Iran

Electron acceleration in vacuum by a nonlinearly chirped laser pulse is studied and it is shown that utilizing optimized higher order chirp functions leads to enhancement of the electron energy gain.

Electron acceleration in vacuum by optimized nonlinearly chirped laser pulse
M. Akhyan1, M.R. Pandari1, F. Jahangiri1, A.R. Niknam2, R. Massoudi1, Shahid Behesti Uniex, Iran

Electron acceleration in vacuum by a nonlinearly chirped laser pulse is studied and it is shown that utilizing optimized higher order chirp functions leads to enhancement of the electron energy gain.

Optical-to-MHz conversion and scattering in metals
I.V. Oladyskvin1, D.A. Fadeev1, V.A. Mironov1; Inst. of Applied Physics RAS, Russia

Laser induced terahertz waves generation from metals is a result of thermal effects in the electrical gas near the surface. We discuss the generation mechanism and the possibility of electron scattering investigation with a help of nondestructive optical-to-THz conversion on the surface. It is showed that THz responses can be used to determine electron scattering frequency for electron gas temperatures up to 1-2 eV.

Passively mode-locked fiber laser at 1μm with tungsten disulphide absorber
Ya. Song, H. Guoyu, K. Li, Zh. Dou; Beijing Univ. of Technology, China

A passively yb-doped mode-locked fiber laser around 1μm with an WS2 film SA is demonstrated. The stable mode-locking was obtained with a pulse width of 2.5 ns. The 3-dB bandwidth was 1.1nm at 1030.3 nm and the repetition rate was 2.84 MHz. At the maximum pump power of 350 mW, the average output power was 8.02 mW, corresponding to pulse energy of 2.82 nJ.
**WeR8-p01**
Output beam quality improvement in broad-area class-B lasers subject to optical injection
A.V. Pakhmov\(^1\), N.E. Molevich\(^2\), A.A. Krents\(^3\), A.A. Anchikov\(^1\); 1 - Samara State Aerospace Univ, 2 - Lebedev Physical Inst, Samara, Russia

We study analytically and numerically the spatio-temporal dynamics of class-B broad-area lasers under external optical injection into the cavity. It is shown that weak external optical injection can enable stabilization of transverse instabilities inherent for class-B broad-area lasers. The coherent optical injection can be also applied for the effective suppression of the relaxation oscillations and spiking behaviour.

**WeR8-p02**
Quantum entanglement of vectorial optical self-diffraction in ion-implanted silicon quantum dots
C. Torres-Torres\(^1\), J. Bornacelli\(^2\), R. Rangel-Rojas\(^1\), A. Oliver\(^1\); 1 - National Polytechnic Inst, 2 - National Autonomous Univ of Mexico, 3 - Optics Dept, CICESE, Mexico

Entangled multi-spatial-optical fields provided by a multi-wave mixing process in silicon quantum dots were analyzed. The samples were nucleated by an ion-implantation method in a silica matrix. It is highlighted that configurable quantum correlations can be tailored by controlling the physical mechanisms responsible for the third order optical nonlinearities.

**WeR8-p03**
Polarizing properties of Ti-indiffused lithium niobate waveguides
M. Parfenov\(^1\), P. Karavov\(^2\), P. Agruzov\(^2\), I. Illich\(^1\), A. Shamray\(^1\); 1 - Peter the Great St. Petersburg Polytechnic Univ, 2 - Ioffe Inst, 3 - ITMO Univ, Russia

Methods for selection, transformation, and control of light polarization in Ti:LiNbO\(_3\) waveguides on lithium niobate (LiNbO\(_3\)) substrates are described. The influence of technological parameters and waveguide topology is considered. The polarization extinction ratio higher than 40 dB/cm was experimentally demonstrated.

**WeR8-p04**
Stationary and dynamically persistent modes in non-linearly coupled three-dimensional harmonic oscillators
R. Driben\(^1\), V.V. Konotop\(^2\), B.A. Malomed\(^3\), T. Meier\(^2\); 1 - ITMO Univ, Russia, 2 - Univ. of Paderborn, Germany, 3 - Univ. de Lisboa, Portugal

The dynamics of a pair of three-dimensional matter-wave harmonic oscillators (HOs) coupled by a repulsive cubic nonlinearity is investigated through direct simulations of the respective Gross-Pitaevskii equations (GPEs) and with the help of the finite-mode Galerkin approximation (GA).

**WeR8-p05**
Generation of high extinction optical pulses by means of LiNbO\(_3\) Mach-Zehnder modulators
V.V. Lebedev\(^1\), A.V. Tronov\(^1\), A.N. Petrov\(^1\), P.M. Agruzov\(^2\), I.V. Illich\(^1\), A.V. Shamray\(^1\); 1 - Ioffe Inst, 2 - ITMO Univ, 3 - Peter the Great St. Petersburg Polytechnic Univ, Russia

High extinction optical pulse generation via cw modulation in lithium niobate Mach-Zehnder integrated optical modulators is discussed, and methods for bias point stabilization and pulse shape measurements are presented. Generation of high dynamic extinction (>40 dB) optical pulses by a high static extinction lithium niobate modulator was experimentally demonstrated.

**WeR8-p06**
Threshold effect in the substance with carbon nanotubes and graphene oxide within optical limiting
M.S. Siveliev, A.Yu. Gerasimkenko, S.A. Tereschenko, V.M. Podgaetsky; National Research Univ of Electronic Technology (MIET), Russia

Determination of nonlinear optical characteristics of active substances of the limiters of high-power laser radiation was carried out with the help of non-threshold and new threshold models. Experimental data of z-scan with open aperture was obtained, which helped to determine values of the nonlinear optical characteristics for dispersion media with carbon nanotubes and graphene oxide. Advantages of threshold model experimental data processing in comparison with non-threshold model was shown.

**WeR8-p07**
Nonlinear band-structure of an exciton-polariton condensate in a one-dimensional lattice
I.Yu. Chestnov\(^1\), A.V. Yulina\(^2\), A.P. Aloidants\(^2\), I.A. Sheklnik\(^1\), O.A. Egorov\(^2\); 1 - Stotevos Vladimir State Univ, Russia, 2 - ITMO Univ, Russia

We study steady-states and nonlinear band structure of dissipative incoherently dripped exciton-polariton condensate localized in periodic one-dimensional potential. Within the framework of mean-field description we predict existence of the persistent current Bloch states at the edge of Brillouin zone. Influence of the nonlinear band structure on exciton-polariton condensate dynamics is discussed.

**WeR8-p08**
Laser processing of materials in the multiple filamentation mode
K.S. Khorkov, D.A. Kochuev, D.V. Abramov, A.S. Chernikov, S.M. Arakelian, V.G. Prokoshev; Stotevos Vladimir State Univ, Russia

The phenomenon of filamentation of femtosecond laser pulses enables to implement controlled redistribution of intensity in the cross section of the laser beam. Spatial distribution of radiation intensity after passing through the transparent medium shows further spread the multiple filaments that allows realize laser microprocessing of materials.

**WeR8-p09**
Non-trivial regimes of a polariton Rabi oscillator
N.S. Voronova\(^1\), A.A. Elistratov\(^2\), Yu.E. Lozovik\(^2\); 1 - National Research Nuclear Univ. MEPhI, 2 - Russian Quantum Center, 3 - Inst. for Nanotechnologies in Microelectronics RAS, 4 - Inst. for Spectroscopy RAS, Russia

We analyze the effects of detuning, gain, and dissipation on Rabi oscillations in semiconductor microcavities, assuming a cw pumping via excitonic reservoir. We show the existence of non-trivial regimes reminiscent of internal Josephson effect, Van de Pol oscillations with amplitude-dependent damping, and the «inverted» stationary state with polaritons accumulating at the upper polariton branch while the lower branch becomes unstable.

**WeR8-p10**
Slow soliton-like elastic waves in metals: one more observation and application
E.M. Kudriavtsev\(^1\), S.D. Zotov\(^1\), A.A. Lebedev, V.V. Raschupkin\(^1\); 1 - Lebedev Physical Inst, RAS, 2 - Baykov Inst of Metallurgy and Material Science RAS, Russia

To decrease the number of defects in preliminary deformed sample of nickel, it was annealed in vacuum furnace (during 5 hours at T~100°C). This time period could be markedly decreased by help of previous sample irradiation with the 2 Hz CO\(_2\) laser pulses during 30 hours but now at room temperature.

**WeR8-p11**
Investigation of nonlinear properties of media with Kerr nonlinearity by imaging of an amplitude object with powerful laser radiation
A.A. Murzachev, V.O. Martynov; Inst. of Applied Physics RAS, Russia

Propagation of the powerful radiation through the optical system may be accompanied by a number of distortions in the transmitted image. We characterize the nonlinear phase of the laser beam for the media with instantaneous local Kerr nonlinearity by characterization of distortions in the image transferred through the nonlinear optical system.

**WeR8-p12**
Influence of classic noise on entangled state formation in nonequilibrium systems
V.O. Martynov, V.A. Maronov, I.A. Smirnov; Inst. of Applied Physics RAS, Russia

Features of high-temperature entangled states formation have been studied in a system consisting of two parametrically coupled identical quantum harmonic oscillators, each of which is placed in a separate independent thermal bath, in the conditions of partially coherent pumping.

**WeR8-p13**
Temperature dependence of SHG efficiency by focusing of laser radiation
A.L. Bondarenko\(^1\), S.G. Grechin\(^2\), D.G. Kochiev\(^2\), A.E. Kokh\(^3\), A.N. Sharikov\(^2\); 1 - Space Research Inst. RAS, 2 - Bauman Moscow State Technical Univ, 3 - Prokhorov General Physics Inst. RAS, Russia

The paper presents the peculiarities of the temperature dependence for the second harmonic generation efficiency of focusing laser radiation. It is shown that an asymmetry of the dependence is the result of the vector phase-matching process near the crystal axis.

**WeR8-p14**
Damage of an AR-coated LBO crystal by laser pulses of microsecond duration
S.G. Grechin\(^1\), D.G. Kochiev\(^1\), A.E. Kokh\(^1\), A.N. Sharikov\(^1\); 1 - Bauman Moscow State Technical Univ, 2 - Prokhorov General Physics Inst. RAS, 3 - Sobolev Inst. of Geology and Mineralogy SB RAS, Russia

The optical damage of an LBO crystal by laser pulses of microsecond duration at 1.0796 µm and 0.5398 µm is investigated.
WeR8-p15 09:30-13:30
Numerical simulation of image inversion of small-scale opaque object by the phase contrast technique with adaptive nonlinear Kerr filter
E.L. Bubis1, V.O. Martynov1, A.A. Murzanev1, V.V. Lozhkarev1, O.A. Malshakova1, A.N. Stepanov1, A.I. Smirnov1,2, 1 - Inst. of Applied Physics RAS, 2 - Lobachevsky State Univ. Russia
Numerical simulation of the process of inversion of the small-scale image of the object in phase-contrast scheme with nonlinear Kerr filter described.

WeR8-p16 09:30-13:30
Advanced scheme of amplifier similaritoner laser
D.A. Korobko1, O.G. Dkhijonkov2, I.O. Zolotovskii3, 1 - Ulyanovsk State Univ. Russia, 2 - Tompere Univ. of Technology, Finland
We propose an advanced scheme of amplifier similaritoner laser providing an output pulse spectrum much wider than the gain bandwidth. The proposed scheme demonstrates a drastic increase of the output pulse spectrum width, reduction of the pulse duration, and increase of the output pulse peak power after compression.

WeR8-p17 09:30-13:30
Growth and characterization of new laser & nonlinear optical crystal Nd0,83Y0,22Sc2s95 (BO3)4
A.E. Kohi1, N.G. Konanova1, K.A. Kohi2, A.B. Kuznetsov2, A. Maillard1, R. Maillard1, F. Khaleht1, P. Loseur1, G. Akcr1, 1 - Sobolev Inst. of Geology and Mineralogy SB RAS, Russia, 2 - Novosibirsk State Univ., Russia, 3 - LMOPS Lorraine Univ and Supelec, France, 4 - PSL, Research Univ. Inst. de Recherche de Chimie Paris IRCCP France
Single crystals of Nd0,83Y0,22Sc2s95 (BO3)4 (NdYSB) have been grown in LiBO2–LiF system. NdYSB crystallizes in non centrosymmetrical huntite-like structure with space group R32. The nonlinear optical coefficient d(1) = d11 has been determined to be 1.77 pm/V. Fluorescence spectra of the NdYSB by the exciting at X = 811 nm shows 4F3/2 → 4I11/2 transition of the Nd3+ ions expected NdYSB crystal to laser oscillations at 1061nm. In fact NdYSB crystal can investigate as self doubling laser material.

WeR8-p18 09:30-13:30
Raman gain coefficients in potassium-gadolinium tungstate at the wavelength of 532 nm
R. Chulkov1, V. Markovich1, V. Orlovich1, M. El-Dessoki2, 1 - Stepanov Inst. of Physics NASB, Belarus, 2 - King Abdulaziz City for Science and Technology (KACST), Saudi Arabia
Experimental and numerical data on Stokes generation under the spectrally-limited nanosecond pulse excitation are collated to find the steady-state Raman gain coefficients. The approach is tested for barium nitrate. For potassium-gadolinium tungstate, the coefficients values of 14.3 and 11.23 cm/GW are determined in the p[mm]p and p[gg]p sample orientations, respectively, at 532 nm wavelength.

WeR8-p19 09:30-13:30
Dispersive distortions of signals in an ananl fiber-optic link with direct intensity modulation
V.V. Shcherbakov1, A.F. Salodkov1, A.A. Zadernovsky1, 1 - JSC "Center VOSPI", 2 - Technological Univ. MIREA, Russia
We present experimental results on transmission of signals in an analog fiber-optic link with direct intensity modulation and direct detection of photocurrent. It was found that the output signals reveal either power suppression or power revival depending on the modulation frequency. We also observed nonlinear distortions of the signals. Theoreticall interpretation of the experimential results is presented.

WeR8-p20 09:30-13:30
Approach for producing the nanocrystalline sitall samples with distributed refractive index
I.L. Vinogradova1, A.I. Salihov1, R.V. Kutlyarov1, A.Kh. Sultanov1, Ufa State Aviation Technical Univ, Russia
We have explored a novel technique for producing transparent volumetric nanocrystalline sitall by means of intensive plastic deformation. This material is intended to be used for components of fiber optic devices, including various applications in all-optical networks. We have examined properties of the material experimentally and by means of the proposed analytical model.

WeR8-p21 09:30-13:30
Numerical modeling of the dynamics of bidirectional long ring Raman fiber laser
S.V. Sukhanov1, L.A. Melnikov2, Yu.A. Mazhirina2, Gagarin State Technical Univ. of Saratov, Russia
We demonstrate the numerical model which allows investigation of gyroscopic effect in hybrid mode-locked bidirectional Erbium-doped fibre ring laser. The model is based on transport theory with accounting of dispersion, gain in EDFA and saturable absorption. The predictions of gyroscopic effect are also presented for the particular laser cavity.
Optical vortex generation using photoinduced orientational defects in nematic liquid crystals
I.A. Budagovsky¹, S.A. Shvetsov²,³, M.P. Smayev¹, A.S. Zolotko¹, M.I. Barnik¹
¹ - Lebedev Physical Inst. RAS, 2 - Moscow Inst. of Physics and Technology, 3 - Shubnikov Inst. of Crystallography RAS, Russia

Optical vortices were generated by means of photoinduced point defects in orientation of the nematic liquid crystal (NLC). The axisymmetric distribution of NLC director field was produced due to photorefractive effect in NLC or due to isotropic channel formation in light absorbing NLC.

Nonlinear polarization in comb-spectroscopy
S. Uvarova, A. Antipov, S. Pulkin, E. Borisov, V. Arnautov; St. Petersburg State Univ., Russia

Two methods were applied to compute the 2-level atom driven by a polychromatic field. The first method is a direct numerical solution of the density matrix equations and the second one is a harmonic basis decomposition resulting in an infinite linear algebraic equation system. It is showed the resonance frequency mostly follows the transition frequency. But some frequency pulling or pushing is observed depending on the transition frequency inside the field component bounds or not.

On diagnostic capability of scattered laser radiation in internal defect analysis of conduct pipe
VA. Vologdin, VV. Davydov, EN. Velichko, VN. Nikolsky; 1 - Peter the Great Saint Petersburg Polytechnic Univ., 2 - ITMO Univ., Russia

A new method of diagnostics of defects on internal parts of pipelines by scattered laser radiation on flowing fluid is considered. A coordinate of junction point of laser beams in section plane of pipeline with fluid flow was calculated.

Swift C5+ ion irradiated optical ridge waveguides in nonlinear Yb:YCOB crystal
Ya. Cheng, Sh. Zhou, F. Chen; 1 - Shandong Univ., China, 2 - Inst. of Ion Beam Physics and Materials Research, Germany

We report on the fabrication of optical ridge waveguides in Yb:YCOB crystal. The ridge waveguide structures show good guiding properties at 1064 nm along TM polarization and the lowest propagation loss is measured to be 1.7 dB/cm.

Induced modulation instability of surface plasmon polaritons in an ultra-thin metal film
S. Moiseev, D. Korabko, I. Zolotovskii; 1 - Ulyanovsk State Univ., 2 - Kotelnikov Inst. of Radiocommunication and Electronics RAS, Russia

The effect of the modulation instability of surface plasmon polariton waves in an ultra-thin metal film is demonstrated. It is shown that the modulation instability effect could be used for the generation of signals with a repetition rate in the terahertz range and ultrafast trains of picosecond optical pulses.

Numerical modeling of gyroscopic effect in bidirectional ultrafast erbium-doped fibre laser
S. Sukhanov, L. Melnikov, M. Chernysheva; 1 - Gagarin State Technical Univ. of Saratov, Russia, 2 - Aston Univ., United Kingdom

We demonstrate the numerical model which allows investigation of gyroscopic effect in hybrid mode-locked bidirectional erbium-doped fibre ring laser. The model is based on transport theory with accounting of dispersion, gain in EDFA and saturable absorption. The predictions of gyroscopic effect are also presented for the particular laser cavity.

Collision of 3D bipolar light pulses in an array of carbon nanotubes
A.V. Zhukov, R. Bouffanais, B.A. Malomed, H. Leblond, D. Mihalache; 1 - Singapore Univ. of Technology and Design, Singapore, 2 - Tel Aviv Univ., Israel, 3 - Univ. of Angers, France, 4 - Academy of Romanian Scientists, Romania, 5 - Horia Hulubei National Inst. of Physics and Nuclear Engineering, Romania, 6 - Technion-Israel Inst. of Technology, Israel, 7 - Vavilov State Optical Inst., Russia, 8 - ITMO Univ., Russia, 9 - Ioffe Inst., Russia, 10 - Volgograd Inst. of Business, Russia, 11 - Volgograd State Univ., Russia

We study the propagation and collision of extremely short electromagnetic pulses in an array of semiconductor carbon nanotubes. The mathematical model takes into account non-uniformity of the pulses' fields and redistribution of electron concentration in the system. We establish a possibility of stable post-collision propagation of pulses over distances much greater than their sizes.
A new beam shaping technique implemented in 260 watt 1 kilohertz repetition rate picosecond pulse laser J. Adamonis1, A. Aleknavicius2, T. Gertus2, A. Michailovas1,3; 1 - EKSPLA, 2 - Fiber Optics Research Center RAS, Russia

We present a practical implementation of a novel beam shaping technique (based on partially variable phase retardation plate inscription in fused silica glass by femtosecond pulses) in a high power picosecond pulse laser amplifier.


Thermally induced phase distortions of disc laser active element are measured and calculated. Theoretical model shows deviation from experiment. Extra heat sources are expected to be the reason of the deviation.

ThR1-29 All-solid-state laser system with coherent combining of independent channels via common laser beam A.P. Pogoda, A.V. Fedin, A.S. Boreysho, Baltic State Technical Univ., Laser Systems LTD, Russia

The multichannel laser system with coherent combining as a result of fourwave mixing in active laser media is proposed.

ThR1-30 Single frequency MOPA based on Nd:YAG bulk and fiber single crystals Z. Liu, S. Men, Y. Liu, H. Rao, Z. Cong, S. Zhang, X. Zhang; Shandong Univ., China

By employing Nd:YAG single crystal fiber and rods, single frequency 1064-nm master oscillator power amplifier is realized. Output power is 31.3 W with peak power of 464 kW and linewidth of less than 130 MHz.

ThR1-31 Thin-tapered-rod Yb:YAG amplifier for fiber oscillator I.U. Kuznetsova, I.B. Mukhin, O.V. Palasovich; Inst. of Applied Physics RAS, Russia

High average power and high-gain laser amplifier based on thin-tapered-rod Yb:YAG crystal with waveguide diode pumping is realized. Signal of the sub-second fiber oscillator is amplified up to 15 W average power with 20% optical efficiency.

ThR1-32 A 13 W LD-pumped narrow-line width linearly polarized Yb-doped fiber laser operating at 1152 nm L. Huang, H. Zhang, X. Wang, R. Su, P. Zhou; National Univ. of Defense Technology, China

We demonstrate a 1152 nm narrow line width linearly polarized all-fiber laser directly pumped by laser diodes at 976 nm. When temperature of gain fiber is increased to about 115 °C, a maximum output power of 13 W is obtained and corresponding slope efficiency is ~45%. The polarization extinction ratio and 3dB linewidth at the maximum output power are 18 dB and 0.14 nm respectively, which is an attractive result for some special applications such as nonlinear conversion.

- Coffee Break -

ThR1-33 Invited 11:30-12:00 High-power Yb:amplifiers seeded by a femtosecond Er:fiber laser D. Brda, J. Fischer, P. Storz, A. Leitenstorfer; Univ. of Konstanz and Center for Applied Photonics, Germany

We present two alternative implementations of high-power Yb:amplifiers designed for advanced applications in ultrafast science. The seed is generated by ultrabroadband Er:fiber laser technology. Our fiber-based setup produces pulses at 1030 nm with energies of 6 µJ at a repetition rate of 10 MHz and duration of 145 fs. The thin-disk amplifier is operated at 3 kHz repetition rate and generates 655-fs pulses with energies up to 17 µJ.

ThR1-34 Dispersion-managed soliton generation in the hybrid mode-locked Erbium-doped All-fiber ring raser D.A. Dvuretsky1, S.G. Sazonkin1, V.S. Voropaev1, S.O. Leonov2, A.B. Pnev1, V.E. Karasik1, A.A. Krylov2, E.D. Obraztsova3; 1 - Bauman Moscow State Technical Univ., 2 - Fiber Optics Research Center RAS, 3 - Prokhorov General Physics Inst. RAS, Russia

We report on the ultra-short dispersion-managed soliton generation in the erbium-doped all-fiber ring laser hybrid mode-locked with Carbon:Bronitride Single-Walled Nanotubes in the co-action with a nonlinear polarization evolution.

ThR1-35 Uni- and bidirectional hybrid mode-locked Erbium-doped isolator-free fibre laser M. Chernysheva1, M. Al Arajmi1,2, S. Sukhanov1, R. Arif1, A. Rozhin1; 1 - Aston Inst. of Photonic Technologies, Aston Univ., United Kingdom, 2 - Al-Munif States College of Technology, Sultanate of Oman, 3 - Gagarin Saratov State Technical Univ., Russia, 4 - Univ. of Sulaimani, Iraq

We have investigated a hybrid mode-locked Erbium-doped fibre ring laser without optical isolator. Creating different losses in the cavity for counter-propagating pulses via net birefringence adjusting, the laser can operate in both unidirectional regimes with extinction over 22 db, as well as can establish stable bidirectional generation.

ThR1-36 Generation of harmonic oscillations in ring resonator with high Q-factor S.A. Kolpakov, H. Kbash, Yu. Loika, S. V. Sergeyev; Aston Univ., United Kingdom

We report on generation of harmonic oscillations with frequencies of hundreds of kHz from a passively modelocked fiber laser oscillator. This high stability makes these oscillators a suitable substitute for existing quartz resonators used in high frequency optoelectronics applications.

ThR1-37 All-fiber hybridly mode-locked similartion ring laser for frequency metrology V.A. Lazarev1, A.A. Krylov1, S.G. Sazonkin1, A.B. Pnev1, S.O. Leonov2, D.A. Shelstov1, M.K. Tarabrin1, V.E. Karasik1, A.N. Kireev1, M.A. Gubin1,2; 1 - Bauman Moscow State Technical Univ., 2 - Fiber Optics Research Center RAS, 3 - Lebedev Physical Inst. RAS, 4 - National Research Nuclear Univ. MEPhI, Russia

We demonstrate the generation of stable 127 fs selfsimilar pulses at a central wavelength of 1560 nm with 7.14 mW average output power. Similar lasers have low repetition rate deviation in the averaging time interval 1 – 105 s, a low relative intensity noise ~125 dBc/Hz, a narrow single comb line width of 32 kHz, and high reliability. Thus, such lasers are highly promising for further development of the stabilized combs.

ThR1-38 Highly compact stretcher-compressor module for ultrafast chirped pulse amplification laser system B. Lee1, B. Jeong1, S.A. Chizhov1, E.G. Sall1, J. Yang1, V.E. Yashin1, G.H. Kim1; 1 - Korea Electrotechnology Research Inst., Republic of Korea, 2 - Vavilov State Optical Inst., Russia

We introduce and demonstrate a simple, compact stretcher-compressor module that uses a single transmission diffraction grating. Three stretcher-compressor modules with different compression ratio have been compared.
**R1. SOLID-STATE LASERS**

**TECHNICAL SESSION**

Location: Stenberg Room, floor 3, 15:00 – 17:00

Solid-State Lasers VII
Session Chair: Maximilian Lederer,
European XFEL GmbH, Germany

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**ThR1-39** 15:00-15:15
1 kHz, 10 mJ Q-switched diode pumped Nd:YAG laser with a variable reflectivity mirror

B. Oreshkov1, K. Popov2, S. Gagarisky2, N. Belashenkov2, I. Buchvarov2; 1 - Sofia Univ., Bulgaria, 2 - IBPhotonics Ltd., Sofia Univ., Bulgaria, 3 - ITMO Univ., Russia

We demonstrate 1 kHz, 10mJ actively Q-switched Nd:YAG laser with 15 ns pulse duration at 1 kHz repetition rate. A smooth output beam intensity distribution is achieved by the use of variable reflectivity Gaussian output mirror.

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**ThR1-40** 15:15-15:30
Post-pulse generation effect in Q-switched lasers

K.F. Burdonov, E.A. Khazanov, A.A. Shaykin; Inst. of Applied Physics, Russia

We revealed experimentally the generation of a second giant pulse at the neighboring longitudinal mode in an Nd:YLF Q-switched laser and implemented new method of longitudinal mode selection based on this effect.

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**ThR1-41** 15:30-15:45
6 mJ@3.3kHz Q-switched single mode single-frequency Nd:YAG end pumped laser

A.F. Kornev, V.P. Pokrovskiy, S.S. Sobolev, S.S. Terekhov; ITMO Univ., Russia

End pumped MOPA Nd:YAG pulsed laser was built and investigated. High extraction efficiency ~50% in single-pass amplifier is achieved due to high small-signal gain provided with longitudinal pumping. Pumping of amplifier is near uniformly distributed along 2 laser rods with low concentration using two-lens relay between them in order to decrease end overheating.

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**ThR1-42** 15:45-16:00
946 nm Nd:YAG regenerative amplifier 20 mJ/3 ns

E.A. Buslaeva1,2, S.V. Gagarisky2, P.A. Gnatyuk2, A.S. Kovalyov1, A.F. Kornev1, V.P. Pokrovskiy2; 1 - Lasers and optical systems, Ltd., 2 - ITMO Univ., Russia

Laser is based on scheme “master oscillator with cavity dumping (MO) → regenerative amplifier (RA)”. It produces 20 mJ with pulse repetition rate 50 Hz and pulse length 3 ns. High-speed drivers were used. The radiation divergence close to the diffraction-limited and high stability of output signal were obtained.

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**ThR1-43** 16:00-16:15
Diode-pumped Pr:LiY0.3Lu0.7F4 and Pr:LiYF4 red laser at 640 nm

A.A. Lyapin1, P.A. Ryabochkina1, V.G. Gorieva2; 1 - Inst. of Physics and Chemistry, Ogarov Mordovia State Univ., 2 - Kazan Federal Univ., Russia

The laser quality Pr:LiY0.3Lu0.7F4 and Pr:LiYF4 fluoride single crystals have been prepared by Bridgman method. Laser oscillations of Pr:LiY0.3Lu0.7F4 crystal was obtained at 640nm under diode pumping at 442nm, with the slope efficiency of 9%. Also, the continuous-wave laser have been obtained for Pr:LiYF4 crystal at 640nm pumped by a diode laser with the slope efficiency of 8.5%.

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**ThR1-44** 16:15-16:30
On the nature of donor centres involved into the down-conversion in Yb doped Scheelite-like crystals

K.A. Subbotin, Yu.N. Osipova, D.A. Lis, D.A. Nikolaev, V.A. Smirnov, E.V. Zharikov, I.A. Shcherbakov; Prokhorov General Physics Inst. RAS, Russia

The efficient 1 µm Yb3+ luminescence was found in Scheelite-like molybdate and tungstate crystals at UV-excitation. The presentation is devoted to discussion about the nature of optical donor centres in the crystals, which absorb the UV excitation and non-radiatively transfer their excited state energy to the 2F5/2 excited state of Yb3+ ions.

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**ThR1-45** 16:30-16:45
Color centers transient absorption and ultra-short pulse lasing from LiLu0.7Y0.3F4:Ce3+ active medium

I.I. Farukhshin, A.S. Nizamutdinov, V.V. Semashko, S.L. Korableva, M.A. Marisov; Kazan Federal Univ., Russia

We have obtained the single pulse laser oscillation with 400±10 ps pulse duration at 311 nm from LiLu0.7Y0.3F4:Ce3+ crystal was obtained from intracavity loss modulation via pump-induced color centers bleaching. Modulation of intracavity losses is regulated via color centers concentration.

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**ThR1-46** 16:45-17:00
A tunable laser near 535 nm

X. Liu, G. Tang, X. Zhang, Zh. Cong, X. Chen, Z. Qin, Zh. Liu, J. Lu; Shandong Univ., China

This paper presents a tunable laser near 535 nm. It is obtained by the intracavity frequency doubling of the tunable Stokes laser emission based on the stimulated polarization scattering in MgO:LiNbO3 crystal. The tunable green laser wavelength range was from 534.8 nm to 536.9 nm. The maximum output energy at 535.7 nm was 4.48 mJ.
R2. HIGH POWER LASERS

**ThR2-14**

**Pressure broadening of Ar (811.5 nm) by neon**

A.R. Gidartov 1,2, PA. Mikheyev 1,2, A.K. Chemshyov 1,3, N.I. Ufimtsev 1, V.N. Azyazov 1, M.C. Heeven 1,2, 1 - Samara State Aerospace Univ., 2 - Lebedev Physical Inst. RAS, Samara Branch, Russia, 3 - Emory Univ., United States

Results of systematic measurements of pressure broadening for argon in 40 MHz RF discharge plasma in neon are presented. Using the tunable diode laser spectroscopy, we obtained the experimental data on pressure broadenings for argon 811.5 nm line by neon and pressure broadening coefficient was determined for the first time.

**ThR2-15**

**A non-chain HF laser with repetitive rate of 100Hz**

H. Chao, H. Ke, Y. Ai-ping, T. Ying, Zh. Feng, M. Lian-ying, L. Gao-peng; Northwest Inst. of Nuclear Technology, China

The non-chain HF laser with the self-acting ultraviolet preionization was developed. A pair of like Chang profiled electrodes defines a 12\times17\times480 mm3 discharge volume where gas flow is forced in the direction transverse to the optical axis. In 100Hz pulse repetitive operation, the average power obtained was 40W in a 92% SF6:8% CO2 Hf gas mixture.

**ThR2-16**

**Vibrational kinetics of molecular singlet oxygen**

A.R. Turbin 1,2, PA. Mikheyev 1,2, M.C. Heeven 1,2, V.N. Azyazov 1, 1 - Samara State Aerospace Univ., 2 - Lebedev Physical Inst. RAS, Samara Branch, Russia, 3 - Emory Univ., United States

Experimental study of vibrationally-excited singlet oxygen O2(axv) kinetics have been performed. Rate constant of O2(axv=1) quenching by CO2 was measured. It was shown that vibrational excitation of singlet oxygen molecule accelerates the rate of reaction between O2(axv) and O3 molecules.

**ThR2-17**

**Long-term mode degradation in ytterbium-doped pulsed fiber lasers**

K.K. Babkov, M.M. Bubnov, S.S. Aleshkina, M.E. Liakhachev; Fiber Optics Research Center RAS, Russia

A novel effect of long-term mode degradation in a low-average-power high-peak-power ytterbium-doped pulsed fiber lasers based on large mode area step-index fibers has been reported for the first time.

**ThR2-18**

**10-60 kHz operation mode of waveguide CO2-laser with wavelength selection option**

A.A. Boyko, A.I. Karapuzakov, S.S. Chernolov, V.V. Spitsin 1, K.G. Zenkov, I.B. Kuznetsova 1, A.A. Markelov 1, 1 - Special Technologies, Ltd., 2 - Inst. of Laser Physics, SB RAS, Russia

Possibility of obtaining the pulse-periodic lasing mode with 100% modulation at pulse repetition rates from 10 kHz to 60 kHz is reported.

**ThR2-19**

**Absorption in N2O and CH4 of overtone CO laser radiation measured by the using a topographic target and receiving telescope**

A.A. Ionin 1,2, I.O. Kinyavski 1, Yu.M. Klimachev 1, A.Yu. Kozlov 1, A.A. Kotkov 1, G.G. Matveenko 1,2, O.A. Romanovsky 1, V.V. Yakovlev 1, 1 - Lebedev Physical Inst. RAS, 2 - Zuev Inst. of Atmospheric Physics SB RAS, 3 - Tomsk National Research State Univ, Russia

The trace remote sensing scheme of atmospheric gas components (nitrous oxide and methane) with emission lines of pulsed first-over tone CO laser is tested using a topographic target and receiving telescope. Results of the measurements and calculation of absorption on 20 selected emission lines in gas mixtures with the studied gases at various configurations of the experimental scheme are presented.

**ThR2-20**

**Optimization of the parameters of gas-discharge active medium and optical resonator of RF excited planar CO2 laser at room temperature**

A.P. Mireev 1, S.M. Nefedov 1, P.P. Pashinin 1, P.A. Goncharov 1, V.V. Kiselev 1, Prokhorov General Physics Inst. RAS, Russia

An output power of CO2-lasers has been studied for operation at room temperature of the cooling running water from +7 to +160°C. A cw output power of 41W for stable resonator and 21W for unstable resonator has been achieved. The new configuration of hybrid waveguide-unstable optical resonator with the external additional mirror for the lasers is proposed and realized. We carried out experiments about the possibility of the optimization of the coupling coefficient of optical resonator with the aid of the external mirror, that is plane-parallel plate with different reflection coefficients.

**ThR2-21**

**Laser on polycrystalline ZnSe:Fe2+ with high efficiency and pulse radiation energy at room temperature**

K.N. Firsov 1,2, E.M. Gavriuchuk 1,2, V.B. Romanin 1,3, S.Yu. Kazantsev 1,3, I.G. Kononov 1, T.V. Kateraeva 1, D.V. Savin 1, N.A. Timofeeva 1, 1 - Prokhorov General Physics Inst. RAS, 2 - National Research Nuclear Univ. MEPhI, 3 - Deyativtikh Inst. of Chemistry of High-Purity Substances RAS, 4 - Lobachevsky Nizhny Novgorod State Univ, Russia

A laser on polycrystalline ZnSe:Fe2+ is investigated at room temperature. Pumping of the laser was performed by pulsed electrode discharge HF laser. In experiments, the spot diameter of HF laser radiation to the incident surface of polycrystal varied from 6.7 to 14.5 mm. The generation energy of ~11 J has been obtained with the efficiency with respect to the energy absorbed in the polycrystal t=50%

**ThR2-22**

**Exhaustion of gas flow optical quality of Chemical Oxygen-Iodine Laser (COIL) resonator area**

Yu.A. Adamenko 1, M.I. Beznukov 1, M.A. Garbunov 1, M.L. Leonov 1, A.V. Selezniev 1, D.V. Sokolov 1, RFNC-VRNIIF, Russia

Optical techniques for supersonic Chemical Oxygen-Iodine Laser (COIL) active medium exploration using methods of interferometry based on Talbot effect have been developed and implied. We have implemented these techniques in experiments on test gaseous mixture, that modeling real COIL gas flow conditions without COIL generation. We have measured \(\Delta n\) and Strehl number of active medium gas flow in optical resonator area.

**ThR2-23**

**Optimization of power optics for laser processing heads**

P.A. Nosov, A.F. Shirankov 1,2, M.N. Martynyov 1, V.Yu. Pavlov 1, Bauman Moscow State Technical University, Russia

The need to use the theory of laser optics to develop modern high-performance optical systems of laser processing heads, which form the beam of the high-power laser, is discussed. The technique for synthesis of high-performance optical heads of laser systems for various purposes is elaborated and software-implemented.

**ThR2-24**

**The CO laser sum frequency radiation obtained in a nonlinear crystals AgGaSe2 and ZnGeP2 and its absorption in CO2 and N2O gases**

O.V. Budilova 1, A.A. Ionin 1, I.O. Kinyavski 1, Yu.M. Klimachev 1, A.A. Kotkov 1, G.G. Matveenko 1,2, O.A. Romanovsky 1, V.V. Yakovlev 1, 1 - Lebedev Physical Inst. RAS, 2 - Zuev Inst. of Atmospheric Physics SB RAS, 3 - Tomsk National Research State Univ, Russia

The broadband laser system based on sum frequency radiation of multi-line Q-switched CO laser in a nonlinear crystals AgGaSe2 and ZnGeP2 was developed. The absorption of the sum frequency radiation in such gaseous substances as nitrous oxide and carbon dioxide was studied. A comparison of the experimental data with the theoretically calculated absorption spectrum of radiation was carried out.

**ThR2-25**

**Novel laser design based on intracavity chirped Bragg gratings**

V. Smirnov 1,2, O. Mokhun 1, R. Vasilyev 1, A. Glebov 1, A.E. Zubko 1, E.V. Shashkov 2, A.V. Smirnov 2, N.S. Vorobyev 2, 1 - OptiGrate Corp., United States, 2 - Prokhorov General Physics Inst. RAS, Russia

Chirped Bragg Gratings (CBGs) in photo-thermo-refractive glass allow stretching and compression of ultra-short pulses. United Statesge of CBG as an intracavity element of Nd:Yag laser results in generation ps-pulses in compact and robust design. This paper will discuss properties of Nd:Yag laser and discuss potential applications for this laser.

**ThR2-26**

**Precise testing of reflection and transmission coefficients of optical coatings of wide aperture elements**

C.Yu. Golovkin 1, V.N. Dorkosh 1, D.V. Sazhin 2, V.A. Shennikov 1, V.O. Lashuk 1, RFNC-VRNIIF, Russia

Technique has been developed for measuring of the reflectance of dielectric coatings of optics having different optical strength. An absolute accuracy less than 0.1% and distribution of reflection for optics having aperture up to 800 mm are got.
Spacial and temporal control of laser beams for biomedical multichannel imaging
J.M. Bueno; Univ. Murcia, Spain

Adaptive optics for ultrashort pulse manipulation
C. Marziani1, A. Cantaluppi, S. Bonora, G. Cerullo, 1 - Politecnico di Milano, Italy, 2 – Max Planck Inst. for the Structure and Dynamics of Matter, Germany, 3 - Univ. degli studi di Padova, Italy

Uniform focal spot formation in adaptive system with Shack-Hartmann sensor and M2 sensor
J. Sheldakova, A. Kudryavtsev, A. Rukasov, A. Lyulov; Moscow Univ. of Mechanical Engineering, Russia

The laser beam focusing closed-loop control system on the long-range dynamic point target, implementing the method of double frequency of the spherical wave front probing

A new method of the real-time atmospheric turbulence modeling
A. Lyulov1, A. Kudryavtsev1, Ju. Sheldakova1, G. Barsony1; 1 - Moscow State Univ. of Mechanical Engineering, Russia, 2 - AKK Optics (SAS), France

Influence of atmospheric turbulence on quality of multichannel laser radiation and correction for distortion
V.P. Lukin1, O.I. Antipov1, P.Yu. Kaney1, N.A. Makarenova1; 1 - Zuev Inst. of Atmospheric Optics SB RAS, 2 - Inst. of Applied Physics RAS, Russia

We demonstrate a beam quality optimization of high energy, high average, high peak power solid state laser amplifier, by the use of a deformable mirror (DM) coupled with a CCD sensor.
B. Le Garrec; LULI/ Ecole Polytechnique, France

ThR4-14 Invited
12:00-12:15

Fast focal-spot-based control algorithm for adaptive optics
D. Yagnyatiniskiy, D. Lyakhov, A. Borshchevnikov, V. Fedoseyev; FSUE SRI SIA “LUCH”, Russia

Orbital angular momentum of the vortex laser beams in a turbulent atmosphere: numerical modeling and asymptotic theory
V.P. Aksenov1, V.V. Kolosov1,2, G.A. Filimonov1, C.E. Pogutsa1; 1 - Zuev Inst. of Atmospheric Optics RAS, 2 - Tomsk Scientific Center SB RAS, Russia

The total orbital angular momentum (OAM) of laser beams propagating through the turbulent atmosphere has been studied numerically and analytically. The variance of OAM fluctuations calculated from the numerical simulation is in a good agreement with the asymptotic estimates of the OAM variance in the domain of their applicability.

Beam quality improvement in kHz solid state laser amplifier through utilization of a piezoelectric deformable mirror
B. Ormikov1, D. Chuchumichov1, I. Bucharov1,2, S. Gagansky, V. Bezubik1, N. Belashenkov2; 1 - Sofia Univ., Bulgaria, 2 - ITMO Univ., Russia

We demonstrate a beam quality optimization of high energy, high average, high peak power solid state laser amplifier, by the use of a deformable mirror (DM) coupled with a CCD sensor.

Beam control for wire lasers based on formation of optical image of laser modes
E.E. Orlova; Inst. for Physics of Microstructures RAS, Russia

We develop an approach to beam control of the lasers with subwavelength transverse dimensions and the length much larger than the wavelength (wire lasers). High radiation divergence of such lasers enables the formation of three-dimensional optical image of laser modes due to the interference of radiation from the distribution of sources along the laser waveguide. We analyze the structure of the image of a wire laser formed by a spherical lens and show that narrow beam can be obtained by choosing the parameters of the optical system leading to formation of a uniform image extended along the lens axis or by separating one of the maxima with a diaphragm.

Coffee Break
**R5. SUPER-INTENSE LIGHT FIELDS AND ULTRA-FAST PROCESSES**

**Session Chair: Sarga Ter Avetisyan, European XFEL GmbH, Germany**

**Super-Intense Light Fields and Ultra-Fast Processes IV**

- **ThR5-19 Invited** 17:30-18:00
  Laser-driven ion acceleration and application to ultrahigh dose rate radiobiology
  M. Borghesi, S. Kar, D. Doria, H. Ahmed, P. Chaudary, L. Romagnani, A. Sgattoni, M. Cherchez, R. Praiad, S. Brauckmann, F. Hanot, D. Gwynne, C. Mazironi, H. Poddari, C. Scuillion, A. Macchi, P. McKenna, O. Willi, K. Prise, 1 - Centre for Plasma Physics, The Queen’s Univ. of Belfast, Northern Ireland, 2 - Centre for Cancer Research and Cell Biology, The Queen’s Univ. of Belfast, Northern Ireland, 3 - LULI, École Polytechnique, CNRS, CEA, UPMC, Palaiseau, France, 4 - Univ. of Strathclyde, United Kingdom, 5 - Heinrich-Heine-Univers, Germany, 6 - Department of Physics E. Fermi, Italy

An intense research activity is currently devoted worldwide to the development of laser-driven ion acceleration, in view of a number of application, including potential use in future cancer therapy. We will report on the activities of the UK-side A-SAIL consortium towards developing novel acceleration mechanisms, as well as applying the ions in a range of radiobiology investigations.

- **ThR5-20 Invited** 18:00-18:30
  Femtosecond X-rays from laser plasma accelerators
  K. To Phuoc, B. Mathieu, A. Döpp, C. Thaury, S. Corde, J. Gautier, E. Guillaume, V. Malo, A. Rousse, L. Lecherbourg, N. Joudain, F. Dorchies, A. Lifschitz, Laboratoire d’Optique Appliquée, ENSTA ParisTech, CNRS, École Polytechnique; CEA, CELIA, France

We will present the principle of these sources, their characterization, recent developments and a few application examples.

- **ThR5-21 Invited** 18:30-18:45
  Turbulence in relativistic plasma - from magnetohydrodynamic to kinetic regime
  Makoto Takamoto, Univ. of Tokyo, Japan

In this presentation, we report our recent finding on turbulence in relativistic plasma. We performed a series of 3-dimensional numerical simulations of turbulence using relativistic magnetohydrodynamics code, and investigated properties of each characteristic mode. We also report our recent results of 3-dimensional Weibel turbulence obtained by Particle-in-Cell simulations.

- **ThR5-22 Intense ultrafast laser-plasma source of quazi-monochromatic Mo-Kα X-rayradiation**
  V. Tcheremiskine, Y. Azamoum, R. Clady, L. Charmasson, A. Ferre, N. Sanner, O. Uteza, M. Sentis, Aix-Marseille Univ, CNRS, France

Characteristics of intense ultrafast quasi-monochromatic laser-plasma x-ray source at 17.4 keV produced using solid Molybdenum target are studied. The source is generated by Ti:Sa laser system "ASUR" capable to deliver 10 TW laser pulses of 25 fs duration with 100 Hz repetition rate and temporal contrast of >10^10. Fluxes of K-alpha X-radiation of 10^9 photon/s per shot and energy conversion efficiency >10^-4 are obtained.

- **ThR5-23 Electron-free UV laser pulse filamentation under coherent rotational SRS in air**
  I.V. Smetanin, A.O. Levchenko, A.V. Shutov, N.N. Ustinovskii, V.D. Zverkin, 1 - Lebedev Physical Inst.RAS, 2 - National Research Nuclear Univ. MEPhI, Russia

Coherent stimulated rotational Raman self-scattering is proposed as the mechanism of electron-free filamentation of the ultra-short KE laser pulse in air.

- **ThR5-24 Ultrashort laser pulse multifoldation in fused silica: plasma channels statistics**
  A.A. Zemlyanov, Yu.E. Geints, Zuev Inst of Atmospheric Optics SB RAS, Russia

The regime of multiple filamentation of gigawatt-power femtosecond laser pulses in fused silica bar is theoretically investigated. The dependence of the number, spatial position, and length of different generations of plasma channels on the energy and focusing conditions of the optical pulse is studied.

- **Coffee Break**
Lasers in environmental monitoring III

Session Chair: Alexandr A. Cheremisin,
Irkutsk State Univ. of Railway Engineering, Krasnoyarsk Railway Inst., Siberian Federal Univ., Russia

11:30-11:45
Using of laser scanner for mobile scanning of environment in work of earthmoving and construction machines and for control of deformation of pit’s slopes
T.V. Golubeva, S.V. Konshin, E.G. Zaytsev; Altamyr Univ. of Power Engineering & Telecommunications, Kazakhstan

The authors propose the use of laser scanning for positioning earthmoving and construction machines relative to terrain and environment, including the objects that are in the places of construction works to eliminate the human factor and increase the quality and speed of the given work.

11:45-12:15
Cavity enhanced spectroscopy in application to spectral line shape study
A. Cypan; Nicolaus Copernicus Univ., Poland

Three cavity enhanced spectroscopy methods are presented: well-known cavity ring-down spectroscopy and two recent techniques: cavity mode-width spectroscopy and one-dimensional cavity mode-dispersion spectroscopy. Application of these techniques to spectral line shape study and atmospheric research is discussed.

12:15-12:45
Identification of the sources of aerosol contamination using laser methods
A. Nagy, M. Veres, A. Kerekes, A. Czitrovsky; Wigner Research Centre for Physics of the HAS, Hungary

Optical aerosol instrumentation was utilized to identify the sources of aerosol contamination in the air of Budapest. The results of the size distribution and absorptivity measurements show clear correlation with weather conditions, indicating the differences between the locations in the neighborhoods.

12:45-13:00
Gold-plated silicon nanostructures for surface-enhanced Raman scattering (SERS)
I. Rigo1, L. Himics1, A. Nagy1, A. Czitrovsky1, S. Toth1, P. Fuerjes1, G. Singh1, M. Veres1; 1 - Wigner Research Centre for Physics of the HAS, Hungary, 2 - Centre for Energy Research HAS, Hungary, 3 - Mavalaya National Inst. of Technology, India

Surface-Enhanced Raman Scattering (SERS) with its single molecule sensitivity is a promising tool for the detection of very low amounts of substances. The effective use of the technique requires specific substrates offering high levels of Raman enhancement. This work compares the performance of gold coated silicon SERS arrays of different morphology.

13:00-13:15
Temperature measurement by projection on latent structures of fluorescence spectra of potassium-alumina-borate glasses with copper-containing molecular clusters
M.A. Khodasevich1, A.N. Babkina2, P.S. Shirshnev2; 1 - Stepanov Inst. of Physics NASB, Belarus, 2 - ITMO Univ., Russia

The use of projection on latent structures allows to reduce the relative error of temperature measurement via a wideband fluorescence spectra of potassium-alumina-borate glasses with copper-containing molecular clusters to value about 1%. These glasses are shown to be a promising material as a temperature sensor.

13:15-13:30
Remote determination of size of surface heterogeneity and displacements of diffusely scattering objects
D.V. Kiesewetter1, V.I. Malyugin1, N.V. Ilyin1, Ch. Surt1; 1 - Peter the Great St. Petersburg Politechnic Univ., 2 - Dalian Univ. of Technology, China

The spectral correlation method for determining the height of the optical inhomogeneities and speckle-interferometer based on optical vortices for increasing sensitivity to longitudinal displacements of the scattering objects are presented.
The physics of ultra-low power conservative and dissipative polariton solitons in GaAs photonic structures is reviewed. Polariton solitons form on a short length scale of 10's of micrometers and can be manipulated within few picoseconds. The effect of spin-dependent polariton nonlinearity on soliton formation is also discussed.

**ThR8-45 Invited**

Ultra-low-power polariton solitons in semiconductor waveguides and microcavities


The physics of ultra-low power conservative and dissipative polariton solitons in GaAs photonic structures is reviewed. Polariton solitons form on a short length scale of 10's of micrometers and can be manipulated within few picoseconds.

**ThR8-46 Invited**

Nonlinear regime of surface polaritons including exciton polaritons in organic materials

B.D. Fainberg, G. Lü; T. - Holon Inst. of Technology, Israel, 2 - Tel Aviv Univ., Israel, 3 - Northwestern Univ., United States.

We develop a theory of nonlinear organic «plasmonics» with strong laser pulses. The bistability response of the electron-vibrational model of organic materials in the condensed phase has been demonstrated. We propose the excitation control of Coulomb blocking in the quantum dot wire based on non-steady-state nonlinear organic «plasmonics» that enable us to obtain near-zero dielectric permittivity during a short time.

**ThR8-47**

The role of ferroelectric domain wall in nonlinear Cerenkov frequency up-conversion in 1D nonlinear crystal

N. An, X. Chen; 1 - Shanghai Inst. of Laser Plasma, 2 - Shanghai Jiao Tong Univ., China.

We reveal a variety of nonlinear Cerenkov radiation patterns that occur in a single photonic crystal modulated by domain walls, which manifest themselves as normal, degenerated and anomalous-dispersion-like nonlinear Cerenkov radiation type sum-frequency generation.

**ThR8-48**

Low-threshold 1064 to 1907 nm hydrogen Raman laser based on hollow-core fibre


1907 nm generation by pure vibrational stimulated Raman scattering in hydrogen-filled hollow-core fibre is demonstrated. Due to special design of hollow-core revolver fiber with nested capillaries, the Raman threshold as low as 270 W of peak power is achieved.

**ThR8-49**

Two-dimensional vortex dissipative optical solitons in polariton laser with saturable absorber


We consider conditions for existing and stability of two-dimensional dissipative vortex solitons in condensates of excitons in a semiconductor polariton laser with a saturable absorber inside the microcavity. Presented is the structure of energy flows in the cases of inertialless media and media with finite relaxation rates.

**ThR8-50**

Optically controlling the optical spin Hall effect

P. Lewandowski, O. Lafont, M.H. Lukić, N.H. Kwong, K.P. Chan, M. Babin; 1 - Holon Inst. of Technology, Israel, 2 - Tel Aviv Univ., Israel, 3 - M. S. Skolnick.

We develop a theory of nonlinear organic «plasmonics» with strong laser pulses.
Phase-matched second harmonic generation in one-dimensional photonic crystals in the Laue geometry  

B.V. Novikov, I.I. Mantysyov, A.I. Matyakbskyi, T.V. Murzina; Lomonosov Moscow State University, Russia

We experimentally observe phase-matched second harmonic generation under Bragg diffraction in the Laue geometry in one-dimensional porous silica based photonic crystals infiltrated by a ferroelectric salt.

Frequency conversion of multi-line carbon monoxide laser in PbIn6Te10 crystal  

A.A. Ionin1, I.O. Kinyaevskyi1, Yu.M. Klimachev2, A.Yu. Kozlov2, A.A. Kotkov2, V.V. Badikov3, K.V. Mitiur4; 1 - Lebedev Physical Institute, 2 - Lomonosov Moscow State University, 3 - National Research Nuclear University "MEPhI", 4 - Moscow Institute of Physics and Technology, Russia

Frequency conversion of carbon monoxide laser was for the first time obtained in PbIn6Te10 nonlinear crystal. Laser-induced damage threshold, sum and different frequency generation efficiency under multi-line CO laser pumping were measured.

Frequency conversion of multi-line carbon monoxide laser in PbIn6Te10 crystal


1 - Lebedev Physical Institute, 2 - Lomonosov Moscow State University, 3 - National Research Nuclear University "MEPhI", 4 - Moscow Institute of Physics and Technology, Russia

Frequency conversion of carbon monoxide laser was for the first time obtained in PbIn6Te10 nonlinear crystal. Laser-induced damage threshold, sum and different frequency generation efficiency under multi-line CO laser pumping were measured.

Extraordinary time-depended processes in the parametric interaction of counter-propagating waves  

V.A. Tkachenko1, A.K. Pagon2, S.A. Myslivets2, VV Slobko2; 1 - Siberian Federal University, Russia, 2 - Purdue University, United States, 3 - Kirensky Inst. of Physics SB RAS, Russia

Three-wave mixing of ordinary and backward electromagnetic waves in the pulsed regime is investigated. It is shown that opposite direction of phase velocity and energy flux in the backward wave gives rise to extraordinary transient processes in the greatly enhanced optical parametric amplification and frequency-shifting nonlinear reflectivity.

Extraordinary time-depended processes in the parametric interaction of counter-propagating waves

V.A. Tkachenko, A.K. Pagon, S.A. Myslivets, V. Slobko

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Three-wave mixing of ordinary and backward electromagnetic waves in the pulsed regime is investigated. It is shown that opposite direction of phase velocity and energy flux in the backward wave gives rise to extraordinary transient processes in the greatly enhanced optical parametric amplification and frequency-shifting nonlinear reflectivity.

Wide tunable BaGa4Se7 optical parametric oscillator pumped by Nd:YLF laser  

N. Kosyukova1, A. Bobylev2, A. Boyko3, K. Zenov4, A. Shadrinsteva5, N. Tretjakova6, V. Badikov7, D. Badikov7, D. Kolker1,2; 1 - Special technology LTD, 2 - Novosibirsk State University, 3 - Inst. of Laser Physics SB RAS, 4 - Kuban State University, Russia

BaGa4Se7 optical parametric oscillator (OPO) pumped by compact nanosecond Nd:YLF laser was demonstrated. Wide tuning range from 2.93 up to 9.3 mkm is shown for first time of our knowledge.

Wide tunable BaGa4Se7 optical parametric oscillator pumped by Nd:YLF laser

N. Kosyukova, A. Bobylev, A. Boyko, K. Zenov, A. Shadrinsteva, N. Tretjakova, V. Badikov, D. Badikov, D. Kolker

1 - Special technology LTD, 2 - Novosibirsk State University, 3 - Inst. of Laser Physics SB RAS, 4 - Kuban State University, Russia

BaGa4Se7 optical parametric oscillator (OPO) pumped by compact nanosecond Nd:YLF laser was demonstrated. Wide tuning range from 2.93 up to 9.3 mkm is shown for first time of our knowledge.

Optical nonlinear response of liquid crystalline polymer  

I.A. Budkovskiy1, V.V. Ochkin2, S.A. Svetlov2; 1 - A.S. Zolot'ko3, 2 - A.A. Bobrovsky1, N.I. Balo1, VF Shibaev2; 1 - Lebedev Physical Ins. RAS, 2 - Moscow Inst. of Physics and Technology, 3 - Moscow State University, Russia

Optical nonlinearity of nematic liquid crystalline polymer caused by molecular reorientation was found and investigated. Under the action of light on the polymer film, director of polymer reorients to light field increasing the refractive index. If the polymer is doped with an azobenzene compound, nonlinear response dramatically increases; in this case, the light-induced refractive index becomes negative.

Optical nonlinear response of liquid crystalline polymer

I.A. Budkovskiy, V.V. Ochkin, S.A. Svetlov


1 - Lebedev Physical Ins. RAS, 2 - Moscow Inst. of Physics and Technology, 3 - Moscow State University, Russia

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- Coffee Break -

Location: Pudovkin Room, floor 3, 17:30 - 19:30

Nonlinearity of Solids, Gases and Plasmas

Chair: Alexander P. Skhurinov

Lomonosov Moscow State University, Inst. on Laser and Information Technologies RAS, Russia

Time-resolved non-linear optical response and photosensitivity of glassy semiconductor  

E.A. Romanova1, Yu.S. Kuzuyukina2, S. Guizardi3, T.M. Benson4, A.B. Seddon4; 1 - Saratov National Research State University, Russia, 2 - Ecole Polytechnique, France, 3 - University of Nottingham, United Kingdom

An interferometric pump-probe method with the femtosecond resolution in time is used to study the third-order non-linear optical response and photosensitivity of a variety of chalcogenide glasses of the system As-S-Se.

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**R2. HIGH POWER LASERS**

**ThR2-p01 15:00-19:00**

*120W single-frequency laser based on active LMA double-clad fiber amplifier*

A.I. Triskhev, V.B. Tsetkov, Prokhorov General Physics Inst. RAS, Russia

We present CW single-frequency laser at 1080 nm (linewidth used for the first, second and third stages of amplifier). A large mode area double-clad fiber is used for the fourth stage of amplifier.

**ThR2-p02 15:00-19:00**

*Prospect of optically pumped oxygen laser*

M.V. Zagidullin1,2, V.N. Ayazov, M.S. Malyshev, N.A. Khvatov1; 1 - Samara State Aerospace Univ., 2 - Lebedev Physical Inst., Samara branch, Russia

O2–I2 gas is irradiated by light near 500nm and further pumped by light at wavelength 1315 nm in resonance with 2P3/2–2P1/2 transition of atomic iodine. A set of chemical and energy exchange reactions result in generation of inverse population and gain of 0.04 m-1 on B–X transition of molecular oxygen.

**ThR2-p03 15:00-19:00**

*Experimental study of iodine dissociation in active medium of oxygen-iodine laser*

M.V. Zagidullin1,2, M.S. Malyshev, N.A. Khvatov1; 1 - Samara State Aerospace Univ., 2 - Lebedev Physical Inst., Samara, Russia

Results of experiments on dissociation of iodine molecules in oxygen-iodine laser medium are presented. Rates constant of key reactions have been reexamined. The experiments confirmed mechanism of iodine dissociation proposed in (J. Phys. Chem., 87, 2348 (1983)). The experiments did not reveal the contribution of vibrationally excited oxygen molecules or three body reactions in the dissociation of iodine.

**ThR2-p04 15:00-19:00**

*Coherent combining of high average power nanosecond pulse laser beams*


For a few nanosecond pulse OPCPA amplification several picosecond pump is required. To develop such pump system for a single passaged picosecond amplification is created in the Institute of Applied Physics RAS. It is then planned to prepare for the integration of a femtosecond seed laser with the cryogenic increasing efficiency.

**ThR2-p05 15:00-19:00**

*High power CPA cryogenic Yb:YAG laser*

E.A. Perevezentsev, I.B. Mukhin, G.V. Palashov, Inst. of Applied Physics RAS, Russia

For a few nanosecond pulse OPCPA amplification several picosecond pump is required. To develop such pump system for a single passaged picosecond amplification is created in the Institute of Applied Physics RAS. It is then planned to prepare for the integration of a femtosecond seed laser with the cryogenic increasing efficiency.

**ThR2-p06 15:00-19:00**

*TEA–CO2 laser with pulse repetition rates up to 5 kHz for technological applications*

B.A. Kozlov, Ryazan State Technical Engineering Univ., Russia

Some investigation results, directed to the creation of sealed–off TEA–CO2 laser with pulse repetition rates from 1 to 5 kHz for technological applications are given. In TEA–CO2 laser with active volume V ≈ 280x0.5x2 cm3 maximum values of radiation energy per pulse 20–25 mJ at 2–3 kHz are obtained. At the 5 kHz the laser energy decreases up to 5–6 mJ. Perspectives of increasing of pulse repetition rates up to 20 kHz are discussed.

**ThR2-p07 15:00-19:00**

*Superscale atmospheric metal–ceramic small–sized sealed–off TE–CO2 laser with PRR up to 25 Hz*

B.A. Kozlov1, D. Kuang Manh2; 1 - Ryazan State Radio Engineering Univ., Russia, 2 - Vietnam

The main interrelations of “electrical wind” velocity in supperl–atmospheric pressure CO2–laser mixtures are investi-gated. For the first time “electrical wind” effect was used for increasing pulse repetition rates (PRR) in TE–CO2 laser at total pressures 1–12 atmospheres. Generation characteristics milli–sealored–off TE–CO2 laser at pulse repetition rates 1–25 Hz are studied. Laser energy per pulse 5–6 mJ at PRR 20–25 Hz with duration 4–5 nanoseconds from active volume V = 5x0.8x0.8 cm3 are obtained.

**ThR2-p08 15:00-19:00**

*Carrier-envelope offset phase control and stabilization of kilohertz solid-state laser system*

A.V. Kiripchukov, V.V. Petrov1,2, G.V. Kuptsov1, A.V. Laptev1, V.A. Petrov1,2, E.V. Pestryakov; 1 - Inst. of Laser Physics SB RAS, 2 - Novosibirsk State Technical University, 3 - Novosibirsk State National Research Univ., Russia

The operating modes of the solid-state laser system with 1 kHz pulse repetition rate consisting of a master oscillator and nine–pass amplifier were investigated and parameters optimization has been carried out. A carrier-envelope offset phase stabilization system was developed and implemented allowing one to achieve residual instability ~0.17 radian (rms) for the 30 fs–pulse. It is considered to be sufficient to generate attosecond pulses in subsequent experiments.

**ThR2-p09 15:00-19:00**

*Products of reaction Rb with C2H6 or CH4*

G.I. Tolstov, S.N. Naumkin, A.R. Torbin1,2, M.A. Metbel, M.C. Heaven1,2, V.N. Ayazov1; 1 - Samara State Aerospace Univ., 2 - Lebedev Physical Inst. RAS, Samara branch, Russia, 3 - Florida International Univ., United States, 4 - Emory Univ., United States

Diode-pumped alkali vapor lasers (DPAL) commonly use CH4 or C2H6 to induce energy transfer between n2P3/2 and n2P1/2 levels. A complication is that the alkali metal reacts with the hydrocarbons. High-level ab initio calculations have been used to study the reactive interactions between Rb and CH4 or C2H6.

**ThR2-p10 15:00-19:00**

*Ablation of optical transparent materials using picosecond laser pulses*

A.G. Verkhoogliad, M.F. Stupak, Technological Design Inst. of Scientific Instrument Engineering SB RAS, Russia

We present experimental results of the different processes that can give from focusing an ultrashort laser light in the picosecond regime on a host of transparent materials, e.g., a silica, a silica glass and dielectric films. We summarize the physical processes and surface and bulk applications and highlight how picosecond lasers can be used to process various materials. Throughout this paper, we will show the advantages and disadvantages of using ultrashort lasers demonstrate their potential for the precision processing of materials and structures.

**ThR2-p11 15:00-19:00**

*Electrohydrodynamic flow application in gas discharge laser circulation system*

I.E. Rebrov, D.V. Dreenun, Yu. V. Khonich, V.A. Yamschikov, Inst. for Electrophysics and Electric Power RAS, Russia

Electric discharge N2-laser with circulation system based on electrohydrodynamic (EHD) flow is described. Experimental studies and mathematical modeling of EHD flow considering configuration of circulation chamber and discharge gap have shown value of a stream more then 15 l/s.

**ThR2-p12 15:00-19:00**

*Evaporation of optical quality of Chemical Oxygen-Iodine Laser (COIL) active medium*

Yu.A. Adamenkov, M.I. Bezzukov, M.A. Garbunov, M.L. Leonov, A.V. Seleznev, D.V. Sokolov, RFNC-VNIIEF, Russia

We have developed optical techniques for supersonic Chemical Oxygen-Iodine Laser (COIL) active medium exploration using focal spot methods. It has been found out that optical impurities of active medium density in an optical resonator area were less than resolution limit of out apparatus, that is An/m.

**ThR2-p13 15:00-19:00**

*Modeling of photolysis oxygen-iodine laser*

S.Y. Pichugin1, A.A. Pershin2, V.N. Ayazov1; 1 - Lebedev Physical Inst., Samara Branch, 2 - Samara State Aerospace Univ, Russia

A theoretical model for predicting of the pulsed photolysis oxygen-iodine laser (POIL) performance has been developed. The calculated output energies of the POIL are in good agreement with experimental ones. Pathways in which the energy of O(1D) is converted to excitation energy of singlet oxygen molecule are discussed.

**ThR2-p14 15:00-19:00**

*Radio frequency and microwave excited planar inert gas mixture infrared lasers*

A.P. Mineev, S.M. Nefedov, R.P. Pashinin, P.A. Goncharov, V.K. Liselev, Prokhorov General Physics Inst. RAS, Russia

Radiation characteristics of planar diffusion-cooled RF lasers are investigated. For the first time a large area RF discharge (2.7x40x385 mm) at a frequency of 40.68 MHz in dependence on gas mixture composition and pressure have been studied. As a result of our experiments we were the first to produce a generation of a planar Ar–He and Kr–He lasers with the transverse cw RF discharge. Planar laser with the transverse cw RF discharge is shown as promising radiation source at a wavelength of 1790 nm and efficiency has been obtained. Combining efficiency degradation sources have been identified and its dependence on some specific misalignments discussed.

**ThR2-p15 15:00-19:00**

*Exploration of optical quality of Chemical Oxygen-Iodine Laser (COIL) active medium*

E.H. Rebrov, D.V. Dreenun, Yu. V. Khonich, V.A. Yamschikov, Inst. for Electrophysics and Electric Power RAS, Russia

We present experimental results of the different processes that can give from focusing an ultrashort laser light in the picosecond regime on a host of transparent materials, e.g., a silica, a silica glass and dielectric films. We summarize the physical processes and surface and bulk applications and highlight how picosecond lasers can be used to process various materials. Throughout this paper, we will show the advantages and disadvantages of using ultrashort lasers demonstrate their potential for the precision processing of materials and structures.
R2. HIGH POWER LASERS

ThR2-p15 15:00-19:00

The efficiency research of laser energy conversion to the third harmonic for ‘Iskra 5’ iodine laser
A.V. Zubkov, S.V. Kalipanov, V.P. Kovalenko, S.P. Kumapalov, V.S. Fazullin; RFNC-VNIIEF, Russia

The method of detection of carbon monoxide on the base of laser diode with Y.V. Lebiadok, D.M. Kabanau, A.N. Imenkov, Y.P. Yakovlev; 1 - SSPA “Optics, Base of GaInAsSb heterolaser ThR3-p05 09:30-13:30

Optical components testing of powerful laser facility based on wavefront and surface profile analysis

Research of energy characteristics of the «Luch» facility power amplifier containing KNFS Nd-phosphate glass slabs and MIRO Silver foil reflectors I.A. Belov, S.A. Bel’kov, I.N. Voronich, S.G. Garanin, V.N. Derkach, S.V. Koschechkin, M.I. Lysov, S.S. Markov, S.V. Savkin; RFNC-VNIIEF, Russia

R3. SEMICONDUCTOR LASERS, MATERIALS AND APPLICATIONS

ThR3-p01 09:30-13:30

High-power 808 nm laser bars (5mm) with wall-plug efficiency more than 67%
T.A. Bagaev, M.A. Ladugin, A.Y. Andreev, A.A. Marmalyuk, S.M. Sapozhnikov, A.V. Lobintsov; R&D Inst. Polus, Russia

High-power 808 nm laser diodes with different waveguides have been compared. It was demonstrated that structures with broad asymmetrical waveguide has higher output power than that with narrow symmetrical waveguide.

ThR3-p02 09:30-13:30

Spatial current density distribution of «vertical» and «face-up» high-power blue AlGaN LMEDs
A.V. Aladov, A.E. Chernyakov, A.L. Zakgeim; Submicron Heterostructures for Microelectronics, Research Engineering Center RAS, Russia

This paper studies current spreading, light emission and heat transfer in high-power «vertical» and «face-up» AlGaN light emitting diodes (LEDs).

ThR3-p03 09:30-13:30

Frequency stability of miniature quantum magnetometer with laser pumping
S.V. Ermak, M.V. Petrenko, V.V. Semenov; 1 - Peter the Great St. Petersburg Polytechnic Univ., 2 - Ioffe Inst., Russia

ThR3-p04 09:30-13:30

Q-switch in injected quantum dot laser
E.A. Viktorov, T. Ermeux, B. Tykałowicz, D. Goulding, P.R. Hegarty, G. Huyet, L.N. Dubinkin, N.A. Fedorov, B. Kelleher; 1 - ITMO Univ., Russia, 2 - Univ. Libre de Bruxelles, Belgium, 3 - Univ. College Cork, Ireland, 4 - Cork Inst. of Technology, Ireland, 5 - Tyndall National Inst., Ireland

We report on Q-switched operation in an optically injected quantum dot laser. It results from the ability of the laser to emit simultaneously from the ground state (GS) and first excited state (ES). The injected GS operates as a gate for the ES output.

ThR3-p05 09:30-13:30

Carbon monoxide concentration measurement on the base of GaInAsSb heterolaser
Y.V. Lebiadok, D.M. Kabanau, A.N. Imenkov, V.P. Yakovlev; 1 - SSPA “Optics, Optoelectronics & Laser Technology”, Belorus, 2 - Ioffe Inst., Russia

The method of detection of carbon monoxide on the base of laser diode with GaInAsSb quantum active layer and its characteristics are discussed in the report.

ThR3-p06 09:30-13:30

Modeling a semiconductor quantum dot laser
I.V. Koryukin; Inst. of Applied Physics RAS, Russia

We analyze the electron-hole asymmetry model of a semiconductor quantum dot laser at different relaxation rates of the transitions between electron and hole levels. It is shown that the model can be simplified when the relaxation between hole levels is much faster than the relaxation between electron levels.

ThR3-p07 09:30-13:30

Quantum cascade laser grown by MOCVD and operating at 9.7 μm

A quantum cascade laser emitting in the spectral range of 9.7 mm at 77 K has been developed. The laser heterostructure based on GaAs/AlGaAs was grown by the MOCVD technology. In the pulsed operation mode, the threshold current density of ~2 kA/cm² and the emission power of above 200 mW have been obtained for the laser of the dimensions of 30 mm x 3 mm.

ThR3-p08 09:30-13:30

Perforated micronizing resonators
I.V. Levitski, V.P. Evtkhiev; 1 - SMP R&E Center, Russia, 2 - Ioffe Inst., Russia

We propose a novel approach to control mode structure of micronizing resonators using subwavelength hollow core defects. Their influence on mode structure was studied computationally and experimentally.

ThR3-p09 09:30-13:30

Metamaterial for the second harmonic generation
G.M. Savchenko, V.V. Dudlev, K.K. Soboleva, V.V. Lundin, A.V. Sakharov, A.G. Deryagin, V.I. Kuchiniskii, N.S. Averkiev, G.S. Sokolovskii; 1 - Ioffe Inst., 2 - St. Petersburg Electrotechnical Univ, 3 - Peter the Great St. Petersburg Polytechnic Univ, Russia

We investigate the metamaterial with the structure comprising alternating semiconductor layers with intrinsic and metallic conductivity that can be grown epitaxially. The metamaterial is designed to demonstrate artificially low dispersion of the refractive index for the efficient second harmonic generation.

ThR3-p10 09:30-13:30

Dynamic model of laser-thyristor based on AlGaAs/GaAs heterostructure for subnanosecond optical pulse generation
O.S. Soboleva, A.A. Podoskin, V.S. Yuferev, N.A. Pikhtin, S.O. Slipchenko, I.S. Tarasov; 1 - Ioffe Inst., Russia

A new approach to high power laser pulse generation based on current switch integrated in to laser heterostructure has been demonstrated. The modeling of various structure designs has been performed and the possibility of obtaining short (2ns) and high amplitude (16 A) current pulses and generating of high-power (46W) optical pulses in optimized structure has been shown.
ThR3-p11 09:30-13:30
Dark soliton generation from semiconductor optical amplifier gain medium ring fiber configuration
S.N. Turutov1, P.A. Chernyshchev2, K.A. Fedorov3, A.A. Gorodetsky4, E.U. Rahafol4; 1 - Univ. of Dundee, 2 - Aston Univ., United Kingdom
We have investigated the mode-lock operation from a semiconductor optical amplifier (SOA) gain chip in the ring fibre configuration. At lower pump currents, the laser generates dark soliton pulses both at the fundamental repetition rate of 39 MHz and supports up to the 6th harmonic order corresponding to 234-MHz repetition rate with an output power of ~2.1mW. At higher pump currents, the laser can be switched between the bright, dark and concurrent bright and dark soliton generation regimes.

ThR3-p12 09:30-13:30
Effect of waveguide design on AlGalNAs/InP laser diode characteristics
1500nm-lasers based on MOCVD-grown heterostructures are investigated. It is determined, that additional barrier layers grown between waveguide and cladding layers block carrier leakage into the cladding layers but results in internal optical loss rise with drive current increase. It is demonstrated that incorporation of barrier layers allows obtaining 92% internal quantum efficiency and 3.2W CW RT output optical power.

ThR3-p13 09:30-13:30
ZnSe-based laser array pumped by electron beam with energy below 6 keV
M.M. Zverev1, N.A. Gamanov1, E.V. Zhdanova1, V.B. Studionov1, I.V. Sedova1, S.V. Sorokin1, S.V. Gronin2, S.V. Ivanov2; 1 - Moscow Technological Institute MEIEA, 2 - Ioffe Inst., Russia
ZnSe-based laser array pumped by a pulsed electron beam with an energy of 5.6 keV has been studied. Output pulse energy up to 180 W per one facet at wavelength of about 548 nm was measured at room-temperature.

ThR3-p14 09:30-13:30
Theory to optical properties of compound semiconductors for laser applications
K. Jandieri1, M. Wiemer1, S.D. Baranowskii2, Filipps Univ. Marburg, Germany
Using analytical calculations based on the set of rate equations and straightforward Monte Carlo computer simulations we provide theoretical description of the temperature-dependent effects for photoluminescence in Ga(NAsP) and GaAsb) successfully used for optically pumped and for electrically injected lasers. Comparison of the theoretical results with experimental data allows one to determine such decisive material parameters as the concentration of non-radiative centres, the compositional dependence of the band gap, and the energy dependence of the density of localized states in the band tails.

ThR3-p15 09:30-13:30
Statistical properties of polarization noise in multimode VCSELs
V.N. Chizhevsky1, A.S. Maloashon2; 1, - Stepanov Inst. of Physics NASB, Belarus, 2 - IOTMO Univ, Russia
We report an experimental study of local and integral statistical properties of polarization noise in multimode VCSELs in broad ranges of the injection current and of laser diode aim to find maximal min-entropy of polarization noise used as a source of randomness for the fast random bit generation.

R4. LASER BEAM CONTROL

ThR4-p01 15:00-19:00
Characterizing photonic nanojets from phase diffraction gratings
A.A. Zemlyanov1, Yu.E. Geints2; Zuev Inst. of Atmospheric Optics SB RAS, Russia
We investigated numerically the specific spatially localized intense optical structures, i.e., photonic nanojet (PNJ), formed in the near-field scattering of optical radiation at phase diffraction gratings. The finite-difference time-domain technique was employed to study the PNJ key parameters (length, width, focal distance, intensity) produced by diffraction gratings with the saw-tooth, rectangle, and hemispheric line profiles.

ThR4-p02 15:00-19:00
Analysis of optical fiber complex propagation matrix in the basis of vortex modes
V.S. Lysubavyt2, A. Tatarczak1, X. Lu1, R.V. Kutliyayov1, S. Romn1, A.Kh. Sultanov2, I. T. Monr1, 1 - Ufo State Aviation Technical Univ, Russia, 2 - Technical Univ. of Denmark, Denmark
We propose and experimentally demonstrate a novel method for reconstruction of the complex propagation matrix of optical fibers supporting propagation of multiple vortex modes. This method is based on the azimuthal decomposition approach and allows the complex matrix elements to be determined by direct calculations. We apply the proposed method to demonstrate the feasibility of optical compensation for coupling between vortex modes in optical fiber.

ThR4-p03 15:00-19:00
Correction of wavefront distortion in YAG:Nd active elements in oblique geometry
Yu.D. Arapov1, V.P. Karakolov2, R.K. Nasyrov3, A.I. Malyshev3, I.M. Ustyanstev4, I.V. Kas'yanov3; 1 - RFNC-VNIIEF, 2 - Inst. of Automation and Electromotion SB RAS, Russia
The paper is devoted to correction of wavefront distortion in large aperture YAG:Nd active elements in oblique geometry by means of conformal correctors.

ThR4-p04 15:00-19:00
Specific features of defects image in doped lithium niobate crystals in polarized light
V.A. Maksimenko; Far Eastern State Transport Univ., Russia
This paper presents the experimental investigation of the photo-induced defects in doped lithium niobate crystals with various polarizations of inducing and testing laser beams. How do the forms of defect images depend on the light polarization is being discussed.
A novel method of surface acoustic wave-based sensors production using laser ablation method is proposed. It provides excellent matching of topologies on a compact multiple pass laser amplifier.

The formation of optical vortex array in broad-area laser is studied using the Maxwell-Bloch equations. The square optical vortex array solution was obtained analytically. Stability of the vortex array solution was investigated both analytically and experimentally. Instability leads to oscillations in the vortex array. The frequency of vortices oscillations was obtained.

We suggest a technique for generation of optical vortex beams with a variable diameter. The propagation dynamics of a vortex beam synthesized is determined. The propagation of vortex beam through a turbulent atmosphere was investigated experimentally and numerically. Instability leads to oscillations in the vortex array. The frequency of vortices oscillations was obtained.

Visualization of transparent microinhomogeneity in the nonlinear optical crystals by phase-contrast technique with adaptive photothermal Zernike filter.

Visualisation of growth-sector boundary and point defects in nonlinear optical crystals by phase-contrast technique with adaptive photothermal Zernike filter.

Suppression of self-mode-locking and control of mode-locking regime of neodymium laser with single crystal GaAs into the cavity.

Low cost adaptable laser transmitter for ground-based orbital observations.

The paper considers the action of conical axicon and the matched linearly layered lens on focusing of the laser beam using FDTD method.

We present optimized predictive controller for adaptive optics system (AOS) that used hypothesis of «frozen» turbulence and Kalman filtering to predict turbulent phase distortions.

Calculation the cross-wind speed at the entrance aperture of an adaptive optical system is performed based on the correlation analysis of the centroids coordinates measured by a Shack-Hartmann wavefront sensor. To ensure the accuracy of the algorithm that calculate cross-wind speed, it must be resistant to noise caused by the sensor construction and performance of mathematical operations. Results of the numerical simulation are presented.

The method to calculate the cross-wind speed at the entrance aperture of an adaptive optical system is performed based on the correlation analysis of the centroids coordinates measured by a Shack-Hartmann wavefront sensor. To ensure the accuracy of the algorithm that calculate cross-wind speed, it must be resistant to noise caused by the sensor construction and performance of mathematical operations. Results of the numerical simulation are presented.
ThR4-p22 15:00-19:00
Thermo-optical phase distortions analysis in high power fiber laser systems
P.A. Semenov, I.P. Zhigan, V.P. Kiselev; A.S. Filatov; KB «Kvantsovo», Russia
This work provides theoretical and experimental results of thermo optical phase distortions analysis in 5 kW high power fiber laser with various optical systems. The comparative analysis of beam formation system with various optical materials is conducted. Optimal parameters of various systems are defined.

ThR4-p23 15:00-19:00
Image processing by means of orientational self-action of light in nematic liquid crystal
E.L. Bubis1, I.V. Kuzmin1, I.A. Budagovsky2, S.A. Shvetsov3, M.P. Smayev, A.S. Zolot'ko2, A.Yu. Bobrovsky1, 1 - Inst. of Applied Physics RAS, 2 - Lebedev Physical Inst. RAS, 3 - Moscow Inst. of Physics and Technology. The Zernike method using a nematic liquid crystal (NLC) filter with orientational optical nonlinearities was applied to visualize phase objects. It was shown that the contrast sign of the image switches by means of varying the incidence angle of a light beam on liquid crystal cell. The comparison of a contrast sign change for various objects in the schemes based on NLC-filter and on liquid filter with thermal optical nonlinearity was performed.

ThR4-p24 15:00-19:00
Assessment of the microoptical gyro parameters for provision of the given limiting sensitivity
Yu.V. Filatov1, E.V. Shalymov1, V.Tu. Venediktov2; 1 - St. Petersburg State Electrotechnical Univ., 2 - St. Petersburg State Univ., Russia
The paper considers the assessment of the parameter values of microoptical gyro, that uses amplitude and phase characteristics of the passive ring resonator, are required to achieve the limiting sensitivity 1°/h.

ThR4-p25 15:00-19:00
The results of experimental research adaptive optical system at different wavelengths
V.Yu. Venediktov1, A. Gorel'ya1, E. Shubenko2, D. Dmitriev1, I. Lochvy1, A. Tverkov1, 1 - St. Petersburg State Electrotechnical Univ., 2 - St. Petersburg State Univ., 3 - Scientific Research Inst. for Optoelectronic Instrument Engineering, Russia
The paper presents the first results of investigations of implementation of the closed-loop adaptive optical system at the beamlet segment with the different length optic path, and reserch operation on different optical wavelengths.

ThR4-p26 15:00-19:00
The gradient method of deformable mirror surface calculation and method realization in «Luch» facility wavefront correction system
I.N. Varonich, V.G. Gladkiy, M.A. Gluhov, V.N. Derkach, I.N. Derkach, R.S. Kuzin, I.E. Chernov; RFNC-VNIIEF, Russia
The new method of deformable mirror surface calculation based on rms phase gradient minimization is described. The method introduced on «Luch» allows to minimize laser beam divergence using adaptive system and to decrease calculation time up to 1-2ms at the same time. The experimental dependence of laser beam divergence on rms phase gradient for «Luch» facility is given.

ThR4-p27 15:00-19:00
Auto alignment system for 100 Hz Nd:YAG laser
A.A. Ryzhov1, I.M. Belousova1, D.A. Vilenich2, A.C. Parfutova1, S.K. Estrayev1, K.S. Estrayev1, M.I. Kudryakov1; 1 - ITMO Univ., 2 - FSUE "RI PhOOLIOS" of RC "S.I. Vavilov SOI", 3 - Peter the Great St. Petersburg Polytechnic Univ., Russia
The optical corrector for beam stabilization is investigated. We use galvo motors and position-sensitive photodetector for real time optical axis guiding. The system is developed for the purpose of 1.064 μm 100 Hz pulsed laser auto alignment system.

ThR4-p28 15:00-19:00
Spectral and optical limiting properties of ZnS nano and bulk crystals
A.A. Ryzhov1, I.M. Belousova1, D.A. Vilenich2, A.C. Parfutova1, S.K. Estrayev1, K.S. Estrayev1, M.I. Kudryakov1; 1 - ITMO Univ., 2 - FSUE "RI PhOOLIOS" of RC "S.I. Vavilov SOI", 3 - Peter the Great St. Petersburg Polytechnic Univ., Russia
Some features of spectral and non-linear optical properties of ZnS quantum dots stabilized by high-molecular polyvinylpyrrolidone have been studied. It is shown that the absorption spectra of ZnS composite materials (sols, coatings) in UV spectral region are determined by quantum confinement effect, exhibiting the dependence of the absorption edge of the size of the ZnS nanocrystals.

ThR4-p29 15:00-19:00
Propagation of vortex eigenfunctions of bounded Hankel transform in a parabolic fiber
M.S. Kirilenko1,2, O.A. Massouli1, S.N. Khanina1,2; 1 - Samara State Aerospace Univ., 2 - Image Processing Systems Inst. RAS, Russia
The fractional Fourier transform (FrFT) was considered in the paper. The vortex singular eigenfunctions of bounded Hankel transform and its propagation through FrFT were studied.

ThR4-p30 15:00-19:00
Quantum dots as luminescent label for immunoassay
A.M. Sobolev1, M.V. Pazhara1, N.V. Beloglazova1,2, L.Yu. Goryacheva1,2, I. Saratov National Research State Univ., Russia, 2 - Ghent Univ., Belgium, 3 - St. Petersburg State Univ., Russia
Luminescent semiconductor quantum dot labels are popular for immunoassay. Synthesis and application of quantum dots as luminescent label and also acceptor for fluorescence resonance energy transfer is described.
Photoactivation of gibberellin influenced by radiation on the surface of plant tissues
A.A. Yakovlev1,2, A.S. Durov1,2, A.S. Grishkanich1, S.V. Kascheev1, A.A. Mak1, J.S. Ruzankina1,2; 1 - St. Petersburg State Forest Technical Univ., 2 - ITMO Univ., Russia
Researches are conducted on studying of the biological processes caused by violet (405 nm) and red (640 nm) laser radiation on seed integumentary layers. A cycle of experiments was carried out to study the dependence of Picea abies a (a fir-tree ordinary, family pine) seed sowing qualities from the influence of laser radiation in different conditions. After being exposed by laser influence, seed germinating ability and seedling growth were studied and compared with the indexes of control group. Results showed that the radiated seed germinating ability is higher, than the one of control group of seeds.

Increase of steel corrosion resistance by photonics
J.S. Ruzankina1, V.V. Elizarov1, S.V. Kascheev1, O.S. Vasilyev2, A.A. Mak1, A.P. Zhevlakov1, ITMO Univ., Russia
The study is devoted to metal corrosion resistance increase possibility by means of laser oxidation. There are represented the results of experimental research of metal surface anti-corrosion protection while oxidizing it by constant fiber laser emission on wavelength λ = 1064 nm. Several tests were carried out to define the optimal processing parameters providing the high anti-corrosion protection of irradiated metal surface.

Creation platinum nanostructures for pH environment analyzer
V.V. Stepanov1, V.V. Elizarov1, A.S. Grishkanich1, A.P. Zhevlakov1, ITMO Univ., Russia
Role and value of pH measurement in bionanotechnologies. Development operation of pH element on the basis of Pt-nanofilms created by the LED method. Manufacture Pt-nanofilm by LED method, agreement with the hypothesis and confirmation of touch element serviceability and suitability. Experiment realization and obtaining the experimental data.

The investigation of aging process of writing inks printed on paper using Raman spectroscopy
K.D. Garshkova1, L.I. Temkin1, A.S. Toromanovich1, E.R. Rossinskaya2, V.A. Kochemirovsky3; 1 - St. Petersburg State Univ., 2 - Kutafin Moscow State Univ. of Law, Russia
The durability against light and aging dynamics of heterogeneous aromatic colorants containing nitrogen atoms used in writing inks was studied using Raman spectroscopy. The mechanisms of their thermal, photo-decomposition were proposed and the rates of these processes were determined. The results obtained in this study can be used for the age estimation of the paper documents up to 15 years.

Eye-safe DPSSL-based TOF-camera for geodesy
A.V. Kovalov1, V.M. Polyakov1, V.A. Buchenkov1; ITMO Univ., Russia
We present a new TOF camera design based on a compact actively Q-switched diode pumped solid-state laser operating in 1.5 μm range and a receiver system based on a short wave infrared InGaAs PIN diodes focal plane array with an image intensifier and a special readout integration circuit. The compact camera is capable of depth imaging up to 4 kilometers with 10 frame/s and 2.5 m resolution. The camera could be applied for airborne and space geodesy location and navigation.

Imaging of hidden objects in millimeter wavelength range
G.S. Rogazhnikov1, I.V. Mishina1, RFNC-VNIIEF, Russia
Electromagnetic radiation of millimeter and sub-millimeter wavelength range can penetrate through the sufficient number of constructional and domestic materials, that's why it is widely used in remote sensing of objects hidden behind the opaque barriers. Present-day technologies and methods make it possible to obtain information both about the appearance of the hidden object with spatial resolution on the order of wavelength and its structure. In this paper we show some ways of enhancing the self-descriptiveness of images being registered at 139-141 GHz frequencies by taking into account barrier features and object location behind the barrier.

SERS-platforms based on alumina and silica with embedded Ag nanoparticles for pre-concentration and detection
N.S. Yurova1,2, A.V. Markin1, T.Yu. RUnited Statesnova1,2, A.A. Mak1,2, A.V. Kovalev1,2; 1 - Lebedev Physical Ins. RAS, 2 - Kutafin Moscow State Univ., Russia
New SERS-active materials were obtained by preparation of alumina and silica with embedded silver nanoparticles. Synthesized materials were applied for pre-concentration of model analytes and their SERS detection directly within the sorbents. The optimal conditions (sonic strength of Ag nanoparticles solution, conditions of silica and alumina synthesis and conditions of analyte pre-concentration) for maximum SERS signal enhancement were chosen.

Self-visualization and self-inverting of objects and structures when focusing spatially-phase-modulated laser radiation in weakly absorbing air environment
E.L. Bubis1, A.M. Kiselev1, I.V. Kuzmin1, S.A. Gusev1, E.V. Skorokhodov2, 1 - Inst. of Applied Physics RAS, 2 - Inst. for Physics of Microstructures RAS, Russia
Processes of self-visualization and self-inverting of objects and structures when focusing spatially – phase-modulated laser radiation in weakly absorbing air environment about addition of small amount of vapors of molecular bromine are realized. The required power of laser radiation for realization of processes doesn’t exceed 200 mW. Processes can be useful when developing laser ladar techniques and measurements for atmospheric remote sensing.

Detecting of thin oil films on water surface via UV filaments
A.A. Ionin1,2, V.M. Mokrousova1,2, V.A. Sereznnev1, D.V. Sinitzyn1, E.S. Sunchugasheva1,2; 1 - Lebedev Physical Ins. RAS, 2 - Moscow Inst. of Physics and Technology, Russia
Femtosecond UV laser pulse induced fluorescence of thin oil films located on water surface was studied experimentally. Wide range of laser pulse intensity including filamentation mode was studied. This method was implemented for femtosecond UV pulses of two central wavelengths of 248 or 372 nm. Spatial resolution of the fluorescence localization was demonstrated to be not worse than 30 cm.
8th International Symposium on High-Power Fiber Lasers and Their Applications

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KEY TOPICS OF THE SYMPOSIUM

• High power fiber lasers for material processing applications
• Cutting and welding with kW fiber lasers
• Fiber laser cladding, sintering, heat treatment and additive technology
• Fiber lasers for automotive applications
• Mid power fiber laser applications
• Pipe and thick section welding
• Marking and engraving
• Mid infra-red, 2 to 3 micron fiber lasers, processing including
• Cutting and welding of plastics
• Visible, UV and ultrafast fiber lasers and applications
• Hybrid lasers
• Life Sciences, medical, surgical, food production, agricultural pest and herbal control applications of fiber lasers
• New materials and parts for fiber lasers: fibers, crystals, glasses, optics, nonlinear elements
TuS1P-01 Plenary 09:00-09:40
Modern state and prospects of applications high-power fiber lasers
V.P. Gapontsev; IPG Photonics Corp., United States
Modern accessories of fiber lasers - their designs and manufacturing techniques. New opportunities of application over powerful lasers.

TuS1P-02 Plenary 09:40-10:20
New developments for laser beam welding with high power fiber laser
J. Standfuss1, E. Beyer1, D. Dittrich1, B. Brenner1, S. Nowotny1, S. Thieme1, F. Brueckner1, C. Leyens1,
1 - Fraunhofer Inst. for Material and Beam Technology, IWS, 2 - Technical Univ. Dresden, Germany
New fiber laser offers a wide range for new advanced laser beam welding technologies for hard-to-weld materials like aluminum or for precise built-up welding. The paper will describe different possibilities and technologies. The brilliant beam quality allows multi-pass welding with extremely narrow gap of less than 5 mm for welding depth up to 50 mm and above. With high frequent beam oscillation of up to 4 kHz and resulting keyhole stabilization pressure die casting aluminum are weldable with tight weld seams. Furthermore new optical configurations like processing heads with coaxial wire feeding allow new applications for welding, cladding and additive manufacturing.

TuS1P-03 Plenary 10:20-11:00
Theory and technology of high productive direct laser deposition by means of high power fiber laser
The article deals with physical processes of material transfer and shape formation in direct laser deposition. Mathematical model of deposition process, joined jet dynamics, powder transfer and heating by laser beam, melt pool formation and stability was developed. Experimental installation was designed on the base of 5 kW fiber laser. Calculation results were verified by comparison with experimental ones.
TuS1A-03 Invited 11:30-11:50
Raman fiber lasers with direct pumping by high-power laser diodes
S.A. Babin1, E.I. Zlobina1, S.I. Kablukov1; 1 - Inst. of Automation and Electrometry SB RAS, 2 - Novosibirsk State Univ., Russia
A brief review of recent results obtained with LD-pumped Raman fiber lasers (RFLs) is given. Direct pumping of gradient-index fibers by multimode LDs offers RFL operation at ~980 and ~950nm with efficiency >40%. Herewith, the quality of output beam is greatly improved as compared with that of LDs. Further development in direction of all-fiber design and higher efficiency is shown.

TuS1A-02 Invited 11:50-12:10
High-energy femtosecond all-fiber oscillator
D.S. Kharenko1, V.A. Gonta1, S.A. Babin1; 1 - Inst. of Automation and Electrometry SB RAS, 2 - Novosibirsk State Univ., Russia
We demonstrate a successful scaling of the pulse energy by increasing the cavity length and the mode-field diameter of the fiber simultaneously. Highly-chirped pulses with energy above 50 nJ at 250 fs compressed duration are generated in the all-fiber all-normal-dispersion cavity with 40-m long 10µm core PM fiber. The maximum pulse energy was limited by the Raman effect.

TuS1A-04 12:30-12:50
2-µm hybrid lasers based on Tm3+:Lu2O3 ceramics in-band pumped by Raman-shifted erbium fiber lasers and their OPO frequency conversion
O. Antipov1, O. Novikov1, S. Larin2, I. Obronov2; 1 - Inst. of Applied Physics RAS, 2 - NTO “IRE-Polus”, Russia
Fiber–broadband hybrid lasers are investigated. Radiation of 30 W power at 2090 nm is obtained from Ho:YAG laser, pumped by 1908 nm thulium fiber laser. Radiation of 2.4 W at 1645 nm is obtained from Er:YAG laser, pumped by 1475 nm Raman fiber laser. The OPO2 AOM is used as a Q-switch for high pulse energy generation.

TuS1A-05 12:50-13:10
Millijoule level nanosecond hybrid thulium pulsed laser
I.V. Baranov1, V.E. Spyin1, S.V. Larin1, D.V. Myasnikov2, G.L. Antipov2; 1 - NTO “IRE-Polus”, 2 - Moscow Inst. of Physics and Technology, Russia
New thulium laser module with hybrid Tm:Lu2O3 booster is presented. Module operates in pulsed mode and has following characteristics: pulse width 10ns, pulse energy up to 1µJ, pulse repetition rate up to 20kHz.

TuS1A-06 13:10-13:30
Single-mode broadband red fiber laser
O.A. Byalkovsky1, V.A. Tyryshnyy1, E.S. Golubynskiy1; 1 - NTO “IRE-Polus”, 2 - Moscow Inst. of Physics and Technology, Russia
18 W of red laser radiation at 633 µm with 3 nm spectral bandwidth was achieved by sum frequency generation (SFG) of Er and Yb pulsed fiber lasers radiations at 1.55 µm and 1.06 µm wavelengths respectively. Noncritical phase matching in lithium triborate (LBO) crystal at 16°C of temperature was used.

- Lunch Break -

TuS1A-07 15:00-15:20
Simulation of nonlinear polarisation rotation laser with consideration of continuous wave emission
D.V. Protasenya, A.I. Baranov, D.V. Myasnikov; NTO “IRE-Polus”, Russia
Simulation of mode-locked lasers operation became an indispensable part of their investigation. Some drawbacks of conventional model have been revealed in my work. Addition of continuous emission to numerical model was shown to give much better correspondence with experiment.

TuS1A-08 15:20-15:40
High power ultrashort fiber laser system at 1.55 µm
A.I. Baranov, D.V. Myasnikov, D.V. Protasenya, A.S. Demkin, VP Gapontsev; NTO “IRE-Polus”, Russia
Ultrashort erbium fiber laser system is presented. Optical module is integrated in IFG standard rack. Pulses with energy up to 20 microjoules are obtained, whereas maximum pulse repetition rate is 2 MHz. One of the main features of the system is fast individual pulse energy modulation. Burst mode of several pulses with specified pulse energy is also supported.

TuS1A-09 15:40-16:00
High power QCW Raman fiber laser at 1246 nm
A.V. Pigarev1, A.A. Surin1, D.V. Myasnikov1; 1 - NTO “IRE-Polus”, 2 - Moscow Inst. of Physics and Technology, Russia
A quasi-continuous-wave all-fiber Raman fiber laser is demonstrated with a master oscillator power amplifier scheme. Ytterbium-doped booster is seeded with wavelengths 1069 and 1246 nm at the same time. Amplified pump at 1069 nm converts to signal Raman wavelength in phosforollic active fiber. A 510 W peak power Raman fiber laser at 1246 nm with an optical efficiency of 58% for the respect to semiconductor multimode laser diode pump is demonstrated.

TuS1A-10 16:00-16:20
Pulsed erbium fiber laser with second harmonic generation in PPLT crystal
A.S. Denkin, A.I. Baranov, VT. Ahtyamov, D.V. Myasnikov; NTO “IRE-Polus”, Moscow Inst. of Physics and Technology, Russia
Nanosecond erbium fiber laser with frequency doubling in PPLT crystal at 780 nm is presented. Laser operates in the regime of constant pulse energy of 5 µJ and pulse duration of 2 ns at different frequencies in the range of 0.5-5 MHz. Average output power of 20 W was reached at the of 780 nm with 70% conversion efficiency.

TuS1A-11 Invited 16:20-16:40
Ultra-wide wavelength tuning of fiber lasers
Ya. Feng, Shanghai Inst. of Optics and Fine Mechanics CAS, China
In the talk, we will review the recent development on ultra-wide wavelength tuning of fiber lasers based on stimulated Raman scattering and Rayleigh scattering.

TuS1A-12 Invited 16:40-17:00
Thermal optimization of high power fiber laser systems
C. Jauregui1, H.-J. Otto1, C. Stihler1, J. Limpert1, A. Tünnermann1,2,3; 1 - Inst. of Applied Physics, Abbe Center of Photonics, Friedrich-Schiller- Univ., 2 - Helmholtz-Inst., 3 - Fraunhofer Inst. for Applied Optics and Precision Engineering, Germany
This work presents an overview on the latest advancements in the understanding of transverse mode instabilities (TMI) together with guidelines to optimize high power fiber laser systems from the thermal point of view.
The paper deals with the research of the problem of thin titan plates laser welding by modeling the distribution of thermal fields. The key features of qualitative welding joints formation using hybrid laser arc welding of hull structures using high power fiber lasers have been investigated in this work including estimation of influencing parameters, numerical modeling and full scale experiments.

We present results of our experimental welding by powerful fiber lasers different metals and alloys.

We will discuss advantages and disadvantages of each approach and report on our progress in development of a machine for parallel macro and micro machining.

We present the technologies and apparatus for laser personalization of high security ID documents based of fiber lasers, including new security element replication using a micromachined tool, and parallel macro and micromachining. We present the research of the problem of thin titan plates laser welding by calculating the distribution of thermal fields with the method of the final element analysis for predicting structural phase state of the weld. The results of modeling were being checked by experiments. The patterns obtained were being investigated for phase-structural transformations, efforts to tear. There were found the modes enabling to weld thin titan plates with a high quality of the weld.

- Lunch Break -
WeS1A-13
QCW thulium fiber laser for medical application
V. Sypin1, A. Volkov2, D. Myasnikov2, F. Scherbina3, A. Maskhin1; 1 - NTO "IRE-Polus", Russia, 2 - Moscow Inst. of Physics and Technology, Russia, 3 - IPG Laser GmbH, Germany
New compact thulium fiber laser module is presented. Module operates in millisecond-pulse mode with peak power up to 500 W, average power up to 500 W, and pulse energy up to 5 J. The module is air-cooled and can be easily integrated in laser system.

WeS1A-14
Multi-kilowatt CW fiber laser systems with record wall-plug efficiency exceeding 50%
V. Gapontsev1, E. Shcherbakov1, V. Fomin1, A. Abramov1, M. Abramov1, A. Ferrini2, M. Mirano2, A. Doronkin2; 1 - IPG Photonics, United States, 2 - IPG Laser GmbH, Germany
The new family of industrial-grade fiber lasers having wall-plug efficiency (WPE) exceeding 50% in 1–10 kW CW optical power range is presented. Maximal achieved WPE value is world’s record 51.2%. Laser concept is based on the preliminary selection of laser components and matching of optimal operation ranges of different laser parts.

WeS1A-15
5 kW average power nano pulse fiber laser
V.P. Zelenova1, V.G. Zelenov2, V. Fomin1, A. Unt1, S. Maryashin1, M. Abramov1, M. Mirano2, A. Ferrini1, V. Khlobardin2; 1 - IPG Photonics, United States, 2 - IPG Photonics Corp., United States, 2 - IPG Laser GmbH, Germany
Parallel combining of multiple nanosecond pulse fiber lasers by means of fused fiber combiners is proposed to scale up the output power of pulse fiber lasers. The radiation of 7 laser modules is coupled into 300 μm core delivery fiber with BPP equalled to 18 mm·mrad. The achieved peak power 0.5 MW and pulse energy 50 mJ correspond to the average power 5 kW within 1064 nm wavelength range.

WeS1A-16
Industry grade ultrafast ytterbium fiber lasers for glass and sapphire
A. Yusim1, O. Shukirshin2, D. Myasnikov3, A. Podyvayzny4, A. Sevian5, A. Boarden6, I. Samarts2, N. Platono3, V. Gapontsev2; 1 - IPG Photonics, United States, 2 - NTO "IRE-Polus", Russia, 3 - NTO "IRE-Polus", Moscow Inst. of Physics and Technology, Russia, 4 - Inst. of Applied Physics RAS, 5 - Inst. of Laser and Information Technologies RAS, 6 - Moscow State Univ., Russia
We report an industrial grade picosecond pulse Yb fiber lasers with >100 μJ pulse energy and 100fs of average pulse for improved laser machining speed of sapphire and glass. The highly efficient laser with >25% wall-plug efficiency resides in a compact 3U rack mountable configuration. Customer controllable features such as repetition rate, pulse duration, burst mode and adjustable pulse energy permit the customer to tailor the laser to their application.

WeS1A-17
Theoretical modeling of Er/Yb-doped fiber laser
A.M. Volkov1, V. Sypin1, A. Baranov, D.V. Myasnikov; NTO "IRE-Polus", Moscow Inst. of Physics and Technology, Russia
High power Er/Yb-doped fiber laser generation is analyzed. Parameters of rate equations are clarified. Upconversion and excited state absorption coefficients are measured.

WeS1A-18
Compact broadly tunable high energy nanosecond Ti:Sapphire laser for photoacoustic applications
D.A. Ouladov1, I. Kuraten, R.S. Biryukov1, V.A. Konovalov, O.G. Melovatsky, Z.V. Hamatov; LASER-COMPACT, Laser-export Co. Ltd., Russia
We introduce TiSon GS - a novel gain-switched Ti:Sapphire laser. The laser outputs up to 1 mJ pulse energies with 10 ns pulse duration and 0.5 nm line width at 1 kHz repetition rate. Wavelength is automatically tuned in the range of 700–900 nm. Random wavelength access is possible with less than 1 ms switching time per any wavelength change.

WeS1A-19
Looking for efficient compressor for high pulse energy femtosecond fiber laser
S. Frankinas, A. Michailovas, N. Rusteika; Ekspil Ltd, Center for Physical Sciences and Technology, Lithuania
The results of pulse compression using different stretcher/compressor configurations of the fiber chirped pulse amplification system are demonstrated.

WeS1A-20
Influence of a backward optical signal on mode instability in Yb3+-doped fiber amplifier
D.A. Alekseev1, V.A. Tyrtynsky2, M.S. Kuznetsov3, O.L. Antipov5; 1 - NTO "IRE-Polus", 2 - Moscow Inst. of Physics and Technology, 3 - Inst. of Applied Physics RAS, 4 - Nizhny Novgorod State Univ, Russia
Influence of both backward reflections and laser radiation of independent source propagating in backward direction of ytterbium fiber amplifier on mode instability was investigated. Dependences of mode instability threshold on both power and wavelength of the backward signal were measured. In order to explain threshold behavior we took into account backward signal in our theoretical model.

WeS1A-21
Mode instability observation infiber amplifier of single-frequency radiation at 1560 nm wavelength
P.K. Pujui, M.V. Zelenova, V.A. Tyrtynsky; NTO "IRE-Polus", Russia
Mode instability was observed in fiber amplifier of single-frequency radiation at 1560 nm wavelength. Mode instability threshold is 3.5 W at 20 mW input signal and 12 W pump power. High order modes intensity, measured using fast photodiode, oscillates at 2 – 3 kHz frequency.

WeS1A-22
Experimental comparison of mode instability threshold in high power fiber amplifier and oscillator
X. Wang, H. Zhang, R. Su, R. Tao, P. Zhou, X. Xu; National Univ. of Defense Technology, China
We investigated the behavior and threshold of mode instability both in high power fiber amplifier and oscillator experimentally. Fiber oscillator and fiber amplifier using the same fiber with core/cladding diameter of 21/400μm and all pumped by laser diodes with center wavelength of 976nm. Results show that fiber laser oscillator holds a lower mode instability threshold than that in fiber amplifier.

WeS1A-23
Laser and supercritical fluid technologies for optical nano-composite materials fabrication
N.V. Minev1, A.D. Rybatovskiy1, V.N. Bagratashvili1; 1 - Inst. of Laser and Information Technologies RAS, 2 - Moscow State Univ., Russia
The technology of structured nanocomposite materials fabrication using supercritical fluid and laser approaches is elaborated. Different types of structures from Ag and Au nanoparticles in polymer and porous optical materials are produced: periodic layered nanostructures (horizontal to film surface) from Ag nanoparticles with unexpectedly short period (90 - 180 nm); filamentary tracks produced: periodic layered nanostructures (horizontal to film surface) from Ag and Au nanoparticles in polymer and porous optical materials are produced: periodic layered nanostructures (horizontal to film surface) from Ag and Au nanoparticles in polymer and porous optical materials are produced: periodic layered nanostructures (horizontal to film surface). Laser-induced ablation of Ag nanoparticles and rare earth metals. These composite materials are prospective for photonic, plasmonic, and sensor applications.

WeS1A-24
Periodically poled MgO doped LiNbO3 and LiTaO3 for coherent high frequency conversion
V.Yu. Shur1, A.R. Akhmatkhanov1, I.S. Baturlin2, M.A. Chuvakova1, A.A. Esin1; 1 - Ural Federal Univ, 2 - Lobef Ltd., Russia
We present the recent achievements in periodic poling in MgO doped single crystals of lithium niobate and lithium tantalate used for second harmonic generation and optical parametric oscillation based on quasi-phase-matched nonlinear optical wavelength conversion. The compact and highly efficient sources of visible and mid-IR laser light have been developed.

JUNE 27 - JULY 1, ST. PETERSBURG, RUSSIA
**TECHNICAL SESSION**

**8TH INTERNATIONAL SYMPOSIUM ON HIGH-POWER FIBER LASERS AND THEIR APPLICATIONS**

**SECTION S1A. FIBER LASERS AND COMPONENTS**

**Location:** Petrov-Vodkin 2 Room, floor 2, 15:00 – 17:00

**Fiber Lasers and Components V**
Session Chair: Nikolay N. Evtikhiev
NTO “IRE-Polus”, Russia

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**WeS1A-25 Invited**

**CVD diamond-prospective optical material**

V.I. Konov, Prokhorov General Physics Inst. RAS, National Research Nuclear Univ. MEPhi, Russia

It will be shown that diamond films and plates produced by plasma chemical deposition technique (CVD diamond) have a number of unique properties such as broadband transparency, record hardness and thermal conductivity. This combination makes CVD diamond extremely attractive for optics, in particular for high power laser systems. Examples of such applications will be demonstrated. Possibility of precise and productive surface and bulk micro and nanostructuring of diamond will be also considered.

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**WeS1A-26**

**Holmium doped fiber amplifier in the spectral region 2-2.15 µm**

V.A. Kamynin1,2, S.A. Filatova1, I.V. Zhukov1, V.B. Tsvetkov1,4; 1 - General Physics Inst. RAS, 2 - Perm Scientific Center, Ural Branch RAS, 3 - Moscow Technological Univ., 4 - National Research Nuclear Univ. MEPhi, Russia

We have demonstrated the amplification of the small signals in a spectral range of 2-2.15 µm by all-fiber Ho-doped amplifier pumped at 1125 nm. Maximum gain more than 35 dB was achieved.

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**WeS1A-27**

**Investigation of the reasons of spectrum distortion of the ytterbium femtosecond fiber laser, working by the Nonlinear Polarization Evolution effect**

I.S. Ulyanov, I.N. Bychkov, A.I. Bananov, D.V. Myasnikov; Moscow Inst. of Physics and Technology (State Univ.), NTO “IRE-Polus”, Russia

In this work we have investigated an influence of intracavity polarizer extinction ratio on the spectral shape of an Ytterbium mode-locked fiber laser, working by the Nonlinear Polarization Evolution effect. We have established both experimentally and theoretically, that reducing this extinction ratio causes distortion of spectral shape of the laser pulse specific ripple occurs. In present work physics involved in this process is explained.

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**WeS1A-28**

**Error analysis and experimental verification of a fiber based displacement interferometer**

X.C. Zhao1, Z.N. Li1, X.S. Tao1, Y.F. Wu2, N.W. Liu1; 1 - Inst. of Fluid Physics, CAEP, 2 - Univ. of Electronic Science and Technology of China, China

The error structure of fiber based displacement interferometers was studied, and an error compensation system developed. Experimental verification was achieved, contrasting gravitational acceleration between theoretical and measured results. The effective measurement velocity range was large with excellent precision.

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**WeS1A-29 Invited**

**Double-clad Yb-free Er-doped fibers for high average and peak power lasers**

L.V. Kotov4, M.M. Bubnov3, L.D. Lipatov3, M.V. Yashkov2, A.N. Guryanov2, M.E. Likhachev1; 1 - Fiber Optics Research Center RAS, 2 - Inst. of High Purity Substances RAS, Russia

An overview of recent progress in development of highly efficient, high average and peak power lasers based on Yb-free Er-doped double clad fibers is presented. The most promising applications of such devices are discussed.
TECHNICAL SESSION
8TH INTERNATIONAL SYMPOSIUM ON HIGH-POWER FIBER LASERS AND THEIR APPLICATIONS

SECTION S1A. FIBER LASERS AND COMPONENTS

Location: Petrov-Vodkin 2 Room, floor 2, 09:00 – 11:00
Fiber Lasers and Components VI
Session Chair: Nikolay N. Evtikhiev
NTO "IRE-Polus", Russia

ThS1A-30 Invited
09:00-09:20
Bismuth-doped fiber lasers and amplifiers: review and prospects
M.A. Melnikov, S.V. Alyshev, S.V. Fishtov, E.M. Dianov; Fiber Optics Research Center RAS, Russia

Review on recent results on lasers and amplifiers operating in four bands between 1.1 and 1.8 µm using Bi-doped active fibers with different compositions will be given. Future prospects of the Bi-doped fibers and devices will be discussed.

ThS1A-31
09:20-09:30
Mode locked fiber laser based on self-phase modulation and spectral filtering
I.N. Bychkov1,2, A.I. Baranov1,2, I.S. Ulianov2, D.V. Myasnikov1, I.E. Samartsev1,
1 - Moscow Inst. of Physics and Technology (State Univ.), Russia, 2 - NTO «IRE-Polus», Russia, 3 - IPG Photonics, United States

In this work we have investigated properties of passive mode-lock fiber laser based on spectral filtering and self-phase modulation effects. We achieved single-pulse mode-lock operation without external source using relaxation oscillations and accurately setting pump power. Numerical analysis of pulse generation in laser has been performed.

ThS1A-32
09:40-10:00
Wide aperture bimorph mirrors for high-power laser beam control
A. Kudryashov1,2, V. Samarkin1, A. Alexandrov1, P. Romanov1, G. Borsoni1,
1 - Moscow Inst. of Physics and Technology, Russia, 2 - Radio Engineering and Electronics, Russia

The deformable mirror with the size of 410x468 mm controlled by the bimorph piezoceramic plates and multilayer piezoceramic stacks was developed. The results of the measurements of the response functions of all the actuators and of the surface shape of the deformable mirror are presented in this paper. The study of the mirror with a Firex interferometer and a Shack-Hartmann wavefront sensor has shown that it was possible to improve the flatness of the surface down to a residual roughness of 0.033 µm (RMS). The possibility of correction of the aberrations in high power lasers was numerically demonstrated.

ThS1A-33
10:00-10:20
High power CW visible laser radiation at 623 nm generated by single pass SHG in PPLT crystal pumped by Raman fiber laser
Y.S. Svirman1,2, A.A. Surin1,2, T.E. Borsenko1, 1 - NTO «IRE-Polus», 2 - Moscow Inst. of Physics and Technology (State Univ.), Russia

We introduce efficient, linearly polarized, continuous wave Raman fiber laser (RFL) operating at 1246 nm with maximum output power 94 W and narrow spectral linewidth 0.17 nm. Single pass second harmonic generation (SHG) was demonstrated using 20 mm long MgO:PPLT crystal and 28 W of 623 nm radiation with 34 % conversion efficiency from 80 W of RFL was achieved.

ThS1A-34
10:20-10:40
State of polarization in anisotropic tapered fiber with extremely large core diameter
V.E. Ustinich1, M.Yu. Vytkin1, S.M. Popov1, Yu.K. Chamorovskii1, M. Filipov1, S.A. Nikitov2,3, 1 - Inst. of Radio-engineering and Electronics of RAS, Russia, 2 - Moscow Inst. of Physics and Technology (State Univ.), Russia, 3 - Russian Quantum Center, Russia

We produced numerical and experimental research of polarization maintaining properties of adiabatic anisotropic tapered optical fiber with extremely large output core diameter. Results show that polarization state of light coupling in the narrow end did not degrade dramatically through whole fiber length (while core diameter increasing adiabatically up to tens of wavelengths).

ThS1A-35
10:40-11:00
Revolver hollow core fibers: optical properties and outlook
A.F. Kosolapov; Fiber Optics Research Center, Russia

The optical properties and applications of low-loss revolver hollow-core fibers are reviewed. The revolver fiber with nested capillaries with core diameter as low as 25 µm and minimum optical losses of 75 dB/km is demonstrated for the first time.

- Lunch Break -
ThS1A-42 Invited Structure simulation and surface modification of photonic crystal fibers for the 2.0-25.0 μm range
L.V. Zhukova, A.S. Korsakov, D.S. Vrublevsky, A.E. Lvov; Ural Federal Univ., Russia
Infrared optical fibers, particularly transparent within 3-5, 8-12 ranges, etc., are applicable for a number of objectives. For such fibers, single mode is preferable with considerably low optical losses and as large mode field distance as possible, e.g. up to 100 μm.

ThS1A-43 Invited Creating an antireflection coating on the surface of silver and a monadic thallium halide crystalline materials
A.S. Korsakov, A.E. Lvov, D.S. Vrublevsky, L.V. Zhukova; Ural Federal State Univ., Russia
On the global market the demands for the quality and, more important, for the level of technological properties of photonic crystal fibers are rapidly rising. The translation at progressively longer wavelengths requires the use of materials with high refractive index. In this regard, the issue arises to create the antireflection coatings, which could neutralize this effect.

ThS1A-44 Invited Nanodefective crystals and crystal-derived optical fibers for the spectral range of 0.4-45.0 μm
L.V. Zhukova, A.S. Korsakov, D.O. Solimogareev, V.S. Korsakov, V.V. Zhukov; Ural Federal Univ., Russia
The crystalline substances form a new class of materials for the infrared optics. For these purposes, the defective crystals are necessary, which have different structure-sensitive properties: optical, mechanical, luminescent, photochemical, etc.

ThS1B-12 Invited Weld joints formation during welding of dissimilar materials by high power fiber laser
G.A. Turchik, E.A. Valdytseva, O.G. Klimova-Korsmik, K.D. Babkin; Inst. of Laser and Welding Technology, Peter the Great St. Petersburg Polytechnic Univ., Russia
The article devoted to experimental and theoretical investigations of laser welding of dissimilar materials. Technological research (the composition of the protective environment, the welding speed, output power, the thickness of the welded plates) and analysis of the influence of process parameters on the weld were made for creation of possibility to weld dissimilar materials without intermediate layers. Improving the welding of dissimilar materials deals with solution of such problems as: formation of continuous layers of intermetallic compounds, cracks and pores in the weld and heat affected zone, formation of oxides at high temperature, shielding welding. Theoretical and experimental results shown, that high power and beam quality of fiber lasers allow get weld joints with acceptable quality for dissimilar materials.

ThS1B-13 Invited Optimization of the regimes of laser sintering of powder materials based on nickel universal equipment to produce blanks of machine parts
D.Yu. Tatarkin1, V.P. Biryukov1, M.A. Murzakov1, V.D. Ivanisov1; 1 - NTO «IRE‑Polus», Russia
The paper presents a metallographic investigation of preparations obtained by alloying powder materials based on nickel. It is shown that the performance of the cultivation process using a fiber laser and universal equipment 1.5 times higher than in serial production installations layer-by-layer laser sintering of metal powders.

ThS1B-14 Invited Ways of optimization the process of three-dimensional laser cladding using a layer by layer strategy of powder alloying
D.P. Bykovsky1, A.O. Andreev1, V.D. Mironov1, V.N. Petrovsky1, I.S. Papkov1, A.N. Solomir1, V.V. Cheverikin1; 1 - NRNU MEPhI, 2 - NUST MISiS, Russia
The authors of the article are studying the most optimal way to implement the process of laser cladding of parts made of 316L stainless steel powder was used for volumetric laser cladding. We studied the microstructure of obtained objects, diffusion processes of the substrate components and the metal of laser cladding. Various strategies of layered metal powder were offered and mechanical tests of the samples properties were performed.

ThS1B-15 Invited Laser drilling of dense micro holes in titanic plates
A.B. Lyukhter1, D.A. Kochuev1, A.A. Voznesenskaya1, K.V. Skvortsov1; 1 - Vladimir State Univ., 2 - Engineering Centre at VlSU, 3 - LLC "VlSU IC", Russia
There have been carried out the experiments on ultra- perforation sheet titan with the thickness of 0.3 mm. Optimal laser action modes and the approach algorithm for laser drilling have been selected. There has been presented the totality of solutions enabling to ease the residual strain in the material after laser micro-perforation.

ThS1B-16 Invited The influence of the addition nanocarbide refractory metals in a serial of powder materials based on nickel to improve the wear resistance by laser cladding
M.A. Murzakov1, D.O. Tatarkin1, V.P. Biryukov1, T.O. «IRE‑Polus», Russia
The paper presents the results of experimental investigations of the laser sintering process using a fiber laser and universal equipment. The obtained data was compared with the WC carbide coated with 15% WC coating shows a dramatic increase in wear-resistance by 4-6 times as compared to carbon steel substrate. There have been described the studies of coatings on opposite electron reflection. There was determined that structure of deposited coating with nanoparticles is fine.
4TH INTERNATIONAL SYMPOSIUM
«LASERS IN MEDICINE AND BIOPHOTONICS»
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Natalia P. Khakamova
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PLENARY SESSION
Location: Levinson Hall, floor 2, 09:00 – 11:00
Session Chair: Ivan A. Shcherbakov,
Prokhorov General Physics Inst. RAS, Russia

TuS2P-01 Plenary
The physics of perfect skin-enhancing the integument through laser
E. Victor Ross, Scrips Clinic, UCSD Medical Center, United States
As an example of this problem based method, a specific new approach to tattoo removal will be discussed. Also, recent works and future strategies for scar reduction will be presented.

TuS2P-02 Plenary
Laser technologies in ophthalmic surgery
S.K. Vartapetov, I.A. Shcherbakov, A.V. Doga; 1 - Prokhorov General Physics Inst. RAS, 2 - Fedorov Eye Microsurgery Federal State Inst., Russia
Modern lasers technologies and systems on the base excimer and femto lasers for refractive surgery are described.

TuS2P-03 Plenary
Enhanced optical imaging and laser treatment in medicine: from UV to terahertz
V.V. Tuchin, Saratov National Research State Univ., Russia
Fundamentals and advances of tissue optical clearing (OC) technology that provides enhanced imaging and treatment of living tissues are presented.

TuS2P-04 Plenary
"New" photons for existing and new medical applications
G. Altshuler, V. Gapontsev; 1 - IPG Medical Corp., 2 - IPG Photonics Corp., United States
We will review existing and potential new medical application of fiber laser, QCW diode laser (currently used for pumping fiber laser) fiber laser and fiber laser pumped solid–state laser (hybrid laser) in ophthalmology, dermatology, urology and dentistry.
Advanced laser systems for medical applications I

Session Chair: David Kochiev,
Prokhorov General Physics Inst. RAS, Russia

TuS2A-00 Invited
11:30-11:50
Spasers as smallest laser and best cellular probe to break the diffraction, spectral and detection limits
E.I. Galanitsa1, D.A. Nedaikin2, A.I. Plekhanov2, M.I. Stockman3, V.P. Zhavor2;
1 - Univ. of Arkansas for Medical Sciences, United States, 2 - Inst. of Automation and Electrometry SB RAS, Russia, 3 - Georgia State Univ., United States

The unique combination of superbright monochromatic emission and strong absorption of the spaser allows to consider this smallest laser as one of the best multifunctional super-contrast low toxicity optical probes that can overcome the spectral, diffraction, and other optical limits with focus on super-resolution spectral microscopy, in vivo flow cytometry, and early theranostics of cancer, infections, and cardiovascular diseases.

TuS2A-01 Invited
11:50-12:10
Pulse- and transverse discharge CO2 laser for medical applications
S. Nikfourov1, Ya. Simanovsky1, A. Pento1, K. Moshkunov2, N. Gorbatova2, S. Zolotov2, S. Alimpiev1,4;
1 - Prokhorov General Physics Inst. RAS, 2 - «Energomashtechnica» clinic, Russia

New laser with Tm-doped YAG crystal is actively used in our clinic. We use it for treatment of urological patients, but physical properties of fiber lasers could open new horizons.

TuS2A-02 Invited
12:10-12:30
1.56 µm laser thermotherapy in treatment of venous and arteriovenous malformations
I.A. Abushkin1, A.G. Denis2, V.O. Lapin3, V.A. Privalov3, A.V. Lappa4, O.A. Romanova5;
1 - South Ural State Medical Univ., 2 - Tver Regional Children's Hospital, Russia

1.56 and 1.68 µm fibers lasers – possible instrument for treatment of staghorn nephrolithiasis. Mini PCNL by laser lithotripter with microsecond pulse duration and second harmonic generation is effective and safe procedure in treatment of staghorn nephrolithiasis.

TuS2A-03 Invited
12:30-12:50
Possible fiber lasers applications in urology
A.Z. Vinarov1,2, A.B. Shehter2, A.V. Kurkov2;
1 - NTO «IRE‑Polus», 2 - Sechenov First Moscow State Medical Univ., Russia

New thulium (Tm) fiber laser with a peak power up to 500 W for lithotripsy has been designed and prototype built. Performance has been evaluated vs. industry-leading Ho laser lithotripsy system in in vitro setting. Tm laser has demonstrated significantly increased stone fragmentation rate, decreased retropulsion effect, and precise selective photodecomposition.

TuS2A-04 Invited
12:50-13:10
Complex measurement of aerosol drug deposition using laser methods
A. Czitrovszky1, A. Nagy2, M. Veres2, A. Kerekes1, I. Rigo3; Wigner Research Centre for Physics of the HUN, Hungary

The authors carried out work on creation of diode pumped solid state laser for the treatment of benign vascular lesions of the skin and subcutaneous tissue by precise selective photodecomposition.

TuS2A-05 Invited
13:10-13:30
Prospects of fiber lasers use in the ENT surgery
V.M. Svistushkin1, E.I. Finkova1, S.A. Zolotov2,3;
1 - Prokhorov General Physics Inst. RAS, 2 - Inst. of Emergency Children's Surgery and Traumatology, Russia

Using of laser radiation with wavelengths of 1.56 µm (Er-doped fiber) and 1.68 µm (Raman fiber laser) allows heating the areas of large volumes pathological tissue and extruding them through a percutaneous approach to the tumor under ultrasound guidance. Fiber lasers applications play a tremendous role in the treatment of urological patients, but physical properties of fiber lasers could open new horizons.

TuS2A-06 Invited
15:00-15:20
Recent advances in fiber and hybrid lasers widen opportunities for medical applications
S.V. Larin1, D.V. Myasnikov2, NTO «IRE‑Polus», Russia

Recent developments of fiber and hybrid lasers covering broad spectral range have been reported. Family of high power narrow-linewidth Raman fiber lasers for the treatment of biological tissues and drug composites is presented. Hybrid systems comprising fiber pump laser and solid-state wavelength converter for visible to mid-IR range are proposed. Medical applications for these sources are discussed.

TuS2A-07
15:20-15:35
Minimally-invasive percutaneous nephrolithotomy in the management of staghorn stones
O.V. Teodorovich1,2, S.A. Naryshkin1,2, G.G. Borienskov3, D.G. Kochiev3;
1 - Central Clinical Hospital No1 JSC RZHD «Russian Railways», 2 - Russian Medical Academy of Postgraduate Education, 3 - Prokhorov General Physics Inst. RAS, Russia

We report our experience of minimally invasive percutaneous nephrolithotomy (Mini PCNL) in the management of staghorn kidney stones. Mini PCNL by laser lithotripter with microsecond pulse duration and second harmonic generation is effective and safe procedure in treatment of staghorn nephrolithiasis.

TuS2A-08
15:35-15:50
The laser for the precision selective photodecomposition of the vascular structures of the skin and subcutaneous tissue
N.E. Gorbatova1,2, A.G. Dorofeev3, G.P. Kuzmin1,2, A.A. Sirotkin1,2, O.V. Tichonovich1,3, S.A. Zolotov2,3;
1 - Prokhorov General Physics Inst. RAS, 2 - Inst. of Emergency Children's Surgery and Traumatology, 3 - Advanced Energy Technologies Ltd, Russia

Super Pulse diode-based laser systems were evaluated for precision soft-tissue surgery and fractional treatment. Disruptive potential of the technology has been demonstrated.

TuS2A-09
15:50-16:05
Super Pulse diode and diode-pumped fiber lasers for fast and precise tissue surgery and regeneration
I.V. Yanoskalskyy1, K.S. Magid2, D.M. Boutoussov3, A.G. Vybornov3, S.V. Larin1,
M.V. Inczochkin2, A.A. Gryazuk1, I.A. Perchuk1, G.B. Altshuler1, 1 - IPG Medical, United States, 2 - Advanced Dentistry of Westchester, United States, 3 - Biolase Inc, United States

Super Pulse diode-based laser systems were evaluated for precision soft-tissue surgery and fractional treatment. Disruptive potential of the technology has been demonstrated.

TuS2A-10
16:05-16:20
In vitro comparison of 1m fiber laser vs Ho:YAG laser for lithotripsy
V.A. Zamyatina1, A.A. Kovalenko1, A.M. Dymov2, D.V. Enikeev2, V.P. Minaev3,
N.N. Sorokin1, A.Z. Vinarov3, I.V. Yanoskalskyy1, G.B. Altshuler1, V.P. Gapontsev1,4;
1 - NTO «IRE‑Polus», Russia, 2 - Sechenov First Moscow State Medical Univ., Russia, 3 - IPG Medical, United States, 4 - IPG Photonics, United States

A new thulium (TiM) fiber laser with a peak power up to 500 W for lithotripsy has been designed and prototype built. Performance has been evaluated vs. industry-leading Ho laser lithotripsy system in vitro setting. TiM laser has demonstrated significantly increased stone fragmentation rate, decreased retropulsion effect, and reduced procedure time vs Ho system.

TuS2A-11
16:20-16:35
1.56 and 1.68 µm fiber lasers – possible instrument for LITT in urology. Preliminary results
A.M. Dymov1, A.A. Kovalenko1, V.P. Minaev3, A.Z. Vinarov3, V.A. Zamyatina1,
A.B. Shehter1, A.V. Kurkov1, 1 - NTO «IRE‑Polus», 2 - Sechenov First Moscow State Medical Univ., Russia

Using of laser radiation with wavelengths of 1.56 µm (Er-doped fiber) and 1.68 µm (Raman fiber laser) allows heating the areas of large volumes pathological tissues without carbonization. It lets to increase the efficiency of the LITT procedure.
TECHNICAL SESSION

4TH INTERNATIONAL SYMPOSIUM «LASERS IN MEDICINE AND BIOPHOTONICS»
SECTION S2A. ADVANCED LASER SYSTEMS FOR MEDICAL APPLICATIONS

TuS2A-12 16:35-16:50
Tm fiber laser application for soft tissue surgery
A.R. Sadykov1, A.M. Dyntov1, N.N. Enikeev2, A.A. Kovalenko3, V.P. Minaev3,
N.N. Sorokin1, A.Z. Vinarov2, V.A. Zamotynta2, G.B. Altshuler2; 1 - IPG Medical, United States,
2 - Sechenov First Moscow State Medical Univ., Russia, 3 - NTO “IRE-Polus”, Russia
A new thulium (Tm) fiber laser with a peak power up to 500 W for soft tissue surgery has been built. This system allows increase efficiency of soft tissue ablation and decrease collateral damage in comparison with modern Tm fiber laser with peak power up to 120 W and holmium (Ho) laser systems (experiment ex-vivo).

TuS2A-13 16:50-17:05
Terahertz reflectometry for the corneal tissue hydration sensing
A.A. Angeluts1, A.V. Balakin1, M.D. Mishchenko2, I.A. Ozheredov2, T.N. Saphonova2,
A.P. Shkurinov2; 1 - Lomonosov Moscow State Univ., 2 - FGBNU NIIGB, Russia
The cornea is one of the most important external structure of the human eye. Its transparency is an important factor for visual function and depends on the tissue hydration. For cornea hydration sensing we use terahertz reflectometer based on difference frequency generation of a pair of continuous semiconductor lasers. Spectral sensitive measurements are obtained by fine frequency tuning of terahertz source.

TuS2A-14 17:05-17:20
Architecture of a new fiber laser for applications in soft tissue surgery and lithotripsy
A.V. Vinnichenko1, S.V. Larin1, A.A. Mashkin2; 1 - NTO «IRE-Polus», Russia, 2 - IPG Laser GmbH, Germany
During the last decades, applications of lasers in medicine enjoyed stable growth. Surgical lasers are developed very intensively and today they occupy a significant market share. In this paper, we present a novel concept of an all-fiber-laser architecture for surgical applications.

4TH INTERNATIONAL SYMPOSIUM «LASERS IN MEDICINE AND BIOPHOTONICS»
A3. MEMORIAL SESSION IN HONOUR OF ALEXANDER PROKHOROV (1916-2002)

Location: Levinson Hall, floor 2, 17:30 – 18:30
Advanced laser systems for medical applications II
Chair: Ivan A. Shcherbakov, Prokhorov General Physics Inst. of RAS, Russia
Official Language: Russian
TuS2A-p01  
Laser percutaneous nephrolithotomy for bilateral staghorn stones  
O.V. Teodorovich1,2, S.A. Naryshkin1, G.G. Borisenko1, M.N. Shatohin1, Y.D. Dalgatov1, S.A. Davlatbiev1;  
1 - Central Clinical Hospital No1 JSC RZhD “Russian Railways”, 2 - Russian Medical Academy of Postgraduate Education, Russia  
The improving outcomes of surgical treatment for bilateral staghorn kidney stones by using laser lithotriptor with microsecond pulse duration and second harmonic generation is investigated.

TuS2A-p02  
The effectiveness of the clinical application of the multiwavelength laser medical installation with antibacterial and therapeutic effect  
K.K. Baranov2,3, N.E. Gorbatova2,3, G.P. Kuzmin1,3, A.A. Sirotkin1,3, O.V. Tichonevich1,3; 1 - Prokhorov General Physics Inst. RAS, 2 - Inst. of Emergency Children's Surgery and Traumatology, 3 - Advanced Energy Technologies LTD, Russia  
In this paper, we proposed a method for the treatment of chronic middle purulent otitis. After the introduction of the optical fiber through the perforations of the tympanic membrane was carried out under the supervision of an endoscope processing structures of the middle ear laser irradiation.

TuS2A-p03  
Improved two-channel laser Doppler flowmeter  
D.G. Lapitan, D.A. Rogatkin; Vladimirsky Moscow Regional Research and Clinical Inst. «MONIKI», Russia  
Noise in the differential-channel setup of a laser Doppler flowmeter was studied. Formation of false spectral components in the output signal due to electrical signals beating was found out. The improved block-diagram of the flowmeter allowing to reduce the noise was developed.

TuS2A-p04  
Sapphire shaped crystals allow combining tissue cryodestruction, laser coagulation and diagnosis  
I.A. Shikunova1, V.N. Kurlov1, K.I. Zaytsev2,3,4, I.V. Reshetov3,4; 1 - Inst. of Solid State Physics RAS, 2 - Bauman Moscow State Technical Univ., 3 - Inst. of Improvement of Professional Skill of the Federal Medico-Biological Agency of Russia, 4 - Sechenov First Moscow State Medical Univ., Russia  
Approach to combine tumor cryosurgery with laser therapy and optical diagnosis using sapphire shaped crystals has been demonstrated. Unique properties of sapphire shaped crystals (thermal, mechanical, and chemical strength complemented with high optical transparency and thermal conductivity) allow performing tissue destruction, or therapy, and optical diagnosis simultaneously.

TuS2A-p05  
Human retina model for laser safety during corneal surgery with a femtosecond laser  
H. Sun, Zh. Fan; Academy of OPTO-Electronics CAS, China  
Femtosecond lasers are widely used in everyday clinical procedures to perform minimally invasive corneal refractive surgery. In the present study a numerical simulation was developed to quantify the temperature rise in the retina during femtosecond intracorneal surgery. Also, ex-vivo retinal heating due to laser irradiation was measured with an infrared thermal camera as a validation of the simulation.
WeS2B-01 Invited 09:00-09:20
Modern fluorescence and other optical methods for early cancer of aerodigestive tract endoscopic diagnostics
V.V. Sokolov, D.V. Sokolov, S.S. Pirogov, Herzen Moscow Oncological Research Inst., Russia
From 1984 through 2015 - 176 early central lung cancer (ECLC) lesions were found in 128 patients, early squamous-cell esophageal carcinoma (ECC) - 43 patients. We have investigated possibilities of combination of white-light (WLI), autofluorescence (AFI), narrow-band imaging (NBI), local fluorescence spectroscopy (LFS), intelligent hemoglobin index (Ihb), probe-based confocal laser endomicroscopy (pCLE) and endocytoscopy (EC) in ECLC and ECC diagnostics.

WeS2B-02 Invited 09:20-09:40
Spectroscopic analysis of the interaction between antioxidants and free radicals in human skin
In the presentation various studies on the interaction between antioxidants and free radicals in human skin are presented which were performed at the Center of Experimental and Applied Cutaneous Physiology at the Department of Dermatology, Venerology and Allergology of the Charité – Universitätsmedizin Berlin.

WeS2B-03 Invited 09:40-10:00
Autofluorescence spectroscopy techniques for skin cancer diagnostics
E. Borisova1, Al. Zhelyazkova1, Ts. Genova2, P. Troyanova2, E. Pavlov2, N. Penkov2, L. Avramov1; 1 - Inst. of Electronics BAS, 2 - Univ. Hospital «Queen Giovanna-ISUL», Bulgaria
A review of the recent achievements in the field of autofluorescence spectroscopy of cutaneous neoplasia will be presented. Excitation-emission matrices, synchronous fluorescence spectroscopy and other steady-state approaches are used for development of whole picture of the autofluorescent properties of benign, dysplastic and malignant lesions. Spectral peculiarities and fluorophores' content changes are used for development of differentiation algorithms for diagnostic needs.

WeS2B-04 Invited 10:00-10:20
Advances in imaging human skin
M.J. Leahy; National Univ. of Ireland, Ireland
The skin is the body's largest and most accessible organ. It can act as a surrogate for other organs due to its similar immunoresponse. Nonetheless, substantial challenges have to be overcome for imaging the skin. This paper will review the challenges and progress in advanced imaging of human skin.

WeS2B-05 10:20-10:35
Hyperspectral imaging for skin neoplasms detection
L.A. Zherdeva1, I.A. Bratchenko1, O.A. Chumakina2, I.V. Reshetov2,3; 1 - Saratov National Research State Univ., Russia, 2 - Inst. of Electronics BAS, Bulgaria, 3 - Tomsk National Research State Univ., Russia
Experimental results for skin neoplasms detection in vivo and ex vivo in a visible spectral range are presented using hyperspectral imaging. Blood supply degree of a capillaries and a melanization degree of skin area are chosen as controlled criteria.

WeS2B-06 Invited 10:35-10:55
The novel horizons in prediction of stroke: optical «instruments» and innovative strategies
O.V. Semyachkina-Glushkovskaya1, A.S. Abdurashitov1, E.G. Borisova2, V.V. Tuchin3; 1 - Saratov National Research State Univ., Russia, 2 - Inst. of Electronics BAS, Bulgaria, 3 - Tomsk National Research State Univ., Russia
We show the current multi-modal technologies that are widely used in clinics and experiments for the study of brain hemorrhages (BH) in newborns: magnetic resonance imaging, ultrasonography, near infrared spectroscopy, laser Doppler, laser speckle contrast imaging and photon correlation spectroscopy. We discuss the advantages and disadvantages of these methods and show avenues for future research of BH in term newborns.

WeS2B-07 Invited 11:30-11:50
Combined optical and terahertz imaging for intraoperative delineation of nonmelanoma skin cancers
A.N. Yaroslavsky1, C. Joseph, R. Patel1, B. Fan1, A. Musikansky1, V.A. Neel2, R. Giles1; 1 - Univ. of Massachusetts at Lowell, 2 - Massachusetts General Hospital, United States
Nonmelanoma skin cancers are the major cause of morbidity in fair-skinned population worldwide. We investigated the feasibility of combining terahertz and optical imaging for accurate intraoperative delineation of these cancers. Fresh thick skin excisions were used for the experiments. The tissue was imaged within four hours after surgery. Obtained images were compared to the corresponding histopathology, which was considered a gold standard. The results of the study indicate that combination of cross-polarized continuous wave terahertz imaging and polarized light optical imaging has potential as an intraoperative bedside tool for controlling the completeness of surgical excision.

WeS2B-08 11:50-12:05
Application of terahertz time-domain spectroscopy for blood glucose monitoring
D.P. Chekhova1, M.M. Nazarov2, A.P. Shkurinov2; 1 - Inst. of Laser Physics SB RAS, 2 - Inst. on Laser and Information Technologies RAS, 3 - Lomonosov Moscow State Univ., Russia
Human skin optical properties were studied in vivo using terahertz time-domain spectroscopy. For the attenuated total internal reflection, the silicon Dowel prism was used. The measurements were carried out on volunteers with normal blood glucose concentration and after glucose intake. The variations of the reflection spectra of human skin were correlated with the changes in blood glucose level.

WeS2B-09 12:05-12:20
Medical diagnosis based on terahertz pulsed spectroscopy and imaging
K.I. Zaytseva1,2, N.V. Chemomyrdin3, S.O. Yurchenko1, V.N. Kurlov1, I.A. Shikunov1, G.M. Katurba1, K.G. Kudrin1, V.E. Karasik1, I.V. Reshetov2,3; 1 - Bauman Moscow State Technical Univ., 2 - Inst. of Improvement of Professional Skill of the Federal Medico-Biological Agency of Russia, 3 - Sechenov First Moscow State Medical Univ., 4 - Inst. of Solid State Physics RAS, Russia
We discuss recent results of our research in the area of biomedical applications of THz pulsed spectroscopy and imaging. We introduce THz aspherical lenses for high-resolution medical imaging and THz photonic crystalline waveguides for THz endoscopy. We consider the results of studying the THz dielectric characteristics of displyastic and non-displyastic skin nevi in vivo.

WeS2B-10 12:20-12:35
The study of terahertz radiation biologic effects as premise for creating of diagnostic and treatment methods
V.I. Fedorov; Inst. of Laser Physics SB RAS, Russia
The report emphasizes the importance of the study of terahertz radiation biologic effects as another direction in the creation of diagnostic and therapeutic methods, along with terahertz imaging and terahertz spectroscopy. Therapeutic and diagnostic use of laser terahertz radiation based on the results of pre-conducted fundamental research of biological effects of terahertz radiation at the organismic, cellular and molecular levels presents.

WeS2B-11 Invited 12:35-12:55
Bag-of-Features approaches for combined classification of laser scanning microscopy and spectroscopy data sets
S.G. Stanciu1,2, R. Boriga3, A.C. Dascalescu4, R. Hristu5, G.A. Stanciu6; 1 - Univ. Politehnica of Bucharest, 2 - Univ. of Bucharest, 3 - “Titu Maiorescu” Univ., Romania
The Bag-of-Features (BoF) paradigm represents a solid solution for the automated classification of digital images. Several BoF approaches for classification of microscopy data have been reported in the past decade, but their number is very low considering the potential that BoF methods hold with respect to this subject. In this contribution we discuss strategies for using BoF architectures for the automated classification of 1D and 2D data sets collected using Laser Scanning Microscopy techniques.

WeS2B-12 Invited 12:55-13:10
Human skin glucose monitoring based on hyperspectral imaging
M.J. Leahy; National Univ. of Ireland, Ireland
The skin is the body's largest and most accessible organ. It can act as a surrogate for other organs due to its similar immunoresponse. Nonetheless, substantial challenges have to be overcome for imaging the skin. This paper will review the challenges and progress in advanced imaging of human skin.
WeS2B-12 12:55-13:10
New generation fluorescence and laser spectral analysis colposcope for early detection of cervix cancer
N.N. Bulgakova¹, E.G. Novikova¹, V.V. Smirnov¹⁺, O.I. Trushina², V.I. Fabelinsky¹⁺;
¹ - Prokhorov General Physics Inst. RAS, 2 - Herzen Moscow Oncology Research Inst., 3 - Inlife LLC, Russia

The system has been developed to perform colposcopic examinations on a new level. It acquires high-quality color and fluorescence images and laser-excited fluorescence spectra taken by a fiberoptical probe from the points selected in course of analyzing acquired images. The colposcope is processed by special software that delivers several evaluated diagnostically-valuable parameter. Preliminary tests show that technical implementation is adequate for early cancer detection.

WeS2B-13 13:10-13:25
Optical alignment of component signals in assay of low proteinuria
A.I. Kuznetsov¹, A. Frorip¹, M. Ots-Rosenberg², A. Sünter¹; ¹ - AS Ldiamon, Tartu Science Park, 2 - Tartu Univ., Estonia

To overcome high selectivity of automated assay methods in low proteinuria a combined fractionation-optical method is proposed. Urine fractionation in the gel columns PD-10 is followed by immediate measurement of protein absorption at 280 nm. The method can be applied in the wide range of total protein concentrations 0.05 – 10 g/L.

WeS2B-14 13:25-13:40
Triple-modality imaging of optoacoustic pressure, ultrasonic scattering, and optical diffuse reflectance with improved resolution and speed
P.V. Subochev, I.V. Turchin; Inst. of Applied Physics, Russia

The method of cost-effective upgrade from an acoustic resolution photoacoustic microscope to a triple-modality imaging system is presented. The newly-developed experimental setup is based on a diode-pumped laser coupled to a fiber bundle with a spherically focused polyvinylidene fluoride detector integrated into the center of a ring-shaped optical illuminator. Each laser pulse illuminating the sample performs two functions. While the photons absorbed by the sample provide a measurable optoacoustic (OA) signal, the photons absorbed by the detector provide the measurable diffuse reflectance (DR) from the sample and the probing ultrasonic (US) pulse. At a 3 mm imaging depth the axial resolution of the OA/US modalities is 38μm/26μm, while the lateral resolution of the DR/OA/US modalities is 3.5mm/50μm/35μm. At LO conference we will present the imaging capabilities of the developed DR/OA/US system using the results on phantom and in vivo experiments.
Actinic keratosis (AK) is considered as squamous cell carcinoma in situ (SCC), obtained in vivo at different depths.

In contrast to epi-illumination or trans-illumination microscopy, various methods of perpendicular or oblique sample excitation are reported in view of minimizing background or out-of-focus signals and avoiding high light exposure. Techniques include scattering and light sheet fluorescence microscopy, TIRFM as well as axial tomography.

New strategies for photothermal ablation and photoacoustic imaging of cancer based on cellular vehicles loaded with plasmonic nanoparticles

We report in vivo micro-scale mapping of cilia and cilia dynamics in the oviduct is not well understood, largely owing to the lack of live imaging approaches. We present a method which will allow simultaneous monitoring of key apoptosis (programmed cell death) processes, drug distribution, such as photodynamic agents, as well as oxygen concentration, which is a critical parameter determining the efficiency of photodynamic therapy. We demonstrate use of a novel sensor and optical coherence tomography (OCT) for imaging of caspase 3, which is activated by different antitumor drugs in vitro and in vivo.

Multimodal embryonic imaging using selective plane illumination microscopy, optical projection tomography and optical coherence tomography

We present an automated laser system for measuring the erythrocytes distribution of erythrocyte distribution in size and optical coherence tomography. Laser diffraction by wet blood smear and measurement of erythrocyte distribution in size

In contrast to epi-illumination or trans-illumination microscopy, various methods of perpendicular or oblique sample excitation are reported in view of minimizing background or out-of-focus signals and avoiding high light exposure. Techniques include scattering and light sheet fluorescence microscopy, TIRFM as well as axial tomography.

Multispectral life-time imaging of tumor in small animal

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Modern tools in biophotonics have revolutionized biological, preclinical and clinical research, providing new insights into the function of living organisms and disease. Technologies such as light-sheet microscopy, optical micro-tomography, optoacoustics and others can be used in label-free and targeted imaging from the whole organism level to single cell. Technologies such as light-sheet microscopy, optical micro-tomography, and other tools in biophotonics have provided the ability to perform for the time and frequency domains. The simulation results turn out to be in an excellent agreement with measurements for aqueous solutions of Intralipid mostly used as bio-phantoms.

- Lunch Break -

Location: Levinson Hall, floor 2, 15:00 – 16:20

Laser interaction with cells and tissues III
Session Chair: Alexander V. Priezzhev,
Physics Dep. and International Laser Centre of Lomonosov Moscow State Univ., Russia

WeS2C-13 Invited
Monte Carlo simulations of photon diffusion in time and frequency domains
V.L. Kuzmin, A.Yu. Valkov, D.A. Oskirko, L.A. Zubkov, 1 - Peter the Great St. Petersburg Polytechnic Univ., Russia, 2 - St. Petersburg State Univ., Russia, 3 - Drexel Univ., United States

The Monte Carlo simulations of the photon diffusion in tissue models are performed for the time and frequency domains. The simulation results turn out to be in an excellent agreement with measurements for aqueous solutions of Intralipid mostly used as bio-phantoms.

Novel photonics in biomedical imaging: modern tools, emerging trends and applications
G. Zacharakis, Laser Interactions and Photonics Division, FORTH – IESL, Greece

Modern tools in biophotonics have revolutionized biological, preclinical and clinical research, providing new insights into the function of living organisms and disease. Technologies such as light-sheet microscopy, optical micro-tomography, optoacoustics and others can be used in label-free and targeted imaging from the single cell to the whole organism level.

WeS2C-14 Keynote presentation
Mid-infrared biophotonics: potential and challenges
B. Mazakov, ULM Univ., Germany

In the recent decade, chem/bio sensing platforms increasingly benefit from miniaturized and integrated optical technologies providing direct access to molecular information. Since in-situ analytical strategies are becoming more prevalent e.g., in harsh environments or for point-of-care diagnostics, detection schemes that do not require reagents or labels are of particular interest providing localized on-site information in - or close to - real-time.
Application of the method autofluorescence diagnosis in endoscopy for investigation mucosal structure in gastrointestinal tract

D.A. Abramov, I.V. Chavkin; ITMO Univ., Russia

Promising for the early diagnosis of malignant diseases of the respiratory organs and the gastrointestinal tract (GIT) is considered a fluorescence method. The aim is to develop a fluorescent light source (illuminator FLU) for videodensocopy complex and determining on the basis of scientific research and prototyping capability for creating fluorescence video endoscopy.

Influence of structured illumination aperture shape in numerically focused Fourier domain optical coherence microscopy: a comparison

A.A. Grebenyuk; Saratov National Research State Univ, Russia

The use of structured illumination in optical coherence microscopy (OCM) allows combining increased transverse resolution with small attenuation of the signal with defocus. This paper presents a comparative analysis of the properties of numerically focused imaging in Fourier domain OCM with different types of structured illumination aperture.

The plasma protein fractions research by Raman spectroscopy method

A.A. Lykina, D.N. Artemyev, Yu.A. Kristoforova, L.L. Davydker, T.P. Kuzmina, V.P. Zakharov; 1 - Samara State Aerospace Univ, 2 - Samara State Medical Univ, Russia

This work is dedicated to the analysis of plasma proteins concentration using Raman spectroscopy setup. The obtained Raman spectra showed significant variation of intensities of certain spectral bands 940, 1005, 1330, 1450 and 1650 cm-1 for different protein fractions and concentrations. Partial least squares regression analysis was used for determination of correlation coefficients. We have shown that proposed method represents the structure and biochemical composition of albumin and immunoglobulins A and G.

NIR autofluorescence skin tumor diagnostics

Y.A. Kristoforova, I.A. Bratchenko, D.N. Artemyev, O.G. Myakinn, A.A. Moratov, S.K. Kaftov, V.P. Zakharov; 1 - Samara State Aerospace Univ, 2 - Samara State Medical Univ, Russia

A method for skin tumors diagnostics based on the analysis of changes in the AF spectrum in the near infrared region is proposed. The analysis of the AF spectrum was implemented via its exponential approximation. Proposed approach allows for benign melanoma diagnosis with an accuracy of 88.4% for ex vivo studies, and 86.2% for the in vivo studies.

Multimodal detection of phase transition in adipose tissue

I.u. Semenova1, E.K. Volkova1, A.P. Popov2, A.V. Bykov3, I.V. Meglinski4, R.V. Tuchin1,2,3, 1 - Univ of Oulu, Finland, 2 - Saratov National Research State Univ, Russia, 3 - Tomsk National Research State Univ, Russia, 4 - Inst of Precise Mechanics and Control BAS, Russia

A quantitative analysis of spectral dependence of phase delay distribution introduced by transparent microscopics objects is discussed. Experimental setup based on Mach–Zehnder interferometer with acousto-optic filtration of wideband low-coherence light is used for calculating the phase delay distribution by means of digital processing of interferograms. An example of a calculated phase delay distribution is shown.

Combined laser and spectral holographic microscopy for investigation of phase objects

A.S. Machikhin, O.V. Polschikova, A.G. Ramazanova; Scientific and Technological Center of Unique Instrumentation RAS, Russia

In this work digital holographic method has been used for investigations of plant cell walls heating process. An analysis of obtained phase images has been performed and major sources of the observed phase shift were determined.
Embedding molecules inside plasmonic nanostructures: a new approach for highly uniform and reproducible surface-enhanced Raman scattering

B.N. Khlebtsov, N.G. Khlebtsov; 1 - Inst. of Biochemistry and Physiology of Plants and Microorganisms RAS, 2 - Saratov National Research State Univ, Russia

Surface-enhanced Raman scattering probes with a nanometer-sized interior gap between Au core and shell, also called nanomaryoshkas (NMs), have attracted great interest for SERS-based bioimaging and biosensing. We found that the structure of nanogaps inside Au NMs strongly depends on the core surface morphology. Here we report on the preparation of uniform Au@Ag core/shell nanorods with a controllable Ag shell thickness. The dependence of Raman intensity on the inside/surface location of the reporter molecules was studied.

Magnetic platform for UV surface-enhanced resonance Raman and fluorescence
H. Bhatt1, A. Alley2, J.R. Gabitov3, V.P. Drachev3; 1 - Univ. of North Texas, Denton, United States, 2 - Univ. of Texas at Dallas, United States, 3 - Skolkovo Inst. of Science and Technology, Russia

Cobalt nanoparticles with high quality crystal structure and spin polarization support an excellent plasmon resonance at about 275 nm, which is comparable with gold nanoparticles. The quality of plasmon resonance is highly correlated with the superparamagnetic response of the isolated nanoparticles and disappeared in the aggregates. The fluorescence enhancement of about 3x103 for surfactant molecules is demonstrated.

Laser-induced co-deposition of copper with cobalt as signal amplification method for biochemical microbiosensors
A.V. Smikhovskaia, E.M. Khairullina, I.I. Tumkin, S.S. Ermakov, O.V. Navalotskaya; St.Petersburg State Univ., Russia

The influence of cobalt (II) chloride on laser-induced copper deposition was studied. Copper deposition experiments in aqueous solutions containing various concentrations of cobalt(II) chloride upon 532 laser irradiation were performed. The influence of additives on the deposition rate, the topology, electrochemical properties of the deposited microstructures was investigated. Sensory activity of these structures towards hydrogen peroxide and glucose was studied.

Application of surface-enhanced infrared spectroscopy for steroids analysis
O.P. Cherkasova1, A.G. Milekhin1,2, I.A. Milekhin1,2, S.A. Kuznetsova1, E.E. Rodyakina1,2, A.V. Lyubchenko1,2; 1 - Inst. of Laser Physics SB RAS, 2 - Novosibirsk State Univ, Russia

The surface-enhanced infrared spectroscopy was used for analysis of steroid hormone cortisol in biological samples. The concentration dependence of the intensity of the IR absorption modes of cortisol deposited on the metal nanoparticles was investigated and the minimum detectable concentration of steroid hormone was determined.

- Coffee Break -
TECHNICAL SESSION

4TH INTERNATIONAL SYMPOSIUM «LASERS IN MEDICINE AND BIOPHOTONICS»

SESSION S2D. PHOTONICS AND NANOBIO TECHNOLOGY

ThS2D-13 Invited
Digital image capture and analysis for simultaneous static and dynamic light scattering for biological systems
G.S. Iannacchione1, S. Algarne2; 1 - Worcester Polytechnic Inst. United States, 2 - King Saud Univ., Saudi Arabia

The Area Recorded Generalized Optical Scattering (ARGOS) approach to light scattering employs large image capture array allowing for a well-defined geometry in which images may be manipulated to extract structure with intensity at a specific scattering wave vector (|q|) and dynamics with intensity at a specific scattering wave vector over time (I(q,t)). The ARGOS method provides morphological dynamics noninvasively over a long time period and allows for a variety of aqueous conditions. This is important because traditional growth models do not provide for conditions similar to the natural environment. The present study found that the population dynamics of bacteria do not follow a traditional growth model and that the ARGOS method allowed for the observation of bacterial changes in terms of individual particles and population dynamics in real time. The observations of relative total intensity suggest that there is no stationary phase and that the bacterial population demonstrates sinusoidal type patterns consistently subsequent to the log phase growth. These observations were compared to shape changes by modeling fractal dimension and size changes by modeling effective radius.

ThS2D-14 Invited
Hybrid gold-based nanoparticles and atomic clusters for analytic and theranostic applications
N.G. Khlebtsov1,2, B.N. Khlebtsov1,2, L.A. Dykman1, V.A. Khanadeev1,2, 1 - Inst. of Biochemistry and Physiology of Plants and Microorganisms RAS, 2 - Saratov National Research State Univ., 3 - Saratov Science Research Veterinary Inst. RAS, Russia

Multifunctional nanocomposites combine therapeutic, diagnostic, and sensing modalities in a single nanostructure, thus constituting the technological basis of theranostic – a rapidly growing and promising field at the crossroads of plasmonics and nanomedicine. In this talk, we summarize our recent efforts in fabrication of hybrid gold-based nanocomposites for analytical and theranostic applications. We discuss also fabrication, optical properties, and applications of multifunctional fluorescent Au nanoclusters.

ThS2D-15
Superresolution optical imaging multimodal system
G.A. Stanciu1, C. Stoichiță1, A. Nigoara1, M. Manfredi2, S.G. Stanciu1, D.E. Tranca1, R. Hristu1, 1 - Univ. Politehnica of Bucharest, Romania, 2 - GNR SRL-Analytical Instruments Group, Agrate Conturbia, Italy

In our work we present a new superresolution optical imaging multimodal system which includes several microscopy techniques working in far field or in near field: this multimodal system integrated several optical microscopy techniques which offer the possibility for investigations at micro and nanoscale on the same area by using laser scanning microscopy techniques. It also included an atomic force microscope.

ThS2D-16
Trends in biosensor development: multifunctional plarformats and enhanced labels
I.Yu. Goryacheva1, Yu.S. Skibina1, T. Nigro2, N.A. Burnistava1, A.A. Shuvalova1, A.A. Chibrova3, 1 - Saratov National Research State Univ., 2 - St. Petersburg State Univ., 3 - SPb Nanostructured Glass Technology Ltd, Russia

Hot-points in biosensors development, such as an application of new bifunctional platforms with an example of photonic crystal fibers and multiplexing of labels with an example of multiloaded with quantum dots nanostructures are discussed.

ThS2D-17
Luminescent quantum dots as labels for multiparametric immunoassay
N.V. Beloglazova1,2, A.V. Gordienko1, A. Foubert2, O.A. Goryacheva1, 1 - Saratov National Research State Univ., Russia, 2 - Ghent Univ., Belgium

Use of quantum dots as highly sensitive labels in immunochemical assay for simultaneous screening of multiple analytes is described.

ThS2D-18
Quantum dots in basic research and practical applications: the role of size and quasi-multivalency
A.V. Salova1, T.N. Belyaeva2, V.V. Kosheverova2, A.A. Leonidiya2, M.V. Kharchenko1, E.S. Kornilova1, Inst. of Cytology RAS, Russia

Quantum Dots (QDs) attract attention as possible fluorescent markers with unique optical properties suggesting their applications for multi-color simultaneous staining of intracellular targets and their detection in live cells. However, their size and quasi-multivalency could affect the overall physiological response. We have shown requirements for endocytically effective EGF-QD complexes formation and analyzed the limiting stages in their interaction with cells.

ThS2D-19
Lectin-based nanoagents for specific cell labelling and optical visualization
V.O. Shipunova1, M.P. Nikitin1,2, P.I. Nikitin3, S.M. Deyev1, I.Yu. Goryacheva1, Yu.S. Skibina3, A.A. Chibrova3, 1 - Shemyakin-Ovchinnikov Inst. of Bioorganic Chemistry RAS, 2 – Moscow Inst. of Physics and Technology (State Univ.), 3 – Prokhorov General Physics Inst. RAS, Russia

Interactions between lectin-modified nanoparticles and various glycoproteins were investigated for development of effective nanoagents for therapy and diagnostics. We screened a variety of lectin-glycoprotein pairs both in cell-free mode and in vitro in human cell culture to create a number of highly specific nanoparticle-lectin conjugates. We showed that the obtained conjugates can be successfully used as biomarker-specific agents for specific cell visualization in biomedical diagnostics.
Photodynamic processes in biology and medicine I

Session Chair: Inna M. Belousova,
Vavilov State Optical Inst., Russia

ThS2E-01 Invited
09:00-09:20
Photoinduced processes in fullerenes and other carbon nanostructures
E.A. Katz, Univ. of the Negev, Israel

I will review the fundamental mechanisms of photoinduced charge generation, separation (charge transfer) and collection in solar cells based on fullerenes and other carbon nanomaterials (carbon nanotubes, buckycones, etc.). I will demonstrate that process in fullerene-based systems for photoinduced inactivation of pathologies can be described with the same language.

ThS2E-02 Invited
09:20-09:40
Organic nanoparticles for tissue diagnostics and PDT
R. Steiner1, C. Scala-Hopp, R. Wittig1, A. Ryabova2, S. Graef1, V. Loschenow1,2,3,4; 1 - Inst. of Laser Technologies in Medicine and Metrology at the Univ. of Ulm, Germany, 2 - Prokhorov General Physics Inst. RAS, Russia, 3 - Biotech Research GmbH, Germany, 4 - National Research Nuclear Univ. (MEPhI), Russia

Organic crystalline nanoparticles (NPs) are prepared from AIPCD and mTHPC raw material. Such NPs are non-fluorescent. After cellular uptake molecules are distributed into the cells, fluorescence and are photocatalytic. This process and the role of macroparticles are evaluated and will be presented. Therefore, such crystalline NPs can be used for tissue diagnostics and PDT.

ThS2E-03 Invited
09:40-10:00
Direct laser excitation of oxygen molecules: application to studies of oxygen photodynamics in systems of biomedical A.A. Krasovskiy, Bach Inst. of Biochemistry RAS, Russia

Oxygenation rates of singlet oxygen traps were compared upon direct laser excitation of dissolved oxygen molecules using continuous and pulse laser radiation and under photostimulation by porphyrins. Novel procedure of data processing was developed and accurate absorption coefficients were obtained for the main IR absorption maxima of molecular oxygen under ambient conditions. Biomedical importance of the data is discussed.

ThS2E-04 Invited
10:00-10:20
Ru(II) complex meditated PDT for bladder cancer, biology and dosimetry
P. Kasper1, S. Lazar2, F. Forward3, Y. Arenas4, A. Mandel5, L. Lüge6, 1 - Theratalase Inc., 2 - Univ. Health Network, Canada, 3 - Univ. of British Columbia, Canada

We present data showing that premixing the Ru2+-complex TLD14331,2 with transferrin increases the molar extinction coefficient, including longer activation wavelengths, reduces photobleaching rates, reduces the toxicity of the complex and improving overall PDT efficacy demonstrated in Human (HT1376) and rat (AY27) bladder cancer cells.

ThS2E-05 Invited
10:20-10:40
Nanophotosensitisers for theranostics
V.B. Loschenov, Prokhorov General Physics Inst., National Research Nuclear Univ. MEPhI, Russia

The limits of tumor detection by means of nuclear medicine do not exceed: 5 mm for X-ray tomography and MRI; 4 mm for PET; 1.5 in diameter in average by clinical investigation among the United States citizens. Thus at least 3 problems remain unsolved: diagnostics and consequent treatment of the one third of all malignant tumors, i.e. their early states, squamous cell carcinoma of mucous tissue; and the third one problem: a long way and expensive. The limit of tumor detection by means of optical spectroscopy is around 1-2 mm, although its principle it is possible to reach pathologies 5-10 µm in diameter. The problem of pathologies is the problem of diagnostics. The solution of this problem: a long way and expensive. The solution of this problem: a long way and expensive.

ThS2E-06 Invited
10:40-11:00
Completed characterization of detonation nanodiamond and cancer chemotherapy using nanodiamond as drug delivery platform
E. Osawa1, D. Ho1, T. Minagawa2, 1 - Shinshu Univ., Japan, 2 - UCLA, United States, 3 - Shinshu Univ. School of Medicine, Japan

We finished characterization of the primary particles of detonation nanodiamond (PPDND, 2.8 nm) in highly purified and monodisperse state. In parallel we have well progressed in evaluating PPDND for drug carrier platform, beginning from cell toxicity tests, to safety and chemotherapy examinations on small to large animals. Now we are preparing for preclinical safety tests on human.

- Coffee Break -

ThS2E-07 Invited
11:30-11:50
Photothermal effects of nanoparticles in liquid media
B. Eberle, C. Hege, M. Körber, A. Azarian, S. Dengler, Fraunhofer IOSB, Germany

We evaluate a variety of different kinds of nanoparticles suspended in various solvents regarding their nonlinear attenuation characteristics with respect to nanosecond laser pulses.

ThS2E-08 Invited
11:50-12:10
mTHPC-based photoactive nanoparticles: basic and pre-clinical research
L. Bezdetnaya1,2, H.-P. Lassalle1,2, S. Marchali3, G. Dolivet4, V. Zarin5, 1 - Univ. de Lorraine, France, 2 - Inst. de Cancérologie de Lorraine, France, 3 - Belarussian State Univ., Belarus

Tumor selectivity of mTHPC could be enhanced using drug delivery systems or carriers, like liposomes and cyclodextrins (CDs). Rapid accumulation of liposomal mTHPC in the xenografted tumors and reduced damage to normal tissues was inherent to liposomal formulations. CDs accelerate mTHPC mobility increasing its bioavailability. Injection of mTHPC-CD complexes resulted in reduced mTHPC accumulation in skin along with its better accumulation in the tumor.

ThS2E-09 Invited
12:10-12:30
Ultrafast photothermal action in nano dimensions
A. Ronchi1, S. Pedri2, M. Chiani1, C. Finetti1, M. Racci1, C. Giannetti1, F. Bandi3, G. Ferrari1, 1 - Univ. Cattolica del Sacro Cuore, 2 - Inst. of Chemistry of Molecular Recognition, CNR, 3 - NEST, Scuola Normale Superiore, Italy

The thermomechanical dynamics of complex biologically-related systems is investigated using ultrafast optical techniques. The extraction of information from experiments is accomplished through data mining techniques. Singular value decomposition (SVD) and a Hierarchical Cluster Analysis provide the basis for the analysis of both a single and ensemble of nano-objects. Paradigmatic examples are shown where ultrafast optoacoustic traces allow to discriminate the dimensions and predict the influence of the environment on nanoparticles bonded to surface chemical complexes, without previous knowledge of the investigated system. These techniques bear great potential as screening platform, to evidence casual or systematic errors and reveal patterns hidden in the data.

ThS2E-10 Invited
12:30-12:50
Photodynamic inactivation of enveloped virus in protein plasma preparations by solid-phase fullerene-based photosensitizer
I.M. Belousova1, I.M. Kisselakov1, T.D. Muraviova1, A.M. Starodubtsev1, T.K. Krikko2, A.A. Selivanov1, N.P. Sivakov1, S. Golovanov1, S.D. Volkov1, A.A. Shirot3, V.V. Zarubezh4, 1 - Vavilov State Optical Inst., 2 - Inst. of Hematology and Transfusiology, 3 - Belarussian State Univ., 4 - Inst. of Laser Technologies in Medicine and Metrology at the Univ. of Ulm, Germany

The ability of fullerene to inactivate influenza virus in protein fraction of donor blood when irradiated with visual light has been studied. The complete inactivation was achieved after 30 min of irradiation. This process did not lead to the toxicity of albumin. The data suggest that the method described is prospective for inactivation of viruses in the preparations of donor blood.

ThS2E-11 Invited
12:50-13:10
Design and optimization of molecular photoacoustic contrast agents (MPACs) for in vivo imaging of breast cancer tumors
M. Hatami, M. Frevertte, S. Buckley-Bollinger, J. Rochford, Ch.S. Yelleswarapu; Univ. of Massachusetts Boston, United States

Design and characterization of BODIPY inspired molecules as photoacoustic contrast agents (MPACs) for in vivo imaging of breast cancer tumors.

ThS2E-12 Invited
13:10-13:30
Photodynamic theranostics
A. Akopov, G. Papayan, N. Petrischke; Pavlov First State Medical Univ., Russia

Demonstrate the possibility of photodynamic theranostics with various methodological improvements in experimental and clinical studies: the use of tumour specific conjugates with biological nanocarriers; two-wavelength excitation; fluorescence image-guided surgery; stereotactic fluorescence biopsy therapy; using the near-infrared light to detect the tumour and sentinel lymph nodes; photodynamic irradiation in a pulsed mode. Fluorescent visualization in radiation therapy improves the tumor treatment efficacy.
The work is devoted to laser method of biocompatible coatings forming to create implants of the human body ligaments. Coating is a carbon nanotubes scaffold formed in the water-protein dispersion by the electric field of the laser radiation. Study has been conducted on the structure and properties of carbon nanotubes coatings and proliferative activity of biological cells on its surface.

Increasing the conductivity of the carbon nanotube-based layers by laser radiation

A.Yu. Gerasimenko1, L.P. Ickitidze1, V.V. Zar1, N.N. Zhurbina1, I.M. Belousova1, N.A. Solovyov3, L.N. Soms1,2; 1 ‑ National Research Univ. of Electronic Technology, 2 ‑ Inst. of Nanotechnology of Microelectronics RAS, 3 ‑ Moscow State Technical Uniu, Russia

The 5-50 µm-thick layers of a nanomaterial consisting of acrylic paint and multilayer carbon nanotubes (~3 mass.%) are investigated. It is shown that laser radiation and heat treatment enhance the conductivity of the layers by a few orders of magnitude. The layers remain stable in water for over 200 h and exhibit a conductivity of – (100–1000) S/m, which make them promising for application in biomedical electrodes and wearable electronics.
Determination of nanorods aspect ratio using depolarized light scattering.

Near infrared luminescent-magnetic nanoparticles for bimodal imaging in vivo.

Biosensors based on magnetic nanolabels: optimization with spectral interferometry and highly-sensitive electronic registration.

Optical method for studying self-assembly of various nanoparticles in liquids.

Real-time sensitive detection of low molecular weight compounds by optical immunosensors.

Colloidal gold nanoparticles change energy transfer standard scheme of a photosensitiser.

Luminescence method to study the growth of CuInS2 quantum dots in real time.

Stimuli-responsive nano- and microstructures based on gold nanoparticles.

Silanized liposomes loaded with luminescent quantum dots as label for mycoctoxin detection.

Colloidal gold nanoparticles change energy transfer standard scheme of a photosensitiser.

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Silanized liposomes loaded with luminescent quantum dots as label for mycoctoxin detection.
**4TH INTERNATIONAL SYMPOSIUM «LASERS IN MEDICINE AND BIOPHOTONICS»**

**POSTER SESSION**

**SECTION S2D. PHOTONICS AND NANOBIOTECHNOLOGY**

**ThS2D-p13 Spectroscopic assessment of biological tissue temperature using upconversion particles**
E.K. Volkova1,2, I.Yu. Yanina1, A.P. Popov1, A.A. Skapton2, Ju.G. Kon'yukhova1, V.I. Kochubei1, V.V. Tuchin1, I.V. Meglinski3; 1 - Univ. of Oulu, Finland, 2 - Saratov National Research State Univ., Russia, 3 - Precise Mechanics and Control Inst. RAS, Russia

The optimum pair of bands in the fine structure of nanoparticles luminescence spectra used for measuring local temperature of biological tissue had been determined.

**ThS2D-p14 The modeling of local distribution of the temperature photosensitizer bleaching rate constant.**
Yu.A. Avetisyan1, A.N. Yakunin1, A.A. Bykov1, V.V. Tuchin1,2,1; 1 - Inst. of Precise Mechanics and Control RAS, 2 - Chernyshevsky Saratov National Research State Univ., 3 - Tomsk State National Research Univ, Russia

In this paper we consider the laser irradiation of the ensemble of absorbing nanoparticles localized in macroscopically-sized area of the tissue sample. The simple formula for estimation of distribution of the local temperature is presented.

**ThS2D-p15 Laser nanosolder characteristics effect on tensile strength and structure of biotissue scaffold weld**
A.Yu. Gerasimenko1, I.P. Tkatchez2, D.I. Rybakov1, S.V. Selischchev1, E.S. Pyanov1, M.V. Mezentseva1, I.A. Suetina1, I.B. Rimshan1,3; 1 - National Research Univ. of Electronic Technology, 2 - Gamalei Federal Research Centre for Epidemiology and Microbiology, Russia

This work is concerned with dissecting the technique of dissected tissue welding using specific facility and nanosolder. The technique performance was studied on the hog stomach mucous membrane samples. Laser solder compositions that allow maximal durability of the tissue welding were revealed and its 3D structure was studied using x-ray microtomography. Biocompatibility of the laser nanosolder was proved.

**4TH INTERNATIONAL SYMPOSIUM «LASERS IN MEDICINE AND BIOPHOTONICS»**

**SECTION S2E. PHOTODYNAMIC PROCESSES IN BIOLOGY AND MEDICINE**

**ThS2E-p01 Determination of the luminescence spectrum of Radachlorin photosensitizer**
M.A. Petrov1,2, V.P. Belik1, M.V. Petrenko1, I.V. Semenova1, O.S. Vasyutinskii1; 1 - Ioffe Inst., 2 - Peter the Great St. Petersburg Polytechnic Univ, Russia

The entire luminescence spectrum of Radachlorin photosensitizer in water is determined. The spectrum contains the fluorescence peak centered at 660 nm, the phosphorescence band centered at 940 nm and a low intensity band centered at about 1300 nm. The interpretation of the data obtained is presented.

**ThS2E-p02 Photodynamic and photocatalytic activity of Fe2O3 nanoparticles**
E.K. Volkova1,2, Ju.G. Kon’yukhova1, V.I. Kochubei1, E.S. Tuchina1, V.V. Tuchin1; 1 - Saratov National Research State Univ., Russia, 2 - Univ. of Oulu, Finland, 3 - Precise Mechanics and Control Inst. RAS, Russia

The photodynamic and photocatalytic activity of the Fe2O3 and Fe2O3-3TiO2 nanoparticles were compared.

**ThS2E-p03 Kinetics of laser induced bleaching of Radachlorin photosensitizer**
D.M. Beltukova1,2, I.V. Semenova1, A.G. Smol’n1, O.S. Vasyutinskii2; 1 - Ioffe Inst., 2 - Peter the Great St. Petersburg Polytechnic Univ., Russia

Experimental monitoring of the fluorescence kinetics of Radachlorin photosensitizer is presented. Data fitting using the derived theoretical expressions allowed determining the photosensitizer bleaching rate constant. The results obtained may be of use for photodynamic therapy and diagnostics.

**ThS2E-p04 The development of fiber-optic scaffold for the glioblastoma diagnosis and prevention**
Yu.S. Maklygaina1, A.V. Borodkin1, G.M. Yusubalieva2, V.B. Loschenov1,3; 1 - Prokhorov General Physics Ins. RAS, 2 - Serbskij State Research Center of Forensic and Social Psychiatry, 3 - National Research Nuclear Univ. MEPHI, Russia

The main goal of the research is creation of the unique fiber-optical multipurpose system created on the basis of porous optical fibers. The fiber-optical scaffolds would perform the role of the structure which is promoting and setting the growth of glial cells. Also this system acts as a port for delivery of a photosensitizers and laser radiation for the purpose of cellular processes monitoring. So developed system allows to carry out a regular fluorescent diagnostics and timely photodynamic therapy of the probed area.

**ThS2E-p05 Dy3+ doped YPO4 nanocrystals for laser induced hyperthermia**
I.O. Romanskikh1, A.S. Vanetskov2, A.V. Rybakov1, Yu.V. Orlavskii1,2; 1 - Prakhov General Physics Ins. RAS, Russia, 2 - Univ. of Tartu, Estonia, 3 - National Research Nuclear Univ. MEPHI, Russia

In this work we investigate the effectiveness of pulse laser heating of Dy3+ doped phosphate nanoparticles by the effect of multiphonon relaxation. The results have shown rapid rise and fall of nanoparticle powder temperature suggesting their potential application as hyperthermia agents.

**ThS2E-p06 Laser pulse mode irradiation to improved photodynamic therapy efficiency**
V.V. Klimenko, N.A. Knyazev, A.A. Bogdanov, M.V. Dubina; St. Petersburg Academic Univ., Russia

Photodynamic therapy (PDT) is an effective treatment for cancer. Laser irradiation parameters strongly influence the singlet oxygen generation during PDT. However, the influence of pulsed and continuous wave (CW) irradiation modes on the type of cell death in terms of increasing the oxygen supply rate to the cells was not analyzed. We found a pattern between the pulsed radiation parameters and the molecular oxygen supply in cells allows increasing the cumulative singlet oxygen concentration compared to CW irradiation during PDT. It was shown that the pulsed irradiation mode of 662nm with a photosensitizer «Radachlorin» in a broad range of irradiation doses lead to apoptotic cell death k562, rather than necrosis, as in the CW mode. Our results show how the selection of parameters of pulsed irradiation mode into account the oxygen supply rate to the cells allows increasing the cumulative singlet oxygen concentration compared to CW irradiation during PDT.
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LASERS AND OPTICAL SYSTEMS

LOS participates in the ITER Project and in the European Fusion Programme

- lasers for material treatment & plasma diagnostics (Nd:YAG, 6 J, 200 Hz, 10 ns, 10^4 rad)

- diode-pumped solid-state lasers for range finding (Yb-Er:Glass, Q-switched, eye-safe range, compact, high brightness, short-pulse)

- airborne lidars for ecological and radionuclides monitoring (oil exploration, pipeline leakage detection, DPSSL Nd:YLF laser 262 nm, 250 Hz, 20 mJ)

LOS
St. Petersburg, Russia
www.los.su
e-mail: info@los.su