



**9th International Symposium
on Nonequilibrium Processes,
Plasma, Combustion,
and Atmospheric Phenomena**

**TECHNICAL
PROGRAM**



**9th International Symposium
on Nonequilibrium Processes,
Plasma, Combustion,
and Atmospheric Phenomena**

**SOCHI, RUSSIA
OCTOBER 5–9, 2020**

TECHNICAL PROGRAM

MONDAY, October 5, 2020

9:00 REGISTRATION

10:10–10:20 OPENING CEREMONY
S. M. Frolov, M. V. Gordin, and A. I. Lanshin

**Session 1: KINETICS OF ELEMENTARY PROCESSES IN PLASMA, COMBUSTION,
AND ATMOSPHERE — I**
Session Chair: A. I. Lanshin

10:20–11:00

PLENARY LECTURE

THE NATURE OF “TUNGUSKA EXPLOSION” (NATURAL VAPOR CLOUD DETONATION)
P. A. Fomin

11:00–11:20

ON THE POSSIBILITY OF THE POSTTRANSITION STATE QUASI-CLASSICAL
TRAJECTORY PREDICTIONS OF ENERGY DEPOSITION IN THE REACTION PRODUCTS’
DEGREES OF FREEDOM
B. I. Loukhovitski and A. S. Sharipov

11:20–11:40

COFFEE BREAK

**Session 2: KINETICS OF ELEMENTARY PROCESSES IN PLASMA, COMBUSTION,
AND ATMOSPHERE — II**
Session Chair: A. V. Eremin

11:40-12:00

INFLUENCE OF NONEQUILIBRIUM FACTORS OF KEY REACTIONS
ON SYNTHESIS GAS IGNITION
I. V. Arsentiev and I. N. Kadochnikov

12:00–12:20

REACTION KINETICS OF CH₄ AND C₂H₆ WITH O₂ IN EXCITED ELECTRONIC STATES:
REACTION PATHWAYS AND RATE CONSTANTS
A. V. Pelevkin and A. S. Sharipov

12:20–12:40

STATE-TO-STATE MODEL FOR HYDROGEN–AIR COMBUSTION
I. N. Kadochnikov and I. V. Arsentiev

12:40–13:00

INVESTIGATION OF THE NONEQUILIBRIUM EXCITATION OF CARBON MONOXIDE
MOLECULES DURING THE OXIDATION OF METHANE BEHIND SHOCK WAVES
N. Bystrov, A. Emelianov, A. Eremin, and P. Yatsenko

13:00–14:00

LUNCH

**Session 3: KINETICS OF ELEMENTARY PROCESSES IN PLASMA, COMBUSTION,
AND ATMOSPHERE — III**
Session Chair: B. I. Loukhovitski

14:00–14:20

THE SOOT OPTICAL PROPERTIES IN PREMIXED ACETYLENE/AIR FLAME
MEASURED BY LASER-INDUCED INCANDESCENCE

A. V. Drakon, A. V. Eremin, E. V. Gurentsov, E. Yu. Mikheyeva, and R. N. Kolotushkin

14:20–14:40

INFLUENCE OF DOPING WITH VARIOUS HYDROCARBONS ON PYROLYSIS
OF ACETYLENE

A. V. Eremin and E. Yu. Mikheyeva

14:40–15:00

BRIDGING NUCLEATION REACTIONS BETWEEN ACENAFTHYLENE
AND NAPHTHALENE: A THEORETICAL STUDY

A. S. Semenikhin, A. S. Savchenkova, I. V. Chechet, S. G. Matveev, M. Frenklach,
and A. M. Mebel

15:00–15:20

REACTIONS OF TRANSFORMATION OF THE FIVE-MEMBERED RING
OF CYCLOPENTAPHENANTHRENE UPON INTERACTION WITH ACETYLENE:
A THEORETICAL STUDY

A. S. Semenikhin, A. S. Savchenkova, I. V. Chechet, S. G. Matveev, I. A. Zubrilin,
M. Frenklach, and A. M. Mebel

15:20–15:40

MODELING OF THE COMPLETE MECHANISM OF OXIDATION OF PHENYL RADICAL
UNDER COMBUSTION CONDITIONS

G. I. Tolstov, I. A. Medvedkov, D. P. Porfiriev, M. V. Zagidullin, A. M. Mebel,
and V. N. Azyazov

Session 4: PHYSICS OF CLUSTERS AND NANOSTRUCTURES
Session Chair: V. N. Mironov

15:40–16:00

SIZE-DEPENDENT EFFECTS IN ATOMIC CLUSTERS

A. S. Sharipov and B. I. Loukhovitski

16:00–16:20

SIMULATION OF HOMOGENEOUS NUCLEATION OF BORIC ANHYDRIDE VAPOR
IN AXISYMMETRIC NOZZLE

A. M. Savel'ev, V. A. Savelieva, D. I. Babushenko, and N. S. Titova

16:20–16:40

COFFEE BREAK

16:40–17:00

SPECIFIC FEATURES OF POLYMETHYL METHACRYLATE COMBUSTION WITH AND WITHOUT TRIPHENYL PHOSPHATE ADDITIVES: INVESTIGATION BY LASER-INDUCED FLUORESCENCE AND COHERENT ANTI-STOKES RAMAN SPECTROSCOPY

O. P. Korobeinichev, S. A. Trubachev, V. D. Kobtsev, D. N. Kozlov, S. A. Kostritsa, V. V. Smirnov, S. Yu. Volkov, and Amit Kumar

18:00–20:00

WELCOME RECEPTION

TUESDAY, October 6, 2020

Session 5: FUNDAMENTALS OF IGNITION, COMBUSTION, AND ABLATION OF ORGANIC, METALIZED, AND SYNTHETIC FUELS — I

Session Chair: A. G. Korotkikh

10:20–11:00

PLENARY LECTURE

FUNDAMENTAL PROBLEMS OF CREATING EFFICIENT RAMJET ENGINES FOR HIGH-SPEED AIRCRAFT

N. N. Yakovlev, I. I. Kostenko

11:00–11:20

SYNGAS/AIR MIXTURE INDUCTION LENGTH REDUCTION IN THE FLOW REACTOR EXPERIMENTS DUE TO THE EXPOSURE OF NITROGEN AND AIR TO THE GLOW DISCHARGE.

I. V. Arsentiev, V. D. Kobtsev, S. A. Kostritsa, D. N. Kozlov, A. S. Sharipov, V. V. Smirnov, and S. A. Torokhov

11:20–11:40

COFFEE BREAK

Session 6: FUNDAMENTALS OF IGNITION, COMBUSTION, AND ABLATION OF ORGANIC, METALIZED, AND SYNTHETIC FUELS — II

Session Chair: I. O. Shamshin

11:40–12:00

THE NUMERICAL SIMULATION OF HYDROGEN COMBUSTION IN A SUPERSONIC AIR FLOW USING VARIOUS COMPUTATIONAL MODELS

S.N. Batura, N.V. Kukshinov, and D. L. Mamyshev

12:00–12:20

NUMERICAL STUDY OF IGNITION AND COMBUSTION OF DIBORANE JETS IN SUPERSONIC COCURRENT AIRFLOW

L. V. Bezgin, V. I. Kopchenov, A. M. Savel'ev, and V. A. Savelieva

12:20–12:40

MECHANISM AND CHARACTERISTICS OF GEL FUEL IGNITION

O. S. Gaydukova, D. O. Glushkov, A. G. Nigay, and A. G. Kosintsev

12:40–13:00

CALCULATION OF THE IGNITION DELAY TIME OF METALLIZED SOLID PROPELLANT BY A CONVECTIVE HIGH-TEMPERATURE FLOW

V. L. Goiko, V.A. Poryazov, and A.Yu. Krainov

13:00–14:00

LUNCH

Session 7: FUNDAMENTALS OF IGNITION, COMBUSTION, AND ABLATION OF ORGANIC, METALIZED, AND SYNTHETIC FUELS — III

Session Chair: V. A. Savelieva

14:00–14:20

COMBUSTION OF pSi-NaClO₄-H₂O COMPOSITIONS WITH MICROPARTICLES OF NANOSTRUCTURED SILICON AT THE NEAR-STOICHIOMETRIC EQUIVALENCE RATIOS OF COMPONENTS

V. N. Mironov, O. G. Penyazkov, E. S. Golomako, and S. O. Shumlyayev

14:20–14:40

INVESTIGATION OF IGNITION OF H₂-O₂, CH₄-O₂, AND C₁₀H₂₂-AIR MIXTURES DURING PHOTODISSOCIATION OF O₂ MOLECULES BY LASER RADIATION

S. Yu. Volkov, V. D. Kobtsev, S. A. Kostritsa, V. V. Smirnov, N. S. Titova, and S.A. Torokhov

14:40–15:00

COMBUSTION CHARACTERISTICS OF LARGE POROUS TITANIUM PARTICLES FALLING FREELY IN AIR

O. G. Glotov, D. Yu. Belyaeva, N. S. Belousova, and M. A. Korchagin

15:00–15:20

NUMERICAL SOLUTION OF THE CONJUGATE PROBLEM OF HETEROGENEOUS METALLIZED SOLID FUEL COMBUSTION WITH REGARD FOR GASDYNAMIC EFFECTS

K. M. Moiseeva, A. Yu. Krainov, and V. A. Poryazov

Session 8: FUNDAMENTALS OF IGNITION, COMBUSTION, AND ABLATION OF ORGANIC, METALIZED, AND SYNTHETIC FUELS — IV

Session Chair: V. A. Smetanyuk

15:20–15:40

EFFECT OF THE METALLIC FUEL NATURE ON COMBUSTION CHARACTERISTICS OF AMMONIUM PERCHLORATE / BINDER / METAL COMPOSITE SOLID PROPELLANTS

V. A. Poryazov, O. G. Glotov, V. A. Arkhipov, G. S. Surodin, and Y. A. Dubkova

15:40–16:00

THE BURNING RATE OF HIGH-ENERGY MATERIALS CONTAINING METAL FUELS BASED ON Al AND B

A. Korotkikh, I. Sorokin, E. Selikhova, and V. Arkhipov

16:00–16:20

**EFFECT OF BORON ON THE COMBUSTION CHARACTERISTICS
OF METALLIZED HIGH-ENERGY MATERIALS**

A. Korotkikh and I. Sorokin

16:20–16:40

COFFEE BREAK

Session 9: INTERNAL COMBUSTION AND JET ENGINES AND POWER PLANTS — I

Session Chair: O. V. Gus'kov

16:40–17:00

**COMPARATIVE ANALYSIS OF TWO MODELS OF TURBULENT COMBUSTION
OF AN IMPERFECTLY PREPARED LEAN MIXTURE OF METHANE AND AIR
USING REYNOLDS-AVERAGED NAVIER–STOKES AND SCALE ADAPTIVE
SIMULATION METHODS**

M. V. Drobysch, A. N. Dubovitsky, A. B. Lebedev, and K. Ya. Yakubovsky

17:00–17:20

**COMPUTATIONAL AND EXPERIMENTAL STUDIES OF A LOW-EMISSION BURNER
FOR A PERSPECTIVE TURBOJET ENGINE WITH THE COMPRESSION RATIO EXCEEDING 40**

M. A. Danilov, M. V. Drobysch, A. N. Dubovitsky, F. G. Markov, and A. V. Vladimirov

17:20–17:40

**SUPPRESSION OF HIGH FREQUENCY MODES OF UNSTABLE COMBUSTION
IN LOW-EMISSION COMBUSTORS OF INDUSTRIAL GAS TURBINES**

A. N. Dubovitsky, E. D. Sverdlov, K. S. Pyankov, H. F. Valiev, and S. A. Cheprasov

17:40–18:00

**INFLUENCE OF FLOW SWIRLING ON COMBUSTION OF ALUMINUM POWDER
AEROSUSPENSION IN A CHAMBER WITH EXTENSION**

A. Yu. Krainov, K. M. Moiseeva, and V. A. Poryazov

WEDNESDAY, October 7, 2020

10:00–17:00

EXCURSION TO KRASNAYA POLYANA AND ROSA PEAK

THURSDAY, October 8, 2020

Session 10: INTERNAL COMBUSTION AND JET ENGINES AND POWER PLANTS — II

Session Chair: S. M. Frolov

10.00-10.40

PLENARY LECTURE

**GLOBAL TRENDS IN THE DEVELOPMENT AND TEST FIRES OF ENGINE
DEMONSTRATORS FOR HIGH-SPEED AIRCRAFT**

A. N. Prokhorov, K. Yu. Arefiev, V. Yu. Alexandrov, O. V. Gus'kov, O. V. Kukshinov,
V. S. Zakharov

10:40–11:00

PULSE THERMAL CONTROL OF MOISTURE IN AIRCRAFT LIQUID FUELS

A. A. Starostin, D. V. Volosnikov, and P. V. Skripov

11:00–11:20

**EXPERIMENTAL AND NUMERICAL STUDY OF COMBUSTION OF AVIATION
KEROSENE TS-1 SURROGATES**

D.V. Idrisov, S. S. Matveev, S.G. Matveev, N. I. Gurakov, I.V. Chechet, and A. S. Semenikhin

11:20–11:40

COFFEE BREAK

**Session 12: PLASMA, LASER AND COMBUSTION ASSISTED TECHNOLOGIES,
FUEL REFORMING, NANOMATERIALS AND SURFACE TREATMENT**

Session Chair: M. S. Assad

11:40–12:00

**CONTROL OF THE COMPOSITION OF GAS-PHASE REACTION REAGENTS
USING A LIQUID ELECTROCAPILLARY RESONATOR**

P. S. Kuleshov

12:00–12:20

**CATALYTIC PROCESSES ON THE SURFACE OF THERMAL PROTECTION
SILICON-BASED COATINGS UNDER INTERACTION WITH DISSOCIATED AIR FLOW**

A. A. Krupnov and M. Ju Pogosbekian

12:20–12:40

**ADVANTAGES OF HIGH VOLTAGE CONSOLIDATION OF HAFNIUM CARBIDE
POWDERS AND TUNGSTEN-BASED ALLOYS**

E. G. Grigoryev, V. Yu. Goltsev, A. V. Osintsev, A. S. Plotnikov, E. L. Strizhakov,
S. V. Nescoromniy, V. G. Vinogradov, and S. O. Ageev

12:40–13:00

**INTEGRATED SIMULATION OF PLASMA AND GAS DYNAMICS OF PROSPECTIVE
PROPULSION SYSTEMS WITH THE EMPHASIS TO THERMOEMISSION COOLING
OF THEIR ELEMENTS**

A. V. Kolychev, V. A. Kernozhitsky, M. V. Chernyshov, and V. A. Savelov

13:00–14:00

LUNCH

Session 12: PHYSICS OF SHOCK AND DETONATION WAVES-I

Session Chair: P. A. Fomin

14:00–14:40

PLENARY LECTURE

**COMBINED PROPULSION SYSTEMS FOR PERSPECTIVE REUSABLE SPACE
TRANSPORT SYSTEMS OF AVIATION TYPE**

A. I. Lanshin and O. V. Sokolova

14:40–15:00

RELAXATION PROCESSES BEHIND THE SHOCK WAVE IN AIR

A. I. Bryzgalov

15:00–15:20

PARALLEL SOLVER FOR THE SIMULATIONS OF DETONATION WAVES
ON UNSTRUCTURED GRIDS

A. I. Lopato and A. G. Eremenko

Session 13: PHYSICS OF SHOCK AND DETONATION WAVES-II

Session Chair: N. N. Yakovlev

15:20–15:40

DETONABILITY OF FUEL–AIR MIXTURES IN TERMS
OF DEFLAGRATION-TO-DETONATION TRANSITION

S. M. Frolov, V. I. Zvegintsev, I. O. Shamshin, M. V. Kazachenko, V. S. Aksenov, I. V. Bilera

15:40–16:00

ORGANIC WASTE GASIFICATION WITH HIGHLY SUPERHEATED STEAM
PRODUCED BY CYCLIC DETONATIONS OF METHANE–STEAM–OXYGEN MIXTURES

S. M. Frolov, V. A. Smetanyuk, I. O. Shamshin, V. S. Aksenov, I. A. Sadykov, A. S. Silantiev,
and F. S. Frolov

16:00–16:20

SIMULATION OF INCOMPRESSIBLE AND COMPRESSIBLE GAS FLOWS
BY MESHLESS METHODS OF SMOOTHED PARTICLE HYDRODYNAMICS

S. M. Frolov, V. S. Ivanov, V. S. Ivanov, and R. R. Tukhvatullina

16:20–16:40

COFFEE BREAK

Session 14: COMBUSTION TECHNOLOGIES

Session Chair: A. N. Prokhorov

16:40–17:00

THERMAL AND CALORIC EQUATIONS OF STATE FOR NITROGEN
IN A WIDE RANGE OF DENSITY AND TEMPERATURE:

APPLICATION TO CRYOGENIC INJECTION CONDITIONS

N. M. Kuznetsov, S. N. Medvedev, S. M. Frolov, F. S. Frolov, B. Basara, and K. Pachler

17:00–17:20

INFLUENCE OF ADDITIONAL AIR ON THE DETONATION VELOCITY
IN HEPTANE/OXYGEN AND JET A-1/OXYGEN MIXTURES

IN A PULSING REACTIVE TYPE COMBUSTOR

M. S. Assad, O. G. Penyazkov, I. I. Chernuho, and K. Alhussan

17:20–17:40

OUTDOOR TESTS OF A TOWED BOAT MODEL WITH FUEL COMBUSTION
IN A BOTTOM CAVITY

S. M. Frolov, S. V. Platonov, K. A. Avdeev, V. S. Aksenov, V. S. Ivanov, A. E. Zangiev,
I. A. Sadykov, F. S. Frolov, and I. O. Shamshin

17:40–18:00

INTEGRATED EXPERIMENTAL STUDY USING INFRARED THERMOGRAPHY METHOD ON BEHAVIOR OF WOOD CONSTRUCTIONAL MATERIALS IN FIRE CONDITIONS

D. Kasymov, V. Agafontsev, E. Loboda, Yu. Loboda, and V. Reyno

18:30–22:30 CONFERENCE DINNER

RESTAURANT “AMSHENSKY DVOR”

15A Krasnoflotskaya Str., Sochi

FRIDAY, October 9, 2020

10:20–11:00

PLENARY LECTURE

SPHERICAL DIFFUSION FLAME IN MICROGRAVITY CONDITIONS: FIRST RESULTS OF JOINT RUSSIAN–AMERICAN SPACE EXPERIMENT “FLAME DESIGN — ADAMANT”

S. M. Frolov

11:00–11:20

COFFEE BREAK

Session 15: POSTERS, TELECONFERENCE, DISCUSSION

Moderators: S. M. Frolov and A. I. Lanshin

11:20–12:20 TELECONFERENCE

11:20–11:40

ROLES OF IONIC REACTIONS IN NANOSECOND DISCHARGE PLASMA-ASSISTED TEMPERATURE-DEPENDENT PYROLYSIS AND OXIDATION OF METHANE FUEL

Qi Chen, Jintao Sun, Jianyu Liu, and Baoming Zhao

11:40–12:00

STOCHASTIC MOLECULAR DYNAMICS OF FORMATION OF POROSITY NANOSTRUCTURES AND CONDENSATION CLUSTERS

G. I. Zmievszkaya

12:00 – 12:20 (P. Leyland, TBA)

12:20–13:20 POSTERS

13:20–14:00 DISCUSSION

14:00–16:00

FAREWELL LUNCH

POSTER SESSION

(posters are exhibited during all Symposium days; Poster dimension is 80 x100 cm)

<i>Poster 1</i>	N. G. Bykova, I. E. Zabelinsky, P. V. Kozlov, Yu. V. Tunik, V. Yu. Levashov, and V. O. Maiorov	INVESTIGATION OF THE PROCESSES IN THE HIGH-PRESSURE CHAMBER OF SHOCK TUBE
<i>Poster 2</i>	A. Yu. Krainov, V. A. Poryazov, and D. A. Tsvetkova	THE COMBUSTION RATE OF AMMONIUM PERHLORATE BASED METALLIZED COMPOSITE SOLID PROPELLANT IN THE FORCE FIELD
<i>Poster 3</i>	S. S. Matveev, D. V. Idrisov, and A. S. Semenikhin	LAMINAR BURNING VELOCITY OF INDIVIDUAL HYDROCARBONS AND KEROSENE SURROGATES
<i>Poster 4</i>	A. Nikolayev, A. M. Mebel, and V. N. Azyazov	THE ENERGIES AND MOLECULAR PARAMETERS INVOLVED IN THE REACTION OF CH + 1,3-BUTADIENE
<i>Poster 5</i>	A. S. Savchenkova, A. S. Semenikhin, I. V. Chechet, S. G. Matveev, M. Frenklach, and A. M. Mebel	DIMERIZATION OF POLYAROMATIC HYDROCARBON MOLECULES WITH FORMATION OF E-BRIDGE BOND: A THEORETICAL STUDY
<i>Poster 6</i>	A. P. Torbin, A. V. Panova, and P. A. Mikheev	THE STUDY OF DIELECTRIC BARRIER DISCHARGE PROPERTIES FOR THE CONDITIONS OF PLASMA-INITIATED COMBUSTION
<i>Poster 7</i>	V. I. Uvarov, R. D. Kapustin, and A. O. Kirillov	POROUS CATALYTIC-ACTIVE CERAMIC MEMBRANES FOR HYDROCARBON DEHYDROGENATION
<i>Poster 8</i>	V. I. Uvarov, R. D. Kapustin, and A. O. Kirillov	POWDER CONSOLIDATION USING TECHNOLOGICAL COMBUSTION FOR DEVELOPMENT OF CATALYTICALLY ACTIVE MEMBRANES FOR HYDROCARBON DEHYDROGENATION

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