X International conference

Plasma Physics
and
Plasma Technology

Program
&
Book of Abstracts

Minsk, Belarus
September 12 – 16, 2022

B.I. Stepanov Institute of Physics
National Academy of Sciences of Belarus

X International Conference

PLASMA PHYSICS and PLASMA TECHNOLOGY

PPPT-10

Minsk, Belarus
September 12 – 16, 2022

Program and Book of abstracts

Edited by

Nikolai Tarasenko
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of the Russian Academy of Sciences

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TOPICS

1. Fundamental physical processes and phenomena in plasmas

2. Electrical discharges and other plasma sources, novel plasma generation approaches

3. Atmospheric pressure plasmas, plasma in and in contact with liquid, plasma-liquid interactions

4. Non-ideal and dusty plasmas, extreme plasma regimes, fusion and astrophysical plasmas, collective and nonlinear phenomena

5. Laser-plasma interactions with materials, laser ablation, modification of materials, sputtering and deposition

6. Plasma diagnostics and modeling

7. Plasma applications and advanced plasma technologies *(plasma for nanomaterials synthesis and processing, plasma in medicine and biology, plasma in agriculture, plasma in catalysis, etc.)*

Important dates

Registration	11-13.09.2022
PPPT-10 conference working days	12-16.09.2022
Conference dinner	13.09.2022
Excursion	15.09.2022

Table of contents

General information

Conference venue. The Conference halls are located in the building of the B.I. Stepanov Institute of Physics, NAS of Belarus, at 68-2 Nezalezhnasti ave., 220072, Minsk, Belarus.

The Conference program will include following types of presentations:

1. invited (40 min)
2. sectional reports (20 min)
3. poster presentations and discussions
4. short poster presentations

The conference language is English

Oral presentations

Oral presenters will have overall 20 minutes to present their talks including the discussion. The recommended duration for the talk is 15 minutes, leaving 5 minutes for questions. Participants are welcome to use the provided computer with software for showing slides in PPT, PPTX and PDF formats. The presenters should upload their files and test their presentations before the start of the session.

Poster presentations

We recommend to prepare **A1** size poster in portrait. All poster boards will be labeled with a poster number. Participants can put their posters up at the beginning of the day of their poster session or just before it.

Short Poster presentations

All the poster presenters will have an opportunity to introduce their posters during the short poster presentation session (2 min, max 2 slides in PowerPoint format). The slides should summarize the poster and should not be a repeat of a poster.

Social program

Conference dinner – Tuesday, September, 13-19.00-22.00

The conference dinner will take place in the "Arbat" restaurant located at 143 Nezalezhnasti ave., building 1. The program of the dinner includes a degustation of the traditional Belarusian food and drinks.

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Excursion - Thursday, September, 15 - 11.00-21.00

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The excursion will be organized to the **Belarusian Park-Museum of Interactive History Sula**.
A guided tour allows an acquaintance with the history of Belarus starting from ancient times till XV-XVII century. This includes a visit of the site of the megalithic culture, the site of paganism and the temple with the Old Slavonic rite of purification by fire, visiting the Varangian pier, riding on a drakkar along the river, acquaintance with the medieval quarter, journey to the XV-XVII century, the era of the nobility. An excursion allows learning of old traditions, tasting of local drink in a local brewery. The excursion ends with a phaeton ride.
To get to the Sula Park-Museum, a bus will be organized from the conference venue. The duration of the excursion is 10 hours and includes the lunch.

If you have any questions, please contact organizers:
pppt10@ifanbel.bas-net.by

Monday – September 12, 2022

Hall I 10:00-12:40

10:00-10:20 Conference Opening

Chairman: N.V. Tarasenko

10:20 T4-INV **Strongly coupled Coulomb systems of Brownian grains at temperature of superfluid helium**

O.F. Petrov, R.E. Boltnev, M.M. Vasiliev
Joint Institute for High Temperatures, Russian Academy of Sciences, RUSSIA

We provide experimental evidence for the active Brownian motion and evolution of structures driven by quantum effects for micron-sized grains levitating in superfluid helium. The active Brownian motion of grains was induced by quantum turbulence during the absorption of laser irradiation by grains. The intensity of Brownian motion associated with quantum vortices increased by 6-7 orders of magnitude compared to the values from the Einstein formula.

11:00 T1-INV **Study of self-organization of near-electrode current structures in atmospheric pressure glow discharges in helium**

I. Rafatov, G. Islamov, C. Yesil
Middle East Technical University, TURKEY

The work deals with the study of current structures emerging in near-electrode regions of direct current glow discharges at atmospheric pressure in helium. Although these structures are interesting in themselves as fundamental physical phenomena, they can affect the stability of discharges, leading to fluctuations in their parameters. The results of a comprehensive numerical study of the self-organization of these structures and the mechanisms of their formation are presented.

11:40 **New results from dusty plasma experiments at the "Plasma Kristall - 4" laboratory on board the International Space**
T4-1 **Station**

O.F. Petrov (1), A.D. Usachev (1), A.M. Lipaev (1), A.V. Zobnin, (1) M.Y. Pustylnik (2), M. H. Thoma (3), H.M. Thomas (2)
(1) Institute for High Temperatures of RAS, RUSSIA
(2)Institut fur Materialphysik im Weltraum, Deutsches Zentrum fur Luft- und Raumfahrt (DLR), GERMANY
(3) I. Physikalisches Institut, Justus-Liebig-Universit¨at Gießen, GERMANY

An overview of the Russian-European joint space experiment "Plasmakristall-4", which operates on the International Space Station (ISS) since 2015, will be presented. The PK-4 facility is designed to study a highly non-ideal dusty plasma in a combined DC-RF discharge under microgravity conditions and installed in the Columbus laboratory module on the ISS. A disign of the PK-4 installation on board the ISS, the methodology for conducting experiments and the main experimental results will be given.

12:00 **Active Brownian particle in a plasma**

E.A. Lisin, O.S. Vaulina, I.I. Lisina, O.F. Petrov
T4-2 *Joint Institute for High Temperatures, Russian Academy of Sciences, RUSSIA*

A distinctive feature of an active colloidal plasma is a low viscosity at which the rotational inertial effects play a significant role and the overdamped approximation of active Brownian motion is not justified. In the framework of active Langevin particle model, analytical equations for the mean kinetic energy and mean-square displacement of a free and confined self-propelled particle in a plasma are obtained.

12:20 **Fractal dimension of extensive systems of Janus and metal-covered grains in colloidal plasmas**

T4-3 X.G. Koss, E.A. Kononov, I.I. Lisina, M.M. Vasiliev and O.F. Petrov
(1) Joint Institute for High Temperatures, Russian Academy of Sciences, RUSSIA
(2) Moscow Institute of Physics and Technology, RUSSIA

We analyze the experimental data on the motion of systems of active Brownian micrograins in RF discharge plasmas. Two types of microparticles were used: 1) plastic grains fully covered with metal, 2) Janus particles with a thin metal cap. We studied the dependencies of the MFPT dynamic entropy on the coarsening parameter, the fractal dimension of the system on its mean kinetic temperature, and the mean localization area of the grain on its mean kinetic temperature.

12:40-14:00 Lunch

Hall I 14:00-16:40

Section 3 - Atmospheric pressure plasmas, plasma in and in contact with liquid, plasma-liquid interactions

Chairman: B. Obradović

14:00 **Optical and electrical characterization of pulsed nanosecond discharge on water surface**

T3-INV A. Hamdan, A. Herrmann, J. Margot
Département de Physique, Université de Montréal, CANADA

In this paper, we investigate the influence of voltage amplitude (V_a) and gap distance (d) on the streamer discharge behavior at the surface of water. Time resolved images show the formation and propagation of plasma dots (ionization front of streamers) at water surface. Based on the measurement of the propagation velocity and on the estimation of the E-field in the medium, an average mobility of plasma dots is evaluated. From both this value and the instantaneous measured velocity, the temporal evolution of charge per dot (Q_{Dot}) and charge number are determined.

14:40 **Direct oxidation of benzene to phenol in low-temperature barrier discharge plasma: Influence of reactor temperature**

T3-1 A. Leshchik, S. Kudryashov
Institute of Petroleum Chemistry, SB of the RAS, RUSSIA

In this study, the influence of the reactor temperature on the main parameters of the benzene oxidation process in a barrier discharge was studied. When treated at atmospheric pressure plasma, a liquid product and a precipitate are formed. The resulting products were analyzed by GC, GC-MS, IR-spectroscopy and NMR. The results showed that an increase in the temperature of the plasma-chemical treatment of benzene leads to a decrease in the content of diatomic phenols in the reaction products.

15:00 **Liquid anode method as a method for the formation of spherical metal particles**

T3-2 Yu.S. Baryshnikov, R.O. Kurakin, K.V. Tverdokhlebov, A.V. Chikiryaka, S.A. Ponyaev
Ioffe Physical-Technical Institute of the RAS, RUSSIA

In this work, we studied the process of formation of spherical metal particles by plasma spraying of a metal cathode when it comes into contact with a liquid anode. The resulting spherical particles are geometrically suitable for additive technologies and other technical applications.

15:20 **Electric discharges of direct and alternating current in a gas-liquid flow at atmospheric pressure**

T3-3 F.M. Gaysin (1), A.A. Khafizov (2), R.I. Valiev (2), L.N. Bagautdinova (1), Az.F. Gaysin (3), Al.F. Gaysin (1)
(1) Kazan National Research Technical University named after A.N.Tupolev - KAI, RUSSIA
(2) Kazan Federal University - Naberezhnye Chelny Institute, RUSSIA
(3) Kazan State Power Engineering University, RUSSIA

The results of experimental studies of an electric discharge in a gas-liquid flow for various interelectrode distances, the composition and concentration of the electrolyte are presented. A multi-channel discharge with a transition to a volumetric discharge was detected. Depending on the intake of air and electrolysis, the discharge can burn at the cathode or anode, as well as in the interelectrode gap.

15:40 **Atmospheric pressure glow discharge as the instrument of the transformation of metal ions in the water**

T3-4 D.A. Shutov, A.N. Ivanov, K.V. Smirnova, V.V. Rybkin
Ivanovo State University of Chemistry and Technology, RUSSIA

The results of studies on the reduction processes of some metal ions and the synthesis of metal-containing powders in solution under the action of a contact glow discharge are presented. The atmospheric pressure direct current glow discharge in air was used as reducing process activation tool of Cr and Mn in water solution. Also, Zn, Cd, Co, Ni, Fe, Cu binding to the solid powders using discharge was shown. The mechanisms of processes were proposed.

16:00 **Decomposition of CO_2 in a microwave discharge in liquid hydrocarbons**

T3-5 Yu.A. Lebedev (1), T.S. Batukaev (1), G.V. Krashevskaya (2), I.V. Bilera(1)
(1) Institute of Petrochemical Synthesis named after. A.V. Topchiev RAS, RUSSIA
(2) National Nuclear University "MEPhI", RUSSIA

The task of CO_2 decomposition is one of the components of the problems associated with global warming. One of the promising directions is the use of low-temperature plasma. This paper presents the first results on the study of microwave discharge products in liquid Nefras C2 80/120, when CO_2 is introduced into the discharge zone. The main products of the discharge are H_2, C_2H_2, C_2H_4, CH_4, CO_2, and CO. It is shown that the degree of CO_2 decomposition reaches 70%.

16:20 **Zero-dimensional simulation of a microwave discharge in a mixture of ethanol with water**

T3-6 Yu.A. Lebedev, A.V. Tatarinov, A.Yu. Titov, I.L. Epshtein
A.V.Topchiev Institute of Petrochemical Synthesis, RUSSIA

In the zero-dimensional approximation, a simulation of a microwave discharge inside a bubble filled with microwave plasma in water and ethanol vapors at a pressure of one tenth of an atmosphere was carried out. The calculated concentrations of the main products of the decomposition of an aqueous solution of alcohol are in good agreement with the experimental data available in the literature in a wide range of the initial composition of the mixture and the power input into the discharge.

16:40-17:00 Coffee Break

17:00-18:00 Short poster presentations

Hall III **18:00-19:00** **Poster session**

Hall II **14:40-16:40**

Section 4 - Non-ideal and dusty plasmas, extreme plasma regimes, fusion and astrophysical plasmas, collective and nonlinear phenomena

Chairman: L.V. Simonchik

14:40 **Numerical investigation of the effectiveness of the interaction of laser beams with a magnetized target**

T4-4 V.V. Kuzenov (1,2,3), N.V. Batrak (1), N.G. Kopaleishvili (1), S.V. Ryzhkov (1)
(1) Bauman Moscow State Technical University (BMSTU), RUSSIA
(2) Ishlinsky Institute for Problems in Mechanics RAS (IPMech), RUSSIA
(3) Dukhov All-Russian Research Institute of Automatics (VNIIA), RUSSIA

The scheme of the interaction of plasma target with high energy pulse laser beams in the externally applied magnetic field, so-called laser-driven magneto-inertial fusion is considered. A mathematical model of the interaction of high-energy-energy laser beams with a plasma target located in a seed magnetic field is developed by authors. The theoretical calculations of the processes of compression and energy release in the target in a magneto-inertial plasma confinement are carried out.

15:00 **Radiative processes and thermalization in relativistic plasma**

T4-5 M.A. Prakapenia
B.I. Stepanov Institute of Physics of the NAS of Belarus, BELARUS

We show that relativistic plasma needs quantum description beyond diffusion approximation and discuss basic QED processes in opaque relativistic plasma. Thermalization of nonequilibrium relativistic plasma is studied using homogeneous Boltzmann equation including binary and triple QED processes between electrons, positrons and protons. We discuss establishment of kinetic and thermal equilibrium in relativistic plasma.

15:20 **Cosmic dust, electrical phenomena and weather on Earth**

A.V. Kostrov
T4-6 *Federal research center Institute of Applied Physics of the RAS, RUSSIA*

The global electrical circuit of the Earth related to the flows of negatively charged cosmic dust to the surface of our planet is considered. The parameters of the dust particles are calculated from the condition of the quasi-stationary state. Ozone disturbances in the atmosphere are an indicator of non-stationary and inhomogeneous dust flows. Dust reaches the surface in a few days and causes a significant change in the weather in areas over which ozone density perturbation was observed.

15:40 **Rotation mechanisms of dust clusters in stratified dc discharges under the magnetic field action**

T4-7 L.G. Dyachkov (1), E.S. Dzlieva (2), V.Yu. Karasev (2), L.A. Novikov (2), S.I. Pavlov (2)
(1) Joint Institute for High Temperatures of RAS, RUSSIA
(2) Saint-Petersburg State University, RUSSIA

In stratified DC discharges, dust clusters rotate in magnetic fields. In weak (~0.01 T) and strong (> 0.1 T) fields, dust clusters rotate in different directions under the influence of different mechanisms. In PSST 29 085020 (2020) we measured the rotation velocities at 1.1-2.2 T and proposed a calculation model for strong fields. In this report, we show that another mechanism (the main one in weak fields) can make a noticeable contribution to the rotation velocity even in strong fields.

16:00 **Self-consistent relaxation theory of collective dynamics in classical one-component plasma**

T4-8 A.V. Mokshin, I.I. Fairushin
Kazan Federal University, RUSSIA

In this work the self-consistent relaxation theory of the collective ion dynamics in strongly coupled classical one-component plasmas is presented. The information about the structure, the non-ideality and screening parameter of the system is sufficient to describe collective dynamics over a wide range of spatial ranges. The dynamic structure factor, the dispersion parameters are determined within the framework of the theory without using any adjustable parameters.

16:20 **Equation of state for dense tantalum plasma at high energy densities**

T4-9 K.V. Khishchenko
Joint Institute for High Temperatures RAS, RUSSIA

A semi-empirical model of the equation of state is presented. A wide-range equation of state for tantalum plasma has been developed. The calculation results are compared with the available experimental data on shock compression, as well as isentropic and isobaric expansion of the metal. The resulting equation of state can be effectively used in modeling of various processes in dense tantalum plasma at high energy densities. This research is supported by the Russian Science Foundation, grant 19-19-00713.

16:40-17:00 Coffee Break

17:00-18:00 Short poster presentations

Hall III **18:00-19:00** **Poster session**

Tuesday – September 13, 2022

Hall I 9:00-12:40

Section 7 - Plasma applications and advanced plasma technologies

Chairman: I.I. Filatova

9:00 **Enhancement of the photocatalytic efficiency of nanostructured materials via plasma treatment**

T7-INV N.A. Savastenko (1), A.A. Shcherbovich (1), V.A. Lyushkevich (2), I.I. Filatova (2), S.A. Maskevich (1)
(1)Belarusian State University, International Sakharov Environmental Institute BSU, BELARUS
(2)B.I. Stepanov Institute of Physics, National Academy of Sciences of Belarus, BELARUS

In this study, we report the results of systematic study on influence of plasma treatment on exciton-plasmon coupling and photocatalytic performance of ZnO-based photocatalysts impregnated with plasmonic nanoparticles as well as on the photocatalytic performance of the polymer-capped Ru sensitized TiO_2 nanopowders. The plasma-modified materials were employed for photocatalytic degradation of methyl orange and sodium caffeine benzoate.

9:40 **Compact source of non-thermal argon plasma jet for bacterial inactivation**

T7-1 B.B. Baldanov, Ts.V. Ranjurov
Institute of Physical Materials Science, Siberian Branch, Russian Academy of Sciences, RUSSIA

A special type of diffusive discharge (glow discharge) on which a low-current spark discharge is superimposed is created experimentally in a gas flow, in the form of atmospheric pressure plasma jets. The flow of current in the discharge gap is a steady regime of periodical current pulses. A highly efficient portable low-temperature nonequilibrium argon plasma source (the PortPlaSter) is designed on the basis of this glow discharge with superimposed low-current spark discharges.

10:00 **Plasma chemical production of water-soluble chitosan and testing its biological activity**

T7-2 V.A. Titov (1), I.K. Naumova (2), A.V. Khlyustova (1), N.A. Sirotkin (1)
(1) G.A. Krestov Institute of Solution Chemistry of the Russian Academy of Sciences, RUSSIA
(2) Ivanovo State University, RUSSIA

DC discharge in air with chitosan acidic solution as a cathode and an underwater discharge were used to obtain water-soluble chitosan (WSC). The products were characterized by UV-Vis and IR-spectroscopy, XRD, NMR and were tested as stimulators of germination and development of cucumbers and peas compared with a commercial phytostimulant. The use of WSC increased the germination of seeds, the rate of development of roots and shoots, the content of chlorophyll and inhibited the bacteria and fungi.

10:20 **Hybrid-type plasma chemical reactors: developments for natural biopolymers processing**

T7-3 T. Vasilieva (1), M. Vasiliev (2)
(1) Moscow Institute of Physics and Technology (MIPT), RUSSIA
(2) Joint Institute for High Temperatures of the Russian Academy of Sciences, RUSSIA

High molecular weight chitosan processing in non-equilibrium low-temperature hybrid plasma generated by joint action of a continuous electron beam and RF-gas discharge on gas (oxygen or water vapor) at pressures 0.1-10 Torr is considered. Water-soluble chitooligosaccharides with weight-average molecular mass Mw = 800-2000 Da were obtained; solutions of the oligomers enhanced germination in peas and decreased their microbial and fungal contamination. Supported by RFBR_ №20-02-00501_a.

10:40 – 11:00 Coffee Break

Chairman: N.A. Savastenko

11:00 **Beam-plasma reactors for functional gradient materials production**

T7-4 T. Vasilieva
Joint Institute for High Temperatures, Russian Academy of Sciences, RUSSIA

Beam-plasma chemical reactors generating cold hybrid plasma for production of polymeric functionally graded materials for tissue engineering and regenerative medicine are considered. The control techniques of the reaction volume by intermittent electron beam scanning are described. The developed approach allows precisely localize the RF-discharge on the polymeric surface forming abruptly structured or smoothly gradients patterns of functionalities. Supported by RSF grant 21-79-30062.

11:20 **Temperature effects under processing of irradiated reactor graphite and nuclear power plant metal constructions by**
T7-5 **ion-plasma deactivation technology**

A.S. Petrovskaya (1), A.B. Tsyganov (1), S.V. Surov (2), A.Yu. Kladkov (2)
(1) Plasma application department, InnoPlasmaTech LLC, RUSSIA
(2) Science and Innovation, JSC ROSATOM, RUSSIA

To solve the world problem of irradiated reactor graphite and nuclear power plants metal structures decontamination, we are developing new "dry" ion-plasma technology based on high pressure shortened discharge in inert gas for radionuclides removal. We have obtained temperature distributions in reactor graphite GR-280 and reactor steel under ion-plasma deactivation process, and have considered temperature effects of thermal sputtering and atoms desorption from the surface under decontamination.

11:40 T7-6 **Study by SEM X-ray microanalysis method of the sputtered atoms condensation under surface treatment of nuclear power plants constructions by ion-plasma deactivation technology**

A.S. Petrovskaya (1), A.B. Tsyganov (1), S.V. Surov (2), A.Yu. Kladkov (2)
(1) Plasma application department, InnoPlasmaTech LLC, RUSSIA
(2) Science and Innovation, JSC ROSATOM, RUSSIA

Using SEM X-ray microanalysis method, we have studied cathode surface of the nuclear power plants construction samples and the surface of anode (collector of the sputtered atoms) before and after treatment by atmospheric pressure shortened discharge in argon under ion-plasma deactivation technology. SEM X-ray microanalysis spectra of sub-surface (~ 1 micron) layers elemental composition in cathode and anode-collectors are obtained, rate constants of sputtered atoms mass-transfer are estimated.

12:00 T7-7 **Beam-Plasma Systems for "green" technologies: multifunctional experimental complex for R&D**

M. Vasiliev (1), T. Vasilieva (2)
(1) Joint Institute for High Temperatures of the Russian Academy of Sciences, RUSSIA
(2) Moscow Institute of Physics and Technology (MIPT), RUSSIA

Plasma excited by electron beam injecting in dense media is known to be effective for gas reforming, waste treatments, biomass recycling, bio-polymers processing. This presentation aims to highlight beam-plasma technologies for clean energy production, eco-friendly industry and agriculture, resource saving and environmental remediation. R&D complex parameters, its operation and experiments arrangement in these fields are considered on examples of practically-oriented developments carried out.

12:20 T7-8 **Investigation of zigzag wires layout in exploding wire array**

S. Anishchenko (1), A. Gurinovich (1), E. Gurnevich (1), D. Leonenko (2), A. Rouba (1)
(1) Research Institute for Nuclear Problems, BELARUS
(2) Electrophysical laboratory, BELARUS

Results of investigation of wires layout in exploding wire array are presented. Straight and zigzag layouts are considered. Zigzag layout can be used to minimize wire array length. SF_6 medium for zigzag layout was used to prevent array breakdown. Requirements for SF_6 pressure and distance between wires for zigzag layout were obtained. Influence of wire damage caused by extra tension applied to wires during installation on exploding wire array operation is considered.

12:40-14:00 Lunch

Hall II **9:40-12:40**

Section 4 - Non-ideal and dusty plasmas, extreme plasma regimes, fusion and astrophysical plasmas, collective and nonlinear phenomena

Chairman: F.M. Trukhachev

9:40 **Calculations of equation of state and electronic transport coefficients of low-temperature bismuth plasma**

T4-10 E.M. Apfelbaum
Joint Institute for High Temperatures of Russian Academy of Science, RUSSIA

The pressure, internal energy and electronic transport coefficients (conductivity, thermal conductivity) for the low-temperature bismuth (Bi) plasma were calculated within the temperature range 10 -100 kK and densities less than the normal one. The chemical model was applied for the calculations of the thermodynamics, while the relaxation time approximation was used for the coefficients. The other data for these properties in the considered range for Bi plasma have been absent up to now.

10:00 **The nature of abnormal particle heating in the plasma dust structures**

T4-11 S.I. Mol'kov, A.S. Shtykov
Petrozavodsk State University, RUSSIA

Dusty plasma is an example of an open non-equilibrium system where a self-assembly process occurs, with dissipative structures emerging. Massive dust particles in weakly ionized plasma effectively dissipate their kinetic energy due to collisions with neutral atoms, so they are assumed to be in equilibrium with the atomic component and their temperature T_d is equal to the atom temperature T_a.

10:20 **Volume dust structures in a plasma with magnetized ions**

V.Yu. Karasev, E.S. Dzlieva, S.I. Pavlov, L.A. Novikov,
T4-12 S.A. Tarasov, D.V. Yanicin, O.E. Bashkircev
Saint Petersburg State University, RUSSIA

A dusty plasma was created in the experiment in the form of 3D dusty structures in a strong magnetic field. Dust traps with bulk dusty plasma are organized under conditions of dc discharge under the action of a longitudinal magnetic field. In the lightest inert gases, in a magnetic field of 2 T, not only electrons, but also ions are magnetized. The electron cyclotron radius is comparable to the size of a dust particle, and the ion radius is comparable to the Debye screening length.

10:40-11:00 Coffee Break

Chairman: S.V. Ryzhkov

11:00 T4-13 **Ultracold multimodal dusty plasma in DC glow discharge**

R.E. Boltnev (1,2,3), E.A. Kononov (1,3), F.M. Trukhachev (1,3), M.M. Vasiliev (1,3), O.F. Petrov (1,3)
(1) Joint Institute for High Temperatures, Russian Academy of Sciences, RUSSIA
(2) Branch of the N. N. Semenov Federal Research Center for Chemical Physics, Russian Academy of Sciences RUSSIA
(3) Moscow Institute of Physics and Technology, RUSSIA

Experimental studies of ultracold multimodal dusty plasma in a positive column of the glow discharge are discussed. A multimodal complex plasma formed by a spheroidal dusty structure consisting of polydisperse CeO_2 particles superimposed with a cloud of nanoclusters and solid helical filaments was observed and studied at the temperatures below 2 K and pressure ≈ 4 Pa. The cloud of nanoparticles (with the sizes ~ 10 nm) was observed due to light scattering on non-linear waves.

11:20 T4-14 **Fractal analysis of the surface of dust particles**

A.P. Gorbenko (1), V.A. Polischuk (2), E.S. Dzlieva (1), S.I Pavlov (1), V.Yu. Karasev (1)
(1) Saint-Petersburg State University, RUSSIA
(2) Admiral Makarov State University of Maritime and Inland Shipping, RUSSIA

In dusty plasmas, melamine-formaldehyde particles decrease in size, maintaining a spherical shape; the surface of the particles changes its properties, which is manifested in a change in the roughness Ra and in the fractal dimension depending on the residence time. In this report we present an estimate of the fractal dimension Df value and microparticle surface area of plasma treated particles.

11:40 T4-15 **Shock adiabats of tungsten alloys at high pressures and temperatures**

N.N. Seredkin (1,2,3), K.V. Khishchenko (1,3,4,5)
(1) Joint Institute for High Temperatures RAS, RUSSIA
(2) National Research Nuclear University MEPhI, RUSSIA
(3) Institute of Problems of Chemical Physics RAS, RUSSIA
(4) Moscow Institute of Physics and Technology, RUSSIA
(5) South Ural State University, RUSSIA

Knowledge of the thermodynamic properties of substances at high pressures and temperatures in shock waves is of fundamental and practical interest. In this paper, we calculated the shock adiabats for some alloys of tungsten with nickel, copper, and iron based on the additivity rule for the shock adiabats of components. The results of these calculations are compared with the available data of shock-wave experiments. This research is supported by the Russian Science Foundation, grant 19-19-00713.

12:00 **Self-organization of a laser-irradiated monolayer of active particles modified in an RF discharge plasma.**

T4-16 E.A. Kononov (1,2), M.M. Vasiliev (1,2), O.F. Petrov (1,2)
(1) Joint Institute for High Temperatures of the Russian Academy of Sciences, RUSSIA
(2) Moscow Institute of Physics and Technology, RUSSIA

Changes in the properties of macroparticles can be caused by exposure to such an active environment as plasma. As a result, their behavior in the Coulomb structure may change dramatically: passive Brownian particles may become active, which, in turn, leads to self-organization of such structures. The self-organization of a laser-irradiated monolayer levitating in a capacitive high-frequency discharge plasma, caused by modification of the macroparticles forming it, was experimentally studied.

12:20 **Experimental study of kinetic heating of dust particles in a gas discharge**

T4-17 E.A. Sametov (1,2), E.A. Lisin(1,2), E.A. Kononov (1,2), M.M. Vasiliev (1,2), O.F. Petrov (1,2)
(1) Joint Institute for High Temperatures of the RAS, RUSSIA
(2) Moscow Institute of Physics and Technology, RUSSIA

The results of processing experiments using a new spectral method for studying the mechanism of kinetic heating of dust particles in a gas-discharge plasma are presented. An experimental verification of the previously developed model of kinetic heating of a system of two interacting particles was carried out. It was shown that the work of the effective interparticle interaction forces is the dominant mechanism.

12:40-14:00 Lunch

Hall I **14:00-18:40**

Section 2 - Electrical discharges and other plasma sources, novel plasma generation approaches

Chairman: T. Vasilieva

14:00 **On constriction and striation of a diffuse DBD in a large gap**

T2-INV Yu. Akishev
SRC RF TRINITI, RUSSIA

The object of investigation is the dielectric barrier discharge in a plane-to-plane geometry. For the first time, the DBD with a very long plasma column (120 mm) was created. The experiments with long-gap DBD have revealed many differences in its behavior compared to the well-known DBD in a short gap. Therefore the experimental search on spatial-temporal behavior of a sinusoidal DBD powered in a large volume with long interelectrode gap is the topical issue.

14:40 **Parameters of auxiliary discharge plasma in an electron accelerator based on ion-electron emission**

T2-1 S.Yu. Doroshkevich, V.A. Levanisov, I.V. Lopatin, M.S. Vorobyov, M.S. Torba, S.S. Kovalsky, S.A. Sulakshin
Institute of High Current Electronics SB RAS, RUSSIA

In this work, determination of the parameters of emission plasma was carried out in an electron source based on secondary ion-electron emission with the output of generated large cross section beam into the atmosphere. Role of auxiliary discharge is played by a self-sustained glow discharge with a hollow cathode and two thin-wire anodes. Measurement and recording of probe bias voltage values and their corresponding current values was carried out by a designed automated measurement system.

15:00 **Multiarc grid plasma emitter based on an arc discharge for generating a radially converging electron beam**

T2-2 M.S. Torba, M.S. Vorobyov, N.N. Koval, V.V. Ezhov, S.Yu. Doroshkevich, S.A. Sulakshin
Institute of High Current Electronics SB RAS, RUSSIA

This paper describes the design of a grid plasma emitter based on a low-pressure multi-arc discharge for generating a radially converging submillisecond electron beam. The developed and created power supply system based on inductive energy storage devices makes it possible to generate arc discharge current pulses of submillisecond duration with an amplitude of up to 200 A.

15:20 **Study of the layout of a frequency pulsed plasma electric jet engine with a magnetic energy storage**

T2-3 P.A. Morozov, R.V. Emlin, I.F. Punanov, Y.N. Shcherbakov
Institute of electrophysics of the UB of the RAS, RUSSIA

In the work the effect of a small buffer capacity on the traction and electrical efficiency of a magnetic storage operating with repetition rate of the 400 Hz was investigated. The average power consumption from a 25 V voltage source is 40 watts. The capacitance value varied in the range of 0.7 - 8 nF. An increase in the efficiency of energy transfer to the buffer capacity from 30 to 90% was obtained.

15:40 **Plasma source of a ribbon electron beam with an extended hollow anode**

T2-4 A.S. Klimov, I.Yu. Bakeev, A.A. Zenin
Tomsk State University of Control Systems and Radioelectronics, RUSSIA

The principle of operation, design and test results of a ribbon electron source based on a low-pressure gas discharge are described. The cross section of the beam is 200×5 mm^2. The electron energy is regulated in the range of 0.5-10 keV, the average beam current is from 0.5 to 100 mA. A wide range of operating pressures (0.03-10 Pa) is due to the use of the discharge unit providing the generation of dense plasma based on a discharge with hollow cathodes operating on one hollow anode.

16:00 **Generation of an electron beam in the mode of amplitude modulation in a plasma triode based on an arc discharge**

T2-5 V.I. Shin, M.S. Vorobyov, P.V. Moskvin, V.N. Devyatkov
Institute of High Current Electronics SB RAS, RUSSIA

Traditionally, beams with a rectangular shape of the beam current pulse are generated in electron-beam installations. In this work, the SOLO electron source was modernized by introducing an additional grid electrode, and a power source was created to supply a bias potential between the grid electrodes of the plasma triode. Thus, it becomes possible to generate a beam up to 200 A in the amplitude modulation mode during a pulse up to 1 ms.

16:20 **Increasing the electrical strength of the accelerating gap in systems with plasma cathodes**

T2-6 M.S. Vorobyov, N.N. Koval, P.V. Moskvin, V.I. Shin, V.N. Devyatkov, M.S. Torba., V.A. Levanisov
Institute of High Current Electronics SB RAS, RUSSIA

The work is devoted to demonstrating the unique capabilities of sources and accelerators of electrons with grid plasma cathodes based on a low-pressure arc discharge, which make it possible to generate intense submillisecond electron beams of a large cross section. The problems of increasing the electrical strength of the accelerating gap in such systems are considered, and methods for solving these problems are proposed.

16:40-17:00 Coffee Break

Chairman: S.K. Kunakov

17:00 **Analysis of parameters of coaxial dielectric barrier discharge in carbon dioxide flow at atmospheric pressure**

T2-7 I. Rafatov (1), A. Astafiev (2), S. Cakir (1), Y. Katircioglu (3)
(1) Middle East Technical University, TURKEY
(2) Saint Petersburg Electrotechnical University, RUSSIA
(3) ARTECS Inc., A.U. Teknokent, TURKEY

The work deals with the numerical simulations and experimental analysis of atmospheric pressure DBD sustained in carbon dioxide in coaxial discharge cell. The aim is to gain a deeper understanding of the mechanisms underlying the DBD-assisted carbon dioxide conversion. The effect of various operating conditions on the discharge characteristics is studied for wide ranges of parameters such as the amplitude and frequency of the applied voltage, and different configurations of the discharge cell.

17:20 **On the stability of diffuse attachment on the hot cathode of vacuum arc**

T2-8 V.P. Polishchuk, R.A. Usmanov, A.D. Melnikov, I.M. Yartsev
Joint Institute for High Temperatures of Russian Academy of Sciences, RUSSIA

The report presents experimental studies of the arc on a heated cerium dioxide cathode (T = 2.2-2.4 kK). It was shown that the cathode current attachment can be in diffuse mode and in spot mode. The cathode spots (CS) of 0.1-0.3 mm in size could appear on its surface with a decrease in the cathode temperature. The maximum speed of their motion could reach ~5 cm/s The occurrence of CS did not affect the discharge voltage. The possible reasons for the appearance of CS are discussed.

17:40 **Numerical simulation of light-erosion plasma dynamic MPC-discharges**

T2-9 V.V. Kuzenov (1,2,3), N.V. Batrak (1), N.G. Kopaleishvili (1), S.V. Ryzhkov (1)
(1) Bauman Moscow State Technical University (BMSTU), RUSSIA
(2) Ishlinsky Institute for Problems in Mechanics RAS (IPMech), RUSSIA
(3) Dukhov All-Russian Research Institute of Automatics (VNIIA), RUSSIA

A physico-mathematical model of magnetoplasma compressor (MPC) is presented. Electrotechnical characteristics and power modes of MPC discharges in gases are considered. Radiation-plasma dynamic structures and spectral-brightness characteristics of MPC-discharges are given. Three different types of quasistationary spatial distributions of plasma parameters are calculated for different heating modes (ohmic, transient and plasma dynamic).

18:00 **Plasma studies at Gasdynamic Ion Source for Multipurpose Operation (GISMO) Facility**

T2-10 V.A. Skalyga, I.V. Izotov, A.F. Bokhanov, S.V. Golubev, R.L. Lapin, E.M. Kiseleva, S.S. Vybin, and A.V. Polyakov
Federal Research Center Institute of Applied Physics of the Russian Academy of Sciences, RUSSIA

GISMO facility was constructed in IAP RAS to hold a comprehensive study of high-density pulsed/CW electron cyclotron resonance discharge. It utilizes 28 GHz/10 kW gyrotron radiation for plasma heating in a simple mirror trap. It is of great interest for fundamental and applied research. The prospects of its application for the development of high-current proton or H- source as well as powerful VUV source are discussed.

18:20 **Low-voltage high-current pulsed magnetron discharge as a source of dense metal-free plasma**

T2-11 A.V. Kaziev, D.V. Kolodko, N.P. Orlov, V.A. Tumarkin
National Research Nuclear University MEPhI (Moscow Engineering Physics Institute), RUSSIA

Today, a lot of practical applications demand utilizing efficient sources of highly ionized metal-free plasmas. One of the ways to produce such plasmas is to use high-power pulsed magnetron discharges. Here, the operation of millisecond-scale pulsed low-voltage magnetron discharge in hydrogen and helium was examined. The maximum pulse power was around 80 kW. Plasma parameters were monitored with an electric probe, while the plasma composition was evaluated by an optical emission spectrometer.

19:00-22:30 Conference dinner

Hall II **14:40-16:40**

Section 1 - Fundamental physical processes and phenomena in plasmas

Chairman: M.M. Vasiliev

14:40 **Diagnostics of a hot electron component of an ECR ion source plasma**

T1-1 E.M. Kiseleva (1,2), I.V. Izotov (1,2), V.A. Skalyga (1,2), M.E. Viktorov (1,2), A.V. Polyakov (1,2), S.S. Vybin (1,2), R.L. Lapin (1)
(1) Federal Research Center Institute of Applied Physics of the Russian Academy of Sciences, RUSSIA
(2) Lobachevsky State University of Nizhny Novgorod, RUSSIA

Kinetic instabilities that appear in the electron cyclotron resonance ion source (ECRIS) plasmas significantly reduce efficiency of such sources. This happens because of anisotropy of the electron energy distribution function originating from the resonant nature of the electron heating process. The experiments described in this work were held on the GISMO 28 GHz/10 kW facility to investigate the nature of the instabilities and find the ways to boost the efficiency of ECRIS.

15:00 **The mechanism of single-frequency high power microwave**
T1-2 **generation by relativistic virtual cathode oscillators**

P.V. Molchanov
Institute for Nuclear Problems of Belarusian State University, BELARUS

Virtual cathode oscillators (vircators) are among the promising microwave sources of gigawatt power level pulses, generating an efficiency level of 8-12% under conditions of single-frequency generation. In this paper, we study the conditions for establishing a single-frequency generation mode based on the results of 3D numerical simulation of axial and coaxial vircators with a three-cavity resonator and an electron beam energy of 400-500 keV.

15:20 **Controlling of characteristics of a plasma asymmetric dipole antenna**

T1-3 N.N. Bogachev (1), M.S. Usachonak (2), S.E. Andreev (1)
(1) Prokhorov General Physics Institute of the RAS, RUSSIA
(2) B.I. Stepanov Institute of Physics of the NAS of Belarus, BELARUS

We investigated a plasma asymmetric dipole antenna with a positive column of a glow discharge in neon at reduced pressure, in the frequency range of 1-3 GHz. In numerical simulation, the characteristics of the plasma and the radiation pattern of the antenna are investigated. In experimental studies, the dependences of antenna VSWR and electrical switching between the radiation ranges on an electron density in the plasma column were obtained.

15:40 **Etching kinetics of quartz in a hydrogen-oxygen microwave plasma**

T1-4 V.Yu. Yurov (1), V.G. Ralchenko (1), D.N. Sovyk (1), A.S. Altakhov (1), A.P. Bolshakov (1), I.A. Fedorova (1), E.V. Zavedeev (1), A.F. Popovich (1,2)
(1) Prokhorov General Physics Institute of the Russian Academy of Sciences, RUSSIA
(2) Institute of Radio Engineering and Electronics of the Russian Academy of Sciences, RUSSIA

We studied the etching of quartz in a microwave plasma chemical vapor deposition reactor in pure H_2 and in mixtures of H_2 with a minor addition of O_2 (0.9% vol.) at the gas pressures of 30-60 Torr within the temperature range of 950-1200^{o}C. The etching rate of the silica was measured in situ using a low-coherence interferometer. We found that small O_2 addition allows a noticeable slow-down of the etch process. This work was supported by the Russian Science Foundation, grant No. 21-12-00403.

16:00 **Numerical Simulation of the Flow of an Electrically Charged Dusty Medium with One-Dimensional Geometry**

T1-5 D.A. Tukmakov
Kazan Scientific Center of RAS, RUSSIA

This paper presents a mathematical model of the dynamics of a gas suspension under the action of an aerodynamic field, an electric field, and a gravitational field. The continuum model is used to describe the dynamics of the disperse component. The intercomponent momentum exchange included the aerodynamic drag force, the dynamic Archimedes force, and the added mass force. The Coulomb force acting on dispersed particles was taken into account.

16:20 **High-voltage NS discharge interaction with fs-laser generated blast waves: Gasdynamic diode**

T1-6 A. Starikovskiy, A. Dogariu, M. Shneider
Princeton University, USA

Multiphoton ionization by a powerful fs-laser pulse leads to the generation of a dense strongly nonequilibrium plasma and a strong gasdynamic perturbation in the gas with a density decrease near focal point. A streamer of positive polarity cannot overcome the rarified gas layer, while a streamer of negative polarity could propagate further and finally close the discharge gap. Thus, we form a sort of "gasdynamic diode" with an asymmetric conductivity of the initially symmetrical discharge gap.

16:40 – 17:00 Coffee Break

Hall II **17:00-18:40**

Section 6 - Plasma diagnostics and modeling

Chairman: Yu. Akishev

17:00 **Mathematical modeling of RF plasma flow in vacuum chamber at low pressures**

T6-1 A.Yu. Shemakhin, V.S. Zheltukhin
Kazan Federal University, RUSSIA

RF plasma at low pressures (p = 13.3 - 133 Pa) with gas flow is effectively used for modifying the surfaces of materials of organic and inorganic nature. Calculations of the main parameters of RF plasma flow are completed (electron, ion, metastables density, carrier gas parameters, electron temperature, electromagnetic field) in vacuum chamber with a sample. The reported study was funded by Russian Science Foundation, according to the research project No. 19-71-10055.

17:20 **Specific features of probe measurements of EEDF near the anode**

T6-2 S.N. Andreev (1), A.V. Bernatskiy (1), N.A. Dyatko (2), I.V. Kochetov (1,2), V.N. Ochkin (1)
(1) P.N. Lebedev Physical Institute of the Russian Academy of Sciences, RUSSIA
(2) SRC RF Troitsk Institute for Innovation and Fusion Research, RUSSIA

The probe method is widely used to measure the electron energy distribution function (EEDF) in discharge plasma. The EEDF measured in the near-anode region will be depleted in low-energy electrons due to various effects: natural (absorption of electrons by the anode) and artificial (distortions introduced by the probe). In the present paper, the role of these effects is analyzed in relation to probe measurements of the EEDF in a discharge with a hollow cathode in helium.

17:40 **The dependence of the electron density on the gas flow rate in the induction plasma of argon**

T6-3 T.N. Terentev, A.Yu. Shemakhin, E.S. Samsonova, V.S. Zheltukhin
Kazan Federal University, RUSSIA

The dependence of the parameters of an inductive-coupled radio-frequency discharge at low pressure (113-165 Pa) with the gas flow is investigated by numerical simulation. The calculation is performed in the COMSOL Multiphysics 5.6 software package (modules: plasma, magnetic fields, heat transfer and laminar flow in conjunction with plasma conductivity coupling, electron heat source).

18:00 **Modeling of high pressure short-arc xenon discharge with a thoriated cathode**

T6-4 N. Timofeev (1), V. Sukhomlinov (1), G. Zissis (2), I. Mukharaeva (1), A. Mustafaev (3)
(1) Saint Petersburg State University, RUSSIA
(2) Paul Sabatier Toulouse University, FRANCE
(3) Saint Petersburg Mining University, RUSSIA

A short-arc xenon discharge of high pressure with taking into account the evaporation of cathode material (thorium) into the discharge volume has been studied. The data showed that thorium atoms strongly affected plasma characteristics. This report is devoted to the study of the effect of the electrodes shape on the plasma of short-arc xenon discharge. The calculations show that the shape of electrodes is indeed a strong factor of affecting plasma electrokinetic and optical characteristics.

18:20 **Bactericidal components of air plasma jets diagnostics using absorption IR and UV spectroscopy**

T6-5 A.V. Kazak (1), A.A. Kirillov (1), L.V. Simonchik (1), M.M. Kuraica (2), B. M. Obradovich (2), G. B. Sretenovich (2)
(1) B.I. Stepanov Institute of Physics of the NAS of Belarus, BELARUS
(2) University of Belgrade, Faculty of Physics, SERBIA

This work discusses the application of UV and IR absorption spectroscopy to determine the mole fraction of chemically active molecular components in air plasma jets at atmospheric pressure, the effect of which on bacteria in the case of air jets is the main mechanism of inactivation of microorganisms. An original method for determining the mole fraction of NO in a plasma jet using UV absorption spectroscopy has been developed.

19:00-22:30 Conference dinner

Wednesday – September 14, 2022

Hall I 9:00-12:40

Section 7 - Plasma applications and advanced plasma technologies

Chairman: I.S. Nikonchuk

9:00 **Active brownian grains in colloidal plasma driven by laser radiation**

T4-INV M.M. Vasiliev, O.F. Petrov, R.E. Boltnev, E.A. Kononov, K.B. Statsenko
Joint Institute for High Temperatures, Russian Academy of Sciences, RUSSIA
Moscow Institute of Physics and Technology, RUSSIA

Recently, there has been a significant amount of interest in the study of active Brownian motion. In our work, we present the results of an experimental study of the evolution of dissipative structures of active Brownian particles in a gas discharge plasma. An analysis of the Brownian motion patterns for grains on different time scales and the change in the intensity of grain motion (their kinetic energy and diffusion) depending on the laser radiation power is presented.

9:40 **Plasma treatment and synthesis of powders for additive manufacturing**

T7-9 A.Kh. Gilmutdinov, K.Yu. Nagulin, I.V. Tzivilskyi
Kazan National Research Technical University named after A.N. Tupolev, Dept. of Laser and Additive Technologies, RUSSIA

In additive manufacturing, raw powder materials play a key role in shaping the properties of the final product. Inductively coupled plasma can be used to modify a new powder, recover a spent powder, and synthesize structurally graded powder materials. Examples of the application of plasma processing of powders used in the additive manufacturing are considered.

10:00 **Plasma-liquid treatment of the surface of metal products**

T7-10 Al.F. Gaisin, D.N. Mirkhanov, S.Yu. Petryakov
Kazan National Research Technical University named after A. N. Tupolev - KAI, RUSSIA

Plasma-liquid treatment of the surface of a steel product is considered. Electrophysical characteristics, types and forms of the discharge are investigated. Scanning electron microscopy was used to study the surface microrelief of the samples before and after treatment. The parameters of the roughness of the samples have been studied.

10:20 **Plasma-liquid production of metal powder for 3D printing application**

T7-11 Al.F. Gaisin, R.R. Kayumov, A.I. Kuputdinova
Kazan National Research Technical University named after A. N. Tupolev - KAI, RUSSIA

Plasma-liquid processing of additive manufacturing products into metal powder is considered. The electrophysical characteristics, types and forms of discharge burning are investigated. Using scanning electron microscopy, photographs of the sprayed powder were obtained. The elemental analysis of the obtained powder was carried out.

10:40 – 11:00 Coffee Break

Chairman: V.M. Astashynski

11:00 **Deposition of micro- and nanocrystalline diamond coatings on carbide cutters of small diameter in MW plasma**

T7-12 E. Ashkinazi (1), V. Ralchenko (1), V. Sedov (1), M. Shevchenko (1), D. Vinogradov (2), E. Matasova (2), A. Khomich (3), R. Khmelnitsky (4)
(1) A.M. Prokhorov General Physics Institute, Russian Academy of Sciences, RUSSIA (2) Bauman Moscow State Technical University, RUSSIA
(3) V. A. Kotelnikov Institute of Radio Engineering and Electronics RAS, RUSSIA
(4) P. N. Lebedev Institute of Physics, Russian Academy of Sciences, RUSSIA

Methane-hydrogen and methane-hydrogen-nitrogen microwave plasma was used to deposit diamond coatings on cutters made of WC +6% Co hard alloy. To compensate the high aspect ratio of substrates, a special substrate holder was designed. Precise geometry of the deposition zone was calculated via FEM modeling of the electromagnetic field. Comparative wear tests of resulting cutters have shown that the wear rate of diamond-covered cutters is lower by a factor of 1.75

11:20 **Physical basis of material modification by radio-frequency discharge at low pressure**

T7-13 I.Sh. Abdullin (1, 2) V.S. Zheltukhin (2), A.Yu. Shemakhin (3)
(1) Plasma-VST, LLC, RUSSIA
(2) Kazan National Research Technological University, RUSSIA
(3) Kazan Federal University, RUSSIA

Theoretical and experimental studies of both inductively and capacitively RF discharges in the pressure range from 13 to 133 Pa, plasma gas flow rate up to 0.2 g/s, discharge power from 0.5 to 5 kW, generator frequency 1.76 and 13.56 MHz were performed. The physical mechanism of RF plasma action at reduced pressure on the surface of samples, the mathematical model of RF plasmas, and the results of modifying properties of different material are presented.

11:40 **Investigation of the interaction of ultrathin MoS_2 films with H_2, O_2, and N_2 plasma**

T7-14 D.E. Melezhenko (1), D.V. Lopaev(2), A.I. Zotovich(2)
(1) Lomonosov Moscow State University, Faculty of Physics RUSSIA
(2) Federal State Budget Educational Institution of Higher Education M.V.Lomonosov Moscow State University, Skobeltsyn Institute of Nuclear Physics, RUSSIA

Ultrathin MoS_2 films are being of particular interest due to their application in low-power electronics.The purpose of this work is a study of impact of H_2, O_2 and N_2 remote plasma on MoS_2 films. In this work, it is demonstrated that direct plasma treatment leads to essential damage to the upper layer of the MoS_2, a treatment by remote H_2 plasma creates S vacancies, and treatment with N_2 and O_2 remote plasma leads to the adsorption of these atoms on the surface.

12:00 **Conversion of CO_2-CH_4 mixture in direct current non-self-sustained glow discharge at atmospheric pressure**

T7-15 A.V. Kazak, A.A. Kirillov, L.V. Simonchik, M.U. Tomkavich
B.I. Stepanov Institute of Physics of the NAS of Belarus, BELARUS

The plasma chemical reactor for conversion of CO_2-CH_4 mixture based on a direct current non-self-sustained atmospheric pressure glow discharge in three-electrode configuration was created. The CO_2 and CH_4 mixture conversion into a synthetic gas was investigated experimentally. The degrees of conversion of CO_2 and CH_4 where is about 83% and 78% respectively. The degree of conversion rises with the increase of residence time of the reaction mixture in the reactor core.

12:20 **Behavior of SF_6 in the plasma medium of an electron beam**

S. Sosnovskiy
T7-16 *Tomsk State University, RUSSIA*

In the plasma of a pulsed electron beam, the vibrational levels of molecules are effectively excited. Studies have shown that the effect of an electron beam is realized in the environment SF_6 plasma. The electron beam parameters are as follows: electron energy 400-500 keV, pulse duration at half maximum 60 ns, multiplicity up to 5 pulses per second, pulse energy up to 200 J. The electron beam is injected into the closed reactor through the anode foil. The isotope effect is considered.

12:40-14:00 Lunch

Hall I **14:00-16:40**

Section 5 - Laser-plasma interactions with materials, laser ablation, modification of materials, sputtering and deposition

Chairman: N.N. Tarasenka

14:00 T5-INV **Laser ablation of transition metal nanoparticles for sensitive detection of molecules**

R. Soni
Physics Department, IIT Delhi, INDIA

We present the synthesis of bimetallic ultra-thin shell gold-transition metal core-shell nanoparticles by double-step successive and single-step simultaneous laser ablation in the presence of precursor solutions. The functionalized bimetallic nanoparticles-based SERS substrates are used for the detection of several dyes, pesticides, and explosives molecules. The SERS substrates demonstrate high signal reproducibility, repeatability, and ultra-low limit-of-detection.

14:40 T5-1 **Ultra-short laser pulse processing of Ti-based thin metallic films**

B. Gaković (1), S.I. Kudryashov (2), PA Danilov (2), D. Milovanović (3), A.A. Ionin (2)
(1) Vinča Institute of Nuclear Sciences, University of Belgrade, SERBIA
(2) Lebedev Physical Institute, Russian Academy of Sciences, RUSSIA
(3) Institute of General and Physical Chemistry, SERBIA

In this work, we show the results of our study of Ti-based nanolayer modification by ultrashort laser pulses (ULPs) irradiation. Multilayer thin films (MLTFs) are widely applicable in contemporary nanotechnology. Direct processing of MLTFs, with ULPs, is an extremely precise and fast technique. ULPs can be used for removing complete MLTF from the substrate, or layer/layers from its surface, known as selective ablation. Selective ablation was achieved only at well-defined values of ULP and MLTFs.

15:00 T5-2 **The spatiotemporal validation of local thermodynamic equilibrium during the analysis of a zinc-based alloy by the LIBS technique**

N. Lellouche (1), S. Messaoud Aberkane (2), K. Yahiaoui (2), A. Kellou (1)
(1) Physical Radiation Laboratory, Faculty of Physics, Houari Boumediene University of Science and Technology, ALGERIA
(2) Advanced Technologies Development Center, Ionized Media & Laser Division, ALGERIA

The description of the plasma state and the evaluation of its parameters such as temperature T and electron number density by the calibration free laser induced breakdown spectroscopy (CF-LIBS) can only be possible under the local thermodynamic equilibrium (LTE) condition. For the validation of LTE we used the McWhirter criterion and two other conditions which take into account the transient and heterogeneous nature of the laser induced plasma (LIP).

15:20 **Tungsten modification and fuel retention during plasma exposure**

T5-3 O.V. Ogorodnikova
National Research Nuclear University MEPHI (Moscow Engineering Physics Institute), RUSSIA

W-based samples were exposed to low-temperature D/He plasma to simulate normal operation regimes and pulsed high temperature D/He plasma in quasi-stationary high-current plasma gun QSPA-T to simulate transit events. The results obtained give possibility to assess the particle retention in divertor areas subjected to high thermal loads at different operation regimes and to compare advanced W-based materials with respect to the D and He retention and material modifications.

15:40 **Controlling of materials ablation and plasma formation under bichromatic laser explosure in air**

T5-4 A.N. Chumakov, V.V. Lychkousky, N.A. Bosak
B.I. Stepanov Institute of Physics of the NAS of Belarus, BELARUS

The analysis of a number of materials ablation in atmospheric air with formation of near-surface plasma under irradiation by pulsed Nd:YAG laser with radiation wavelengths of 355, 532 and 1064 nm at power density of radiation up to 5 GW/cm^2 is given. The increased efficiency of ablative plasma formation and heating under bichromatic irradiation of metals, graphite, silicon and glass at leading action of short-wave nanosecond laser pulses has been established.

16:00 **Features of the BK-110 glass destruction and plasma heating by nanosecond laser radiation at wavelengths of**

T5-5 **355 and 532 nm**

A.N. Chumakov, V.V. Lychkovsky
B.I. Stepanov Institute of Physics of the NAS of Belarus, BELARUS

The destruction of BK-110 glass in air under the influence of single and double nanosecond pulses of laser radiation with wavelengths of 355 and 532 nm using optical microscopy and video recording of plasma plume glow has been experimentally investigated. The influence of the sequence order and the time interval between the double pulses of bichromatic laser radiation on the nature of glass destruction and the dynamics of the near-surface plasma is established.

16:20 **Investigation of the properties of thin films and nanostructures prepared from copper oxide ceramic targets**

T5-6 **by PLD technique**

S.T. Pashayan (1), S.V. Zlotski (2), V.M. Anishchik (2)
(*1) The Institute for Physical Research of NAS of Armenia, ARMENIA*
(2) Belarusian State University, BELARUS

In this study vacuum pulsed laser deposition from CuO and Cu_2O ceramic targets was used to grow thin films of nanoscale thickness on glass, sapphire and ITO substrates at different grown temperatures. The effect of annealing and laser radiation parameters on the surface microstructure of the obtained films and their ability to absorb light was investigated. To determine the characteristics of the prepared films and structures SEM, EDX, XRD, RS, surface roughness measurements, UV-Visible absorption were used.

16:40-17:00 Coffee Break

Hall I **17:00-18:00**

Section 7 - Plasma applications and advanced plasma technologies

Chairman: A.N. Chumakov

17:00 **Co-precipitation from solutions of iron, nickel, cobalt nitrates under the action of a glow discharge**

T7-17 K.V. Smirnova, P.A. Ivanova, D.A. Shutov, A.N. Ivanov, V.V. Rybkin
ISUCT, RUSSIA

The coprecipitation of powders from solutions of cobalt and nickel nitrates in the presence of iron nitrates was tested by a method based on the interaction of an atmospheric pressure glow discharge with solutions. The composition and structure of the resulting powders were studied using SEM, XRD, TGA, and DLS. It was shown that the resulting particles have a complex chemical composition and are X-ray amorphous. After high temperature treatment, the powders are pure oxides.

17:20 **Plasma reactor for investigation of biomass high temperature gasification**

T7-18 A. Liavonchyk, I. Khvedchyn, V. Sauchyn
A.V.Luikov Heat and Mass Transfer Institute, BELARUS

Pilot plasma reactor with capacity up to 100 kg/h was designed for investigation of high temperature gasification of different types of biomass such as agriculture waste, municipal or industrial waste. The proposed reactor is intended for conversion of organic part of waste into syn-gas and melting and vitrification of inorganic one to produce homogeneous compound that suits for safety long-term storage or utilizing in building industry.

17:40 **Selection of spectral variables for multivariate calibration on C, Mn, Si, Cr, Ni and Cu in low alloy steels**

T7-19 **characterization by LIBS methods**
M.V. Belkov, D.A. Borisevich, K.Yu. Catsalap, M.A. Khodasevich
B.I. Stepanov Institute of Physics of the NAS of Belarus, BELARUS

The paper discusses the quantitative elemental analysis of steels by LIBS techniques. Quantitative measurements are based on calculating the calibration vectors. To calculate the vectors the multivariate calibration model was used. Within the model scope, three methods of spectral variables selection were tested: 1) the method of ranking of spectral variables; 2) successive projections algorithm and 3) an original modification of combination moving window iPLS.

Thursday – September 15, 2022

Hall I 09:00-10:40

Section 1 - Fundamental physical processes and phenomena in plasmas

Chairman: M. Usachonak

9:00 **Microdynamics and thermodynamics of nonlinear waves in dusty plasma**

T1-INV F.M. Trukhachev (1,2,3), M.M. Vasiliev (1,2), O.F. Petrov (1,2)
(1) Joint Institute for High Temperatures of the Russian Academy of Sciences, RUSSIA
(2) Moscow Institute of Physics and Technology, RUSSIA
(3) Belarusian-Russian University, BELARUS

Properties of the dust-acoustic waves are analyzed on the basis of hydrodynamic model as well as single-particle approximation. Significant differences between dissipative and conservative cases are discussed. The heat dissipation processes that determine the entropy are studied.

9:40 **Dynamics of single particles in a dc glow discharge under the action of laser radiation**

T1-7 A.S. Svetlov (1,2), E.A. Kononov (1,2), O.F. Petrov (1,2), M.M. Vasiliev (1,2)
(1) Joint Institute for High Temperatures of the Russian Academy of Sciences, RUSSIA,
(2) Moscow Institute of Physics and Technology, RUSSIA

The results of an experimental study of the nature of the motion of a single particles with different types of surface under the action of laser radiation of various powers in a dc glow discharge are presented. A single macroparticle was injected into a stratified direct current glow discharge where, as a result of the balance of electric force and gravity, its levitation was observed.

10:00 **Fissile plasma gas dynamics**

S.K. Kunakov (1), A.E. Shapyeva (2)
T1-8 *(1) Al-Farabi Kazakh National University, KAZAKHSTAN*
(2) Moscow Institute of Physics and Technology, RUSSIA

When the moving fissile gas is irradiated by neutron flux, then test fissile gas starts the formation of high-energy particles of fission fragments and electrons, which will strongly affect the chemical kinetics of neutral gas, as well as the formation of the specific hydrodynamic flux and temperature distribution. In this case, the motion of the fissile gas is determined by the system of self-consistent Boltzmann equations for neutral gas and heavy fission fragments.

10:20 T1-9 **The quantum mechanism of detonation for gorenje in a self-consistent field of continuous plasma forms by pumping of laser under conditions of deactivation of the high triplets electronic excited states of polyatomic compounds of hydrocarbons**

A. Obukhov

FAE "25 State Research Institute of Chemmotology of the Ministry of Defense of the Russian Federation", RUSSIA

Using the methods of optics, laser spectroscopy and electron-nuclear magnetism (NMR and EPR) in the series of N-, O-, S-heteroaromatic mono-, bi-, tri-, pentacyclic compounds synthesized on the basis of: benzene, furan, thiophene, oxazole, oxadiazole, oxazoline and pyridine, spatial and electronic structures in the ground state were studied, as well as according to the calculated quantum chemical methods of LCAO-MO SSP-KV NPDP/C and SPP/C full spectra of electronic excited singlet, triplet, were determined.

10:40 – 11:00 Coffee Break

11:00-21:00 Excursion

Friday – September 16, 2022

Hall I 9:00-10:40

Section 6 - Plasma diagnostics and modeling

Chairman: A. Nevar

9:00 **LIBS hydrogen detection: significance in fusion technology**
M. Trtica (1), M. Kuzmanovic (2), J. Savovic (1), D. Rankovic (2)
T6-INV *(1) University of Belgrade, VINCA Institute of Nuclear Sciences, SERBIA*
(2) Faculty of Physical Chemistry, University of Belgrade, SERBIA

Nowadays, developing methods for sensitive detection of hydrogen in nuclear (fusion and fission) technology is of great interest and challenge. Focusing on a fusion reactor, detection of hydrogen in the plasma-facing wall and reactor structural materials is of prime importance. The presence of hydrogen can cause degradation of the reactor materials that drastically reduce their lifetime. Among several methods available for hydrogen detection, such as thermal desorption spectroscopy, nuclear techniques and glow discharge optical emission spectroscopy, laser-induced breakdown spectroscopy (LIBS) is very promising. LIBS ensures high sensitivity, fast, reliable, and in-situ/stand-off detection. The VINCA Institute experiments conducted on polymer (PMMA) and metals will be presented in this context. The work was supported by: MPNTR, projects 451-03-68/2022-14/200017 and IAEA Contract 24076.

9:40 **Elemental analysis of pottery by using libs technique**
M. Kuzmanović (1), A. Stancalie (2), D. Ranković (1), A. Staicu (2), and J. Savović (3)
T6-6 *(1) University of Belgrade, Faculty of Physical Chemistry, 11158 Belgrade 118, Serbia*
dragan@ffh.bg.ac.rs, miroslav@ffh.bg.ac.rs
(2) National Institute for Laser, Plasma and Radiation Physics, 77125 Magurele, Romania
andrei.stancalie@inflpr.ro, angela.staicu@inflpr.ro
(3) University of Belgrade, Institute of Nuclear Sciences Vinca, 11001 Belgrade, Serbia
lelas@vinca.rs

10:00 **Emission of chalcogens in the dielectric barrier discharge**
S.V. Avtaeva (1), A.A. Heneral (2)
T6-7 *(1) Institute of Laser Physics SB RAS, RUSSIA,*
(2) Institute of Electron Physics, NAS of Ukraine, UKRAINE

The development of radiation sources with a spectrum close to the solar spectrum is of particular interest, since such radiation is necessary for life. A pulsed DBD in mixtures of Ar/He with chalcogen vapors is designed. It was found that spectra of the discharge contain intense bands of chalcogen dimers in the visible region of the spectrum. The 1D hydrodynamic model of the DBD in an Ar-S_2 mixture is developed and discharge properties are compared at harmonic and pulsed voltage.

10:20 **Laser-induced plasmas of different organic matrices**

N.I. Sushkov (1), N.N. Kurian (2), S.M. Zaytsev (1), N.V. Lobus (3), A. Kéri (4), Ádám Bélteki (4), Gábor Galbács (4), Timur A. Labutin (1)

(1) Department of Chemistry, Lomonosov Moscow State University, RUSSIA
(2) Department of Mathematics and Informatics, Yanka Kupala State University of Grodno, BELARUS
(3) Timiryazev Institute of Plant Physiology, Russian Academy of Sciences, RUSSIA
(4) Faculty of Science and Informatics, University of Szeged, HUNGARY

T6-8

Hydrobiota provides a number of matrices with variable chemical composition and physical properties (from highly mineralised to mostly organic materials). We studied the parameters and temporal evolution of their laser-induced plasmas, which varied considerably. Spatial distribution of emission and plasma parameters were also studied. Elemental analytical results were compared with those of LA-ICP-MS. The study was funded by RFBR and BRFFR, projects No. 20-53-04036 and Б21РМ-085, respectively.

10:40 – 11:00 Coffee Break

Hall I 11:00-12:40

Section 5 - Laser-plasma interactions with materials, laser ablation, modification of materials, sputtering and deposition

Chairman: R. Soni

11:00 **Spatial distribution of breakdown plasma under laser exposure of colloidal solutions of nanoparticles**

G.A. Shafeev, E.V. Barmina

Wave Research Center of A.M. Prokhorov General Physics Institute of the Russian Academy of Sciences, RUSSIA

T5-INV

The spatial structure of the plasma of laser breakdown of colloidal solutions is experimentally studied. It is found that the breakdown occurs in isolated points of the liquid under irradiation of the metal nanoparticles in water (Nd:YAG laser, p=10 ns, energy per pulse of 2 mJ). These points are associated with the fluctuations of nanoparticles density that leads to appearance of dimers and aggregates. The fluctuations of their density is modelled within the formalism of stochastic geometry.

11:40 **Plasma-assisted synthesis of hybrid and doped silicon-based nanostructures**

T5-7 N.N. Tarasenka (1), V.G. Kornev (1), A.A. Kuchmizhak (2)
(1) B.I. Stepanov Institute of Physics NAS of Belarus, BELARUS
(2) Institute of Automation and Control Processes of FEB RAS, RUSSIA

Silicon nanoparticles (NPs) due to their efficient light absorption are promising for a row of applications, namely solar energy converters and biomedicine. By combining Si nanostructures with plasmonic NPs or by their doping with Ge or Sn, the optical properties can be tuned thus allowing to increase the efficiency of solar energy conversion. In this work, several approaches based on laser ablation and electrical discharge in liquids were developed for the formation of hybrid and doped Si NPs.

12:00 **Laser induced preparation of boron nanoparticles and use as an additive in composite fuel**

T5-8 K.O. Aiyyzhy, E.V. Barmina, G.A. Shafeev
Prokhorov General Physics Institute of the Russian Academy of Sciences, RUSSIA

Boron nanoparticles (NPs) are generated by laser ablation of a sintered Boron target in isopropanol and subsequent laser fragmentation of the suspension. NPs have carbon shell. Allotropic composition of NPs differs from that of the initial Boron target. The boron NPs obtained in these experiments were investigated as additives to composite hydrocarbon fuel. The addition of boron NPs in the amount of 0.5 wt % was found to result in an increase in temperature in the flame front by 150 K.

12:20 **Enhanced proton acceleration from an ultrathin target irradiated by laser pulse**

T5-9 M. Turki (1), D. Bennaceur-Doumaz (2)
(1) University of Science and Technologie Houari Boumediene ALGERIA
(2) Center for Development of Advanced Technologies, ALGERIA

The use of ultrathin target offers optimal conditions for accelerating protons to high energies from laser-matter interaction in the framework of the TNSA (Target Normal Sheath Acceleration) mechanism. In this work, we will study the effects of thickness and composition of targets in proton acceleration. We will demonstrate how the proton energy increase with the target of low atomic number Z.

12:40-14:00 Lunch

Hall I 14:00-16:40

Section 6 - Plasma diagnostics and modeling

Chairman: I. Rafatov

14:00 **Electrical discharge initiated chemistry in prebiotic atmospheres**

T3-INV F. Krčma (1), S. Chudják (1), N. Fojtíková (1), L. Moravský (2), Š. Matejčík (2)
(1) Faculty of Chemistry, Brno University of Technology, CZECH REPUBLIC
(2) Faculty of Mathematics, Physics and Informatics, Comenius University Bratislava, SLOVAKIA

The search of life precursors became a hot topic. One of the life precursors synthesis ways is operation of electrical discharges in so called prebiotic atmospheres. The presented study gives results of organic compounds synthetized in atmospheres related to Titan and Mars by glow discharge at atmospheric pressure. The discharge created species were determined using in situ PTR-TOF mass spectrometry, FTIR, and IMS. The discharge itself was monitored by OES.

14:40 **Time-dependence of the electron energy distribution function in the He-Xe afterglow**

T6-9 G.M. Grigorian (1), A.V. Demyanov (2), N.A. Dyatko (2), I.V. Kochetov (2,3)
(1) St. Petersburg State University, RUSSIA
(2) SRC RF Troitsk Institute for Innovation and Fusion Research, RUSSIA
(3) P.N. Lebedev Physical Institute of the Russian Academy of Sciences, RUSSIA

Electron energy distribution function (EEDF) in the He:Xe=98.5:1.5 afterglow plasma (discharge tube radius 2 cm, gas pressure 1 Torr, discharge current 10 mA, discharge pulse duration 0.4 ms) was measured by the probe method at various times after the end of the discharge pulse. The measured EEDFs are compared with the theoretical ones calculated by solving the time-dependent Boltzmann equation taking into account electron-electron collisions and superelastic collisions of electrons with excited atoms.

15:00 **Electron parameters and absolute glow intensities in a discharge supported by a hollow cathode in mixtures of**

T6-10 **helium and water vapor**

S.N. Andreev (1), A.V. Bernatskiy (1), I. Draganov (1, 2), I.V. Kochetov (1, 3), V. N. Ochkin (1)
(1) P.N. Lebedev Physical Institute of the Russian Academy of Sciences, RUSSIA
(2) Moscow Institute of Physics and Technology (National Research University), RUSSIA
(3) SRC RF Troitsk Institute for Innovation and Fusion Research, RUSSIA

In a plasma supported by a discharge with a hollow cathode (HC), in helium-water vapor mixtures, the change in the electron energy distribution function (EEDF) and the electron density depending on the position between the cut of the hollow cathode and the anode is studied. The absolute intensities of the emission of individual lines of the helium and hydrogen atoms have been measured. The most promising lines for quantitative plasma diagnostics are determined.

15:20 **Characteristics of a cylindrical plasma antenna system and its analysis**

T6-11 A.M. Astafiev, A.S. Chirtsov, N.A. Lesiv, A.M Altmark
Saint Petersburg Electrotechnical University "LETI", RUSSIA

The radiation pattern of a short linear antenna surrounded by gas-discharge tubes was measured at different discharge currents, as well as in a wide frequency range. Both a numerical analysis of this antenna system and an analysis using a simple analytical model have been carried out. The latter makes it possible to establish a relationship between the observed radiation pattern and the discharge current in gas-discharge tubes.

15:40 **Radiation pattern of a system consisting of a short linear antenna and an extended plasma jet**

T6-12 A.M. Astafiev, A.S. Chirtsov, N.A. Lesiv, A.M Altmark
Saint Petersburg Electrotechnical University "LETI", RUSSIA

The problem of determining the influence of an extended cold atmospheric pressure plasma jet on the radiation pattern of a short linear antenna was solved by using Ansys HFSS, as well as by using simple analytical expressions. The electron density and the electron collision frequency were set such that they correspond to atmospheric plasma jets of a barrier discharge in a helium flow. A novel method for microwave diagnostics of atmospheric plasma jets was proposed.

16:00 **Features of plasma composition and fluorine atom kinetics in $CF_4 + O_2$, $CHF_3 + O_2$ and $C_4F_8 + O_2$ gas mixtures**

T6-13 A. Efremov (1), D. Bashmakova (1), D. Travkina (1), K.H. Kwon (2)
(1) Ivanovo State University of Chemistry and Technology, RUSSIA
(2) Korea University, KOREA

Effects of initial compositions of $CF_4 + O_2$, $CHF_3 + O_2$ and $C_4F_8 + O_2$ gas mixtures on electro-physical plasma parameters, steady-state densities of active species and fluorine atom kinetics were investigated under the condition of constant gas pressure and input power. Research scheme included plasma diagnostics by Langmuir probes and 0-dimensinal (global) plasma modeling. The analysis of heterogeneous process kinetics (etching, polymerization) was carried out.

16:20 **The new methodology for measuring ionospheric plasma density on small satellites**

T6-14 A.G. Galka, A.V. Kostrov, M.S. Malyshev
Federal research center Institute of Applied Physics of the Russian Academy of Sciences, RUSSIA

A new sensor of plasma concentration from 10^3 to 10^6 cm^{-3} and its fluctuations on board of a small satellite has been developed for local and continuous monitoring of ionospheric parameters. The high spatiotemporal resolution of the sensor makes it possible to measure plasma inhomogeneities in the ionosphere with an ultra-small scale of less than 1 m. Experimental testing of the measuring system was carried out on a large-scale plasma device in conditions as close as possible to ionospheric.

16:40-17:20 Young Scientist Award and Closing

Hall III 18:00-19:00 Poster Session

Section 1 - Fundamental physical processes and phenomena in plasmas

T1-P-1 **Equations of state for some refractory metals near the liquid-gas critical point**

K.A. Boyarskikh (1,2,3), K.V. Khishchenko (1,2,3,4)
(1) Joint Institute for High Temperatures RAS, RUSSIA
(2) Moscow Institute of Physics and Technology, RUSSIA
(3) Institute of Problems of Chemical Physics RAS, RUSSIA
(4) South Ural State University, RUSSIA

The work is devoted to the description of the thermodynamic properties of metals at high temperatures. Under such conditions, ionization processes become essential, and the substance is plasma. Liquid-gas critical points of refractory metals (W, Re, Mo and Ti) are estimated in three different ways using three equations of state. The results obtained are compared with estimates from the works of other authors. This research is supported by the Russian Science Foundation, grant 19-19-00713.

T1-P-2 **Experimental verification of a nonlocal model in the discharge in crossed fields and the short discharge in helium**

A. Platonov, E. Prokhorova, A. Slyshov
Petrozavodsk State University, RUSSIA

The paper presents the results of a study of a short glow discharge of various configurations (with classical geometry and cylindrical electrodes) in helium from the point of view of nonlocal electron kinetics. The discharge structure is established. The functions of electron distribution and potential distribution are investigated. Various groups of electrons and the formation of a potential well have been detected. The features on the distribution function at 15 and 20 eV are revealed.

Section 2 - Electrical discharges and other plasma sources, novel plasma generation approaches

T2-P-1 **Microwave complex for obtaining low-temperature plasma at atmospheric pressure**

I.A. Ivanov, V.N. Tikhonov, S.A. Gorbatov, A.V. Tikhonov
Russian Institute of Radiology and Agroecology, RUSSIA

The hardware complex was designed and manufactured to produce low-temperature and non-thermal plasma plasmas at atmospheric pressure. The base of the designed complex is powerful (up to 3 kW) and inexpensive magnetron microwave generator. The complex includes three types of applicators, splitter, cable assembly and water load.

T2-P-2 **Simulation of capacitive coupled rf discharge in dynamical vacuum**

E.N. Lazarev (1), N.M. Lukina (1), V.Yu. Chebakova (2), V.S. Zheltukhin (1)
(1) Kazan National Research Technological University, RUSSIA
(2) Kazan Federal University, RUSSIA

Mathematical model of capacitively coupled RF discharge in dynamical vacuum at the pressure range from 13 to 133 Pa, plasma gas flow rate up to 0.2 g/s, discharge power from 0.5 to 5 kW, generator frequency 13.56 MHz is constructed. The influence of the interelectrode distance, gas flow rate and pressure on charged particle densities and electron temperature is established.

T2-P-3 **Low-frequency alternating current arc between liquid and metal electrodes for generating ozone at atmospheric pressure**

Az.F. Gaisin (3), R.Sh. Sadriev (2), I.T. Fakhrutdinova (1), F.M. Gaisin (1), L.N. Bagautdinova (1), M.F. Akhatov (1), R.T. Nasybullin (2)
(1) Kazan National Research Technical University. A. N. Tupolev, RUSSIA
(2) Naberezhnye Chelny Institute of KFU, RUSSIA
(3) Kazan State Power Engineering University, RUSSIA

The results of experimental studies of an alternating current arc between metal and electrolytic electrodes for producing ozone at low frequencies (f=20, 33 and 100 Hz) and atmospheric pressure are presented. The experiments carried out made it possible to build the current-voltage characteristics of the discharge at f = 20, 33 and 100 Hz. The results of experimental studies on the ozone output during an alternating current arc discharge are presented.

T2-P-4 **Slow nonstationary ionization waves in long discharge tubes at low gas pressure**

A.I. Shishpanov, P.S. Bazhin, V.V. Zaletov
Saint Petersburg State University, RUSSIA

Slow non-stationary ionization wave (NIW) forms a single-electrode breakdown in long discharge tube at low gas pressure. Positive NIW was experimentally studied by the x-t diagrams method, supplemented with measurements of the NIW front potential and attenuation coefficients. The dimension theory method allowed to determine the NIW motion law formula, and to show the existence of a similarity complex associating the NIW electrodynamic and kinematic parameters with gas pressure.

T2-P-5 **A new type of microwave non-thermal atmospheric pressure plasma source**

V.N. Tikhonov, S.A. Gorbatov, I.A. Ivanov, A.V. Tikhonov
Russian Institute of Radiology and Agroecology, RUSSIA

Typical examples of non-thermal atmospheric pressure plasma (NTAP) sources are: corona discharge, glow discharge, dielectric barrier discharge (DBD) and non-thermal plasma jet (NTPJ). This paper presents the microwave source of NTAP that combines the characteristics of a dielectric barrier discharge (DBD) by discharge configuration and a non-thermal plasma jet (NTPJ) by plasma jet formation. The discharge tube's axis is perpendicular to the electric field vector in the waveguide.

Section 3 - Atmospheric pressure plasmas, plasma in and in contact with liquid, plasma-liquid interactions

T3-P-1 **Apokamp and prospects of its application in biomedicine**

D.V. Schitz (1), V.A. Panarin (2), V.S. Skakun (2), D.S. Pechenitsin (2)
(1) Immanuel Kant Baltic Federal University, RUSSIA
(2) Institute of High Current Electronics, RUSSIA

A generation of non-thermal plasma in the air at atmospheric pressure in the form of a jet (APPJ) emanating from surface of an arc is reported. This type of plasma was obtained relatively recently and was called as "apokamp" (from Greek «off» and «bend»). Apokamps are formed at maximum applied voltage of positive polarity, provided that the second electrode is capacitively decoupled with ground. The prospects of using apokamp in biomedicine will be also discussed.

T3-P-2 **Fabrication of dye-sensitized solar cells based on novel mixed tungsten-molybdenum and tungsten-titan oxides nanoparticles prepared by impulse underwater plasma**

N.A. Sirotkin, A.V. Khlyustova, V.A. Titov
G. A. Krestov Institute of Solution Chemistry, RUSSIA

In this research, we report a new method for synthesizing advanced nanocomposite materials based on tungsten, molybdenum and titanium oxides by pulsed underwater plasma. This is an environmentally friendly, energy-saving and simple method for obtaining bimetallic oxide nanoparticles with inhomogeneous defect structures. The composition of the resulting mixed oxide nanoparticles can be controlled by changing the discharge polarity and selecting electrode materials.

T3-P-3 **On the possibility of using a gas discharge with a liquid electrolyte cathode to create a steam-water plasma flow**

G.K. Tazmeev (1), B.A. Timerkaev (2), K.K. Tazmeev (1)
(1) Kazan Federal University RUSSIA
(2) Kazan National Research Technical University named after A.N.Tupolev-KAI, RUSSIA

Methods for generating powerful plasma flows in gas discharges with liquid electrolyte electrodes are still far from perfect. There are questions related to the choice of electrolyte, the design of the plasma generator, the introduction of reagents into the plasma, etc. The experimental studies, the results of which are presented in this work, aimed to solve these problems. The experiments were carried out in the current range of 10-20 A.

T3-P-4 **Characteristics of plasma jet generated by coaxial dielectric barrier discharge at atmospheric pressure**

D. Kotov, A. Aksiuchyts, K. Logunov, A. Osipov
Belarusian State University of Informatics and Radioelectronics, RUSSIA

The characteristics of the coaxial type dielectric barrier discharge plasma jet at atmospheric pressure were studied. The geometrical parameters of the plasma jet depending on the gas flow rate and the input signal voltage were established. The operating modes with the maximum long plasma jet are determined. The changes in the emission spectrum of the plasma were also defined in different parts of the torch jet in the wavelength range from 200 to 1000 nm.

T3-P-5 **Investigation of argon/methane cold atmospheric pressure plasma jet**

F. Bedrouni (1), M. Ouchabane (2) , F. Almabouada (2), N. Saidi-amroun (1)
(1) University of Science and Technology Houari Boumediene, ALGERIA
(2) Center for Development of Advanced Technologies, ALGERIA

In this study, dielectric barrier discharge (DBD) atmospheric plasma jet (APJ) was used to produce plasma of argon mixed with methane. The optical emission spectroscopy (OES) was recorded at three different position along the plasma jet at flow rate 1, 3, and 5L/min. Various emission from Ar, CH_4 and N_2 were observed dependent on the probe location and gas flow rate, which indicates a change in the composition of the gas.

Section 4 - Non-ideal and dusty plasmas, extreme plasma regimes, fusion and astrophysical plasmas, collective and nonlinear phenomena

T4-P-1 **Collective effects in an active colloidal system of complex composition under the action of laser radiation**

R.V. Senoshenko (1), E.A. Kononov (1,2), M.M. Vasiliev (1,2), O.F. Petrov (1,2)
(1) Joint Institute for High Temperatures of the Russian Academy of Sciences, RUSSIA
(2) Moscow Institute of Physics and Technology, RUSSIA

Active colloidal systems are a special form of soft matter, which is a dispersive medium (plasma, gas or liquid) containing finely dispersed active particles (droplets) capable of self-motion. The mechanisms of activity and self-organization of as colloidal plasma, as structures of surface-charged droplets in fluid are similar to natural processes. The collective effects in the laser-irradiated monolayer of monodisperse drops of emulsion of complex composition are experimentally investigated.

T4-P-2 **Selection of dust particles in inert gases with different ionization potentials**

M.S. Golubev, E.S. Dzlieva, L.A. Novikov, S.I. Pavlov, M.A. Gasilov, V.Yu. Karasev
Saint Petersburg State University, RUSSIA

In the presented work, an experimental study of the parameters of the selection of particles was carried out with a variation in the type of plasma-forming gas. Using working gases with different ionization potentials, plasma filters (plasma-dust traps) were obtained that are capable of holding dust particles from 3 μm to 9 μm. Of particular interest is the use of gas mixtures, when a small fraction of a gas with a low potential is added to the main gas with a high potential.

T4-P-3 **Dynamic effects in dusty clusters in a magnetic field**

S.I. Pavlov, E.S. Dzlieva, L.A. Novikov, V.Yu. Karasev
Saint Petersburg State University, RUSSIA

The work is devoted to the study the behavior of a dust cluster in a glow discharge striation in a magnetic field in two gases Ne and Ar. The dependence of the angular velocity of cluster rotation on the number of particles in the cluster cross section is obtained. A non-monotonic nature of the dependence of the angular velocity of rotation in both gases was found. There is a threshold character of the occurrence of cluster rotation (in relation to the number of particles).

Section 5 - Laser-plasma interactions with materials, laser ablation, modification of materials, sputtering and deposition

T5-P-1 **Morphology of the surface of natural lamb leather after tannide tanning and laser explosure**

A. Anisovich (1), T. Kodirov (4), U. Khudanov (4), M. Markevich (2), V. Zhuravleva (3)
(1) Institute of Applied Physics of the National Academy of Sciences of Belarus, BELARUS
(2) Physical-Technical Institute of the National Academy of Sciences of Belarus, BELARUS
(3) Military Academy of the Republic of Belarus, BELARUS
(4) Tashkent Institute of Textile and Light Industry, UZBEKISTAN

Currently, for reasons of environmental safety, research is being carried out to replace the chrome tanning of natural leather with tannin. In this work, for the first time, the morphology of the surface of natural lamb leather after tannin tanning and laser exposure in a two-pulse mode was studied. The modes of laser processing in the ablation mode are determined. The possibility of changing the structure of natural skin due to defibration of the dermis and conformational changes is shown.

T5-P-2 **The PLM-M steady-state plasma linear facility for full-scale testing of thermonuclear reactor materials**

Q.V. Tran (1), V.P. Budaev (1,2), S.D. Fedorovich (1), D.I. Kavyrshin (1, 3), A.V. Karpov (1, 2), K.A. Rogozin (1), A.A. Konkov (1), V.S. Kvaskov (1)
(1) National Research University "MPEI", RUSSIA
(2) National Research Center "Kurchatov Institute", RUSSIA
(3) Joint Institute for High Temperatures of the Russian Academy of Sciences, RUSSIA

The PLM-M steady-state plasma linear multi-cusp facility was built for the purpose of full-scale testing of materials, mock-ups and prototypes of the wall and divertor of future thermonuclear reactors. In the PLM-M, experiments were carried out with the combined effect of a powerful stationary plasma, pupulsed arc, and laser load on the surface of the thermonuclear reactor materials, including tungsten mock-ups of the divertor tiles and lithium capillary-porous system (CPS).

T5-P-3 **Crystalline structure changes in metals after their laser treating in different conditions**

A.Yu. Ivanov, E.A. Karpovich, A.L. Sitkevich, N.G. Valko, S.V. Vasiliev
Grodno State University, BELARUS

A change in the crystal structure of several metals (Cd, Ti, Cu) in the zone of exposure to laser radiation was detected by X-ray diffractometry. Calculation of the number of elementary cells spatially transformed during laser treating from equilibrium to distorted ones was made. The discovered effect can be connected with the anisotropy of heat expansion of metal. This effect can be amplified by the internal stress in the irradiated zone during acoustic waves formation in the metal sample.

T5-P-4 **Shielding of the target during laser-plasma treating of metals in electric field**

A.Yu. Ivanov, A.L. Sitkevich, S.V. Vasiliev
Grodno State University, BELARUS

Evolution of plasma plume generation on the surface of metal irradiated by laser beam in the electric field was investigated. After the plasma cloud reaches the electrode an electric breakdown occurs. Electric breakdown leads to increase of electron density and to the shielding of target. In consequence of shielding droplets generation happens only during electric field existence. This explains decrease of the size of droplets in spite of short duration of electric field existence.

T5-P-5 **The role of laser-induced plasma in a liquid for the formation of nanosized particles.**

A.V. Butsen (1), N.V. Tarasenko (2)
(1) Belarusian State Technological University, BELARUS
(2) B.I. Stepanov Institute of Physics of the NAS of Belarus, BELARUS

The main processes occurring in a plasma formed by pulsed laser ablation of a metal target immersed in a liquid are considered. On the basis of spectroscopic diagnostics of plasma, the spatial structure and time range of radiation of laser-induced plasma were elucidated, and its component composition was determined, which is necessary for optimizing the process of nanoparticle synthesis.

T5-P-6 **Formation of yttrium vanadate YVO_4 plasma under two-pulsed bichromatic laser explosure in air**

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Two-pulse laser exposure on yttrium vanadate in air at wavelengths of 532 and 1064 nm with a radiation power density of q ~$3 \cdot 10^9$ W/cm^2 leads to the appearance of near-surface plasma formations. Their structure, composition and parameters significantly depend on the time shift and sequence of laser pulses, while the maximum temperature T reaches approximately 10000 K, and the luminescence is recorded during time interval 100 μs.

T5-P-7 **Influence of laser crater temperature on material ablation and intensity of spectral lines of erosive plasma torch**

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It is shown that the temperature of the laser crater significantly affects the ablation of the material and the intensity of the spectral lines of the erosive plasma torch. The increase in the ablation of the material and the intensity of the spectral lines, with a two-pulse laser impact on the object, is due to the high temperature of the crater after the impact of the first laser pulse. The temperature of the crater 1 μs after the action of the laser pulse is estimated to be 600-900 °C.

T5-P-8 **Microstructure and phase state of silicon carbide irradiated with helium ions**

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The composite based on silicon carbide was irradiated with helium ions with an energy of 40 keV and fluences 1×10^{14}, 1×10^{15}, 1×10^{16}, 5×10^{16}, 2×10^{17} cm^{-2}. The study of the structural-phase state of the initial and irradiated SiC samples was carried out by X-ray diffraction analysis (XRD) and scanning electron microscopy (SEM).

T5-P-9 **Effect of irradiation with krypton ions on the structural-phase state of a multicomponent solid solution based on V-Nb-Ta-Ti**

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It was found that irradiation does not lead to a change in the microstructure of the surface, phase changes and a significant change in the distribution of elements in the volume and surface. However, radiation-stimulated diffusion of lighter elements was detected in multicomponent systems at the depth of the run of krypton ions.

T5-P-10 **Radiation resistance of amorphous zirconium alloys after irradiation with helium ions**

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The stability of the structure of zirconium alloys Zr51.32Ti17.54Ni15.18Cu14.61In1.35 and Ti65.23Zr34.77 after irradiation with helium ions with a fluence of $5x10^{17}$ cm^{-2} was studied by XRD method. In amorphous alloys, after irradiation, the structure actually does not change, since it is not ordered initially, while implanted helium can accumulate in a free volume.

T5-P-11 **Distribution of elements in high-entropy CoCrFeNi and NbTaTiV alloys irradiated with low-energy Kr ions**

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By the Rutherford backscattering method the changes in the elemental composition in high-entropy CoCrFeNi and NbTaTiV alloys irradiated with low-energy Kr ions, as well as the effect of irradiation on the structure (lattice parameter, stress) of these alloys, are studied. The mechanisms of radiation diffusion and segregation in high-entropy alloys and the relationship between the elemental composition and structure of the irradiated material are discussed.

Section 6 - Plasma diagnostics and modeling

T6-P-1 **Mathematical modeling of particle flux formation processes in a reactive ion-plasma etching system at low pressures**

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Mathematical modeling of the processes of formation of flows of uncharged chemically active particles (ChAP) and positively charged ions in a diode-type discharge chamber (DC) with particle motion close to free molecular is carried out. It is taken into account that the formation of ChAP and ions occurs mainly in the plasma volume. In this case, the ChAP fall on the electrode with the processed plate after diffuse separation from other surfaces of the DC, which causes the establishment of a minimum density of their flow in the center of the plate. On the contrary, the ions are practically not reflected from the surfaces of the DC, which are under a negative bias relative to the plasma potential. Therefore, they fall on the treated surface directly from the place of their generation in the plasma volume, which leads to the formation of a maximum of their flux density in the center of the electrode with the treated plate. The simulation results showed the possibility to influence the uniformity and directivity of the ChAP and ion flows on the plasma-treated surface by changing the design parameters of the discharge system. This made it possible to improve the uniformity and increase the anisotropy of the reactive ion-plasma etching process.

T6-P-2 **Simulation of charged particles motion in the cathod-fall region of an abnormal glow discharge in crossed E×H field**

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The paper presents the methodology for calculating the electrical characteristics and geometric parameters of a glow discharge in crossed electric and magnetic fields based on the determination of the spatial distribution of electrons over the cathode-target surface by the Monte Carlo method. Determining the distribution profile of the ion current density on the cathode makes it possible to use the developed simulation for designing magnetron sputtering systems with a preassigned target erosion.

T6-P-3 **Amplitude-time dynamics of radiation of laser-emission plasma of metals formed by dual nanosecond pulses.**

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The results of a study of the amplitude-time dynamics of the laser-induced plasma emission of a formed by dual nanosecond pulses on the surface of Al, B, Bi, C, Cr, Cu, In, Pb, Ti, Zn are presented. The influence of the delay between laser pulses on the ratio of the emission intensities of doubled plasma plume was studied. The influence of the energy of laser pulses on the intensity and duration of emission of a number of spectral lines of Al was established.

T6-P-4 **Optogalvanic oscillations in hollow cathode lamp**

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Optogalvanic effect in hollow cathode lamp (HCL) is produced by a laser diode radiated at the wavelength that corresponded to neon transition $1s^2$-$2p^2$ at 659.89 nm. For certain values of voltage self-sustained current oscillations are observed in the HCL. In the same HCL laser induced optogalvanic dumped oscillations are detected. A phenomenological model, which includes the effective circuit parameters of the discharge, is used to explain the oscillation characteristics.

T6-P-5 **The use of AB-initio generated pseudo potential for computation of optical properties in dense plasma in cut-off coulomb potential, helium case**

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The cut-off Coulomb potential was used up until now for the describing of dense plasma optical characteristics. The model itself is a fully quantum mechanics model for describing of plasma. Usage of numerical calculation methods makes it possible to use more complex pseudo potentials in describing of plasma. Up until now the calculated results are used for the describing of dense plasma characteristics primary in the case of astrophysical plasma.

T6-P-6 **Determination of laser intensity by its interaction with gas cluster targets**

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Determining the laser intensity in the ultra-relativistic case ($> 10^{20}$ W/cm^2) is currently an actual issue. In this work, we propose to use the resonance lines of highly charged ions in a sufficiently rarefied gaseous or cluster medium. We present the results of PIC simulation of the ionization composition of gas jets and clusters for Ar and Xe elements and its dependence on the laser radiation intensity, as well as on the cluster size and density.

T6-P-7 **Studies of analytical capabilities of laser induced breackdown spectroscopy for determination of sulfur in oil products**

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In the work, the capabilities of standard LIBS experimental equipment for determination of sulfur in crude oil and some oil products are analyzed. The obtained results allow to conclude that the LIBS method with standard equipment can not provide a detection of sulfur content in crude oil and oil products at the level of 1% and below. The use of laser radiation of different wavelengths, as well as ablation in inert (helium) atmosphere, does not improve the analytical capabilities of the method.

T6-P-8 **Comparison of double pulsed regimes of laser plasma excitation in air and inert gases**

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In this work a collinear double pulsed scheme of laser plasma excitation was investigated in different ambient gases The plasma was excited using a Nd:YAG laser operating at the fundamental harmonic; the laser pulse energy was 50 mJ and the duration was 10 ns. The change in the surrounding gas around the point of laser action was carried out by blowing the surface of the sample with an inert gas under atmospheric conditions. Standards of low-alloyed steel were used as test samples.

Section 7 - Plasma applications and advanced plasma technologies

T7-P-1 **Photocatalytic and structural properties of nanostructured titanium dioxide obtained by hydrothermal method**

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It has been studied the kinetics of photocatalytic decomposition of methyl orange (MO) and amoxicillin under the action of ultraviolet radiation in water using plasma treated and untreated TiO_2-based photocatalysts. Anatase and rutile TiO_2 were synthesized using hydrothermal method. The synthesized catalysts were characterized by scanning electron microscopy (SEM), Raman spectroscopy and X-ray diffraction analysis (XRD).

T7-P-2 **Plasma induced modification of ZnO-based photocatalysts doped with plasmonic nanoparticles**

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In this paper, the effect of plasma treatment of nanostructured ZnO-based photocatalysts doped with plasmonic Ag nanoparticles was investigated. New hybrid Ag/ZnO nanostructures were synthesized which can be used as catalysts for photodegradation of pharmaceutical waste in water. The photocatalytic activities of synthesized materials were evaluated by measuring the photodegradatation of model compound (sodium caffeine benzoate) in aqueous solution exposed to UV light.

T7-P-3 **The effect of DBD plasma on the morphology of Ag nanoparticles used in photocatalysis**

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Plasmonic silver nanoparticles can be used as active phase of photocatalysts. In our previous work, it was shown that plasma treatment of photocatalysts doped with Ag nanoparticles resulted in enhancement of their catalytic activity. In this study, the effect of DBD plasma on the morphology of Ag nanoparticles was studied in detail by Atomic Force Microscopy and UV-Vis Spectroscopy.

T7-P-4 **Electrolyte-plasma post-treatment of the surface of additive manufacturing products**

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Kazan National Research Technical University named after A.N. Tupolev, Dept. of Laser and Additive Technologies, RUSSIA

The results of electrolytic-plasma post-processing of the surface of gas turbine engine parts are presented. It is shown that the combination of dipping and jet treatment makes it possible to achieve the required surface quality without changing the geometry of the workpiece, including near sharp edges.

T7-P-5 **Plasmachemical recovery of powder materials for additive manufacturing**

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The results of recovery in inductively coupled plasma of powders of heat-resistant alloys based on iron, nickel and cobalt for additive manufacturing are presented. It is shown that, as a result of plasma treatment, the oxygen content in the powder decreases, thermal decomposition of satellites, spheroidization and degassing of powder particles occur.

T7-P-6 **Prospects for the use of lasers for the formation of configurable plasma antennas**

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The main approaches for the formation of configurable plasma antennas are analyzed. Various ways of using lasers to form plasma structures that can be used to control the flow of electromagnetic radiation are considered. The results of experiments demonstrating the possibility of forming configurable plasma antennas in semiconductor structures are presented.

T7-P-7 **Properties of biogenic metal nanoparticles prepared by plasma assisted electrochemistry**

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Colloidal solutions containing Cu, Fe, Mo, and Zn nanoparticles (NPs) were synthesized for biological testing. To simultaneously obtain NPs of all four metals, a modification of the experimental plasma reactor with a liquid electrode was performed. The optimal regimes for the synthesis of stable NPs by the addition of stabilizers (glucose, carboxymethylcellulose) were found and the ratio of biogenic metals in the colloidal solution was determined.

T7-P-8 **Microplasma processes during high-voltage electric pulse consolidation of refractory metal carbides powders**

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The electrothermal processes at the contacts between powder particles during high-voltage electric pulse consolidation (HVC) are analyzed. The experimental studies results of the parameters of HVC action in the processes of consolidation of high-temperature powder compositions, high-voltage welding of dissimilar materials, as well as high-voltage discharges in liquid are presented. The results of measuring the high-voltage electric pulse current and the intensity of thermal radiation are presented.

T7-P-9 **Effect of ion-plasma nitriding and electrolyte-plasma polishing on the hardness and corrosion resistance of high-chrome steels**

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Combined surface treatment of specimens made of high-chromium steels, including ion-plasma nitriding followed by electrolytic-plasma polishing, makes it possible to obtain hardened layers of the required degree, microhardness, and corrosion resistance. As a result of processing, the surface microhardness increases by 2-6 times while maintaining the corrosion resistance at the level of untreated samples with a hardened layer depth of at least 5 μm.

T7-P-10 **Study of plasma parameters in copper/graphene nanocomposite nucleation zone in erosion plasma jets**

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This work studies plasma jet parameters during the synthesis of carbon nanotubes, graphene, and their nanocomposites with copper using spectroscopic methods. The plasma is characterized by strong heterogeneity, and its properties depend significantly on the plasma-forming gas composition. It was possible to achieve complete atomization of the initial mixture at the plasmatron outlet with subsequent cooling in the section preceding the collector, which starts intensive recombination processes.

T7-P-11 **Electrochemical nonchain HF(DF) lasers - main results and new opportunities**

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The key ideas and approaches are analyzed. They made it possible to significantly increase the energy of modern non-chain electrochemical HF(DF) lasers and expand the range of applications. Significant achievements in the field of physics of a self-initiating volume discharge and chemical HF(DF) lasers based on a non-chain reaction initiated by an electric discharge are presented. Possible applications of modern electrochemical HF(DF) lasers are described.

T7-P-12 **A reagent-free method for modifying chitosan**

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Low molecular weight chitosan, chitosan oligosaccharides, and modified chitosan are of interest for agriculture and biomedicine. These compounds are usually obtained using physical, chemical, and biological methods. This paper presents the results of studies using low-temperature plasma in contact with a liquid, which combines physical and chemical effects. Solutions of aqueous suspensions of chitosan without other chemical reagents were subjected to the action of glow and underwater discharges.

T7-P-13 **Energy dissipation in arc discharge occuring after the fuse explosion**

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The destruction of a duralumin fuse of variable cross-section heated by a pulsed current of ~20 kA of industrial frequency has been investigated. It has been shown that the geometry of the foil fuse significantly affects the amount of energy released after its explosion in the resulting arc discharge.

T7-P-14 **Plasmochemical modification of nonwoven polypropylene materials to increase antibacterial and filtration properties**

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The proposed method of plasma chemical modification makes it possible to form functional thin layers of various nature (organic or inorganic) and is promising for giving non-woven polypropylene materials for medical purposes antibacterial and filtration characteristics.

T7-P-15 **The role of monolayers thicknesses ratio for oxidation resistance of AlN/SiNx magnetron sputtered coatings**

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Multilayered AlN/SiN_x coatings with the thicknesses of individual layers from 2 to 10 nm were investigated. The phase composition of multilayered films is quite stable up to 950 °C. The ratios of the thickness of the AlN individual layer to that of the SiNx individual layer which ensure the maximal oxidation resistance of multilayered films were determined using X-ray diffraction analysis, wavelength dispersive X-ray spectrometry of the film composition and scanning electron microscopy.

T7-P-16 **Application of cold plasma and high frequency electromagnetic fields for long linen seed treatment (long-stemmed flax)**

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Seeds of long-stemmed flax were treated with electromagnetic fields of different frequency and with non-thermal plasma generated by two different plasma sources to identify the positive or negative effects on seed germination. It has been identified several treatment modes that contributed to the improvement of growth parameters, as well as modes that inhibited seed germination. Observed negative effects caused by physical stressors can stimulate mutational changes in plants important for future breeding.

T7-P-17 **Magnetron deposition of W-coatings within D-He mixture**

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We have carried out magnetron deposition of W coatings from a thermally insulated tungsten target in a D-He mixture. The deposition was carried out at sample temperatures of 1000-1500 K and various D/He ratios in the mixture. The electrical parameters of the discharge were measured in the DC and HiPIMS modes. The current-voltage characteristics of the discharge were determined. The resulting coatings were analyzed in a SEM.

T7-P-18 **Study of the effect of plasma modification of a UHMWPE thread on the physical and mechanical properties of a polyethylene composite**

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Creation of composite materials based on UHMWPE fibers is an important direction. The main problem is the low adhesive properties of UHMWPE filaments. With the help of plasma treatment in an RF capacitive discharge, it was possible to increase the value of the interlayer adhesive bond. The effect of various types of solvents on the thermoplastic matrix has been studied. The efficiency of using thermoplastics as a matrix for a composite material has been found.

T7-P-19 **Research of aeroions distribution generated by dielectric barrier discharge plasma**

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In our research, the source of negative and positive aeroions is plasma that is generated in the coaxial system with a dielectric barrier discharge (DBD). The spatial distribution of the negative and positive airions concentration in different positions relative to the generation system was established. This investigation allow us to conclude that DBD can be used to generate negative airions for therapeutic application in medicine.

T7-P-20 **Uniformity of ion flux in a laser plasma source for deposition of nanofilms**

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The present work is devoted to the experimental determination of the uniformity of the ion flux density on a substrate with an increased size (~ 200 cm^2) in order to form nanostructures by the laser-plasma method.

T7-P-21 **Increase of the glass surface hydrophilicity by treatment in plasma at atmospheric pressure**

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The surface properties of glass are studied after the action of a low-temperature plasma of dielectric barrier discharge (DBD). To estimate the magnitude of the glass surface hydrophilicity, a sessile drop method was selected to measure the wetting angle. It is established that such treatment leads to the surface cleaning and activation. The dependences of the wetting angle on the processing time, gas consumption and operation distance are obtained.

T7-P-22 **Composition and structure of nanoparticles synthesized in the plasma of an electric explosion of metals in distilled water**

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Nanoparticles of aluminum, copper, and carbon were obtained in electric explosion plasma. The composition, structure, and morphology of the synthesized nanoparticles were determined by atomic force microscopy. The particles with the size up to 60 nm dominate. The profile of size distribution of nanostructures depends on the energy invested in the electric explosion. The size dependences of the obtained nanostructures on the parameters of the electric explosion were established.

T7-P-23 **Research of magnetic field and gas distribution influence on plasma generation and thin diamond-like film uniformity**

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This research is devoted to the study of the magnetic field influence and gas distribution on the inductively coupled plasma generation and the uniformity of diamond-like carbon thin film deposition. It has been determined that the presence of magnetic field up to 1 mT allows to reduce the operating pressure of plasma combustion up to 5 10^{-2} Pa. As a result of our research is the choice of the gas distributor effective configuration for HDP-CVD cylindrical reactor with flat ICP plasma source.

T7-P-24 **Effect of plasma electrolytic pretreatment on a roughness and coloring uniformity of the oxide films on titanium and its alloys**

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The effect of electrochemical oxidation modes, the electrolyte solution composition and methods of pretreatment of titanium and its alloys surface on the thickness and roughness of the oxide layer was studied. It was found that the use of electrolytic plasma polishing as a preliminary surface preparation of titanium implants contributes to the formation of a uniformly colored oxide layer with the parameter roughness Ra in 1.5-2.0 times lower than that at chemical preparation.

T7-P-25 **Research of deposition conditions of TiSiCN nanocomposite coatings in hollow cathode arc discharge with active anode**

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The results of the study of the conditions for the formation of an active vapor-gas medium for the deposition of nanocomposite TiSiCN coatings by plasmochemical decomposition of an hexamethyldisilazane and evaporation of titanium in a hollow cathode arc discharge with an active anode are presented. The effect of discharge parameters on the activaction degree of gas medium components is investigated. nc-TiSiCN coatings with a hardness of up to 30 GPa and thickness up to 10 microns were obtained.

T7-P-26 **Thermosensitive properties of vanadium oxide films deposited by pulsed DC reactive magnetron sputtering**

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The structure and electrical properties of vanadium oxide films deposited by pulsed DC reactive magnetron sputtering were studied. We have studied the change in the temperature coefficient of resistance (TCR) and resistivity of vanadium oxide films depending on their production conditions. The structure of the sputter deposited films was studied by the Raman spectroscopy. As a result of the research, thermoresistive layers with TCR=2.1%/°C were obtained with a resistivity of 2.8 Ohm·cm.

T7-P-27 **Atmospheric pressure plasma-assisted fabrication of iron oxide nanostructures**

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Experimental studies of the process of formation of iron oxide nanostructures by low-temperature plasma electrolysis, including spectroscopic studies of plasma in contact with a solution and characterization of the structure and composition of formed nanoparticles were carried out.

T7-P-28 **Preparation and parameters adjusting of nanoparticle suspensions for a working medium of a laser microengine**

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The dependence of the characteristics of nanoparticle suspensions on the synthesis conditions and adjusting them for using as a working fluid of a laser micromotor is presented. The experiments were curried out by varying laser radiation wavelength, time of particle production, and spatial positioning of a target in the cell with liquid. The range of the optimal parameters for the synthesis of carbon-containing nanoparticles suitable for using in laser micromotors has been determined.

T7-P-29 **Spatially resolved LIBS and XRF for environmental monitoring in aquatic ecosystems**

N.I. Sushkov (1), N.N. Kurian (2), S.N. Anuchin (2), S.M. Zaytsev (1), T.A. Labutin (1)
(1) Lomonosov Moscow State University, RUSSIA
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LIBS and XRF are mutually complementary in terms of analytical potential, including typical analytes and options for local or bulk analysis. We compared their performance for the determination of inorganic pollutants in biosamples. For LIBS, different plasma zones were considered, showing different degrees of self-absorption of spectral lines. This information was used to improve the calibration graphs. The study was funded by RFBR and BRFFR, projects No. 20-53-04036 and Б21РМ-085, respectively.

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FOR NOTES

ФИЗИКА ПЛАЗМЫ И ПЛАЗМЕННЫЕ ТЕХНОЛОГИИ

X Международная конференция
Минск, Беларусь, 12 – 16 сентября 2022 г.

Программа и краткие тезисы

На английском языке

Отпечатано с готового оригинал-макета в ООО «Ковчег»
Свидетельство о ГРИИРПИ № 1/381 от 01.07.2014
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PPPT-10 SCHEDULE

	Mon, September 12th				Tue, September 13th				Wed, September 14th		Thu, September 15th		Fri, September 16th	
	7:00-18:00 Registration													
	Hall I		Hall II		Hall I		Hall II		Hall I		Hall I		Hall I	
9:00-9:20					Savastenko				Vasiliev		Trukhachev		Trtica	
9:20-9:40														
9:40-10:00					T7-1	Baldanov	T4-10	Apfelbaum	T7-9	Gilmutdinov	T1-7	Svetlov	T6-6	Kuzmanovic
10:00-10:20	Opening				T7-2	Titov	T4-11	Mol'kov	T7-10	Gaisin	T1-8	Kunakov	T6-7	Avtaeva
10:20-10:40	Petrov				T7-3	Vasilieva	T4-12	Karasev	T7-11	Gaisin	T1-9	Obukhov	T6-8	Sushkov
10:40-11:00					10:40-11:00 Coffee break									
11:00-11:20	Rafatov				T7-4	Vasilieva	T4-13	Boltnev	T7-12	Shevchenko	11:00-21:00 Excursion		Shafeev	
11:20-11:40					T7-5	Petrovskaya	T4-14	Gorbenko	T7-13	Zheltukhin				
11:40-12:00	T4-1	Usachev			T7-6	Petrovskaya	T4-15	Seredkin	T7-14	Melezhenko			T5-7	Tarasenka
12:00-12:20	T4-2	Lisin			T7-7	Vasiliev	T4-16	Kononov	T7-15	Tomkavich			T5-8	Aiyyzhy
12:20-12:40	T4-3	Koss			T7-8	Rouba	T4-17	Sametov	T7-16	Sosnovskiy			T5-9	Turki
12:40-14:00	12:40-14:00 Lunch												Lunch	
14:00-14:20	Hamdan				Akishev				Soni				Krcma	
14:20-14:40														
14:40-15:00	T3-1	Leshchik	T4-4	Ryzhkov	T2-1	Doroshkevich	T1-1	Kiseleva	T5-1	Gakovic			T6-9	Kochetov
15:00-15:20	T3-2	Baryshnikov	T4-5	Prakapenia	T2-2	Torba	T1-2	Molchanov	T5-2	Lellouche			T6-10	Bernatskiy
15:20-15:40	T3-3	Valiev	T4-6	Kostrov	T2-3	Morozov	T1-3	Bogachev	T5-3	Ogorodnikova			T6-11	Altmark
15:40-16:00	T3-4	Shutov	T4-7	Dyachkov	T2-4	Klimov	T1-4	Altakhov	T5-4	Chumakov			T6-12	Lesiv
16:00-16:20	T3-5	Batukaev	T4-8	Fairushin	T2-5	Shin	T1-5	Tukmakov	T5-5	Lychkovsky			T6-13	Efremov
16:20-16:40	T3-6	Tatarinov	T4-9	Khishchenko	T2-6	Vorobyov	T1-6	Starikovskiy	T5-6	Pashayan			T6-14	Galka
16:40-17:00	16:40-17:00 Coffee break												16:40-17:20 Closing ceremony	
17:00-17:20	17:00-18:00 Short poster presentations				T2-7	Rafatov	T6-1	Shemakhin	T7-17	Smirnova				
17:20-17:40					T2-8	Usmanov	T6-2	Dyatko	T7-18	Sauchyn				
17:40-18:00					T2-9	Ryzhkov	T6-3	Terentev	T7-19	Catsalap				
18:00-18:20	18:00-19:00 Poster session				T2-10	Lapin	T6-4	Timofeev						
18:20-18:40					T2-11	Kaziev	T6-5	Kirillov						
18:40-19:00														
					19:00-22:30 Conference dinner									