

Russian Academy of Sciences SB
Tomsk Scientific Center

May 20, 2024

SESSION I

11.00 AM – 13.30 PM

Chair: **Alexandr Komlev** (IMCES), **Nikolai Karasev** (IAO)

Welcome address: **Mikhail Tarasenkov, Cand. Sc. (Physics and Mathematics) (IAO)**

Invited speaker: **Maria Pupysheva (IMCES) - Dynamics of wildfires in the piedmont of Northern Altai (from the Late Glacial to the present)**

1. Sergey Bitter

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The effect of thermal annealing on the mechanical properties of an aging nanocrystalline NiTi alloy

The relationship between the evolution of the structure during heat treatment with the multi-stage martensitic transformations B2 - R - B19' and the mechanical properties of the nanocrystalline alloy Ti-50.9 at.% Ni with the effects of shape memory and superelasticity is investigated. It has been established that with an increase in the annealing temperature, a change in the mechanical behavior of the material from the superelasticity to the shape memory effect is observed.

Keywords: *nanocrystalline structure, thermal annealing, martensitic transformations*

2. Andrei Luchin

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Temperature dependence of plastic deformation mechanisms and fracture of (Fe₄₀Mn₄₀Co₁₀Cr₁₀)_{100-x}(N)_x multicomponent alloy

This work shows the possibility to increase mechanical performance of multicomponent medium-entropy alloy Fe₄₀Mn₄₀Co₁₀Cr₁₀ by nitrogen alloying. Its influence on microstructure, phase composition and mechanical properties at room and lower temperatures are studied by the methods of scanning electron microscopy, X-ray diffraction analysis and uniaxial static tensile testing.

Keywords: *medium-entropy alloys, solid-solution hardening, thermal-mechanical treatment, microstructure, phase composition, fracture behavior*

3. Semen Peshkov

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Statistical modeling of images in active range-gated systems in conditions of high atmospheric turbidity

This study explores methods for atmospheric correction in active vision systems under high turbidity. Range-gated techniques are highlighted for their advantages, including enhanced image quality and adaptability to environmental variations. Utilizing Monte Carlo simulations and the LOWTRAN-7 model, the research showcases the efficacy of range-gated systems in improving image visibility and contrast. Furthermore, it identifies research gaps and advocates for innovative correction methods tailored to these challenging conditions.

Keywords: *atmospheric correction, active vision systems, range-gated systems, monte carlo simulations, high turbidity conditions*

4. Irina Martyshina

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The ZrB₂ strength properties based on nanoindentation simulation

Dual ceramic composites based on ZrB₂-SiC matrix and TaB₂-SiC granules are promising materials for high-temperature applications in aerospace industry. Detailed experimental studies of such materials are very expensive. To correctly simulate the mechanical behavior of dual composites, it is necessary to know the stress-strain relationship for their components under simple compression and tension. However, such experimental data are not available. The most popular experimental tests for ceramics are nanoindentation and bending. In the literature, there are several methods to obtain the stress-strain relationship from nanoindentation for metallic materials. Herein, we to obtained the strength properties of ZrB₂ from nanoindentation experiments are corresponding simulations using the movable cellular automata method. The results show that ZrB₂ behaves as a viscoelastic materials with a rather large residual strain.

Keywords: *nanoindentation, dual ceramic composite, strength, simulation, the movable cellular automata method*

5. Kirill Salnikov

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Averaging of mueller matrices over the euler angles

A comparison of averaging methods used in scattering problems has been carried out. The comparison was made at a wavelength of 0.532 μm and refractive index 1.3116 on a column height of 4 μm. The results obtained can be used to reduce the number of particle orientations in problems of light scattering by randomly oriented particles.

Keywords: *light scattering, cirrus, solar energy transfer, mueller matrix, euler angles, averaging*

6. Anastasiya Kononova

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Mechanical behavior of CFRP laminates with different layups under low-velocity

impact

Carbon fiber-reinforced composites are popular due to their high strength and light weight. However, these composites are susceptible to impact damage. The objective of this research was to study the behavior of PEEK/CF composites with six stacking sequences under impact loading. Three behavior pattern of layups under drop-weight impact were found: 1 - mostly linear behavior, 2 - initiation and propagation of concentrated damage, 3 - initiation of small, dispersed damage. The results can be used to predict the mechanical behavior of composites for proper structural design.

Keywords: *polymer composite, polyetheretherketone, carbon fiber, stacking sequence, impact behavior*

7. Anna Manisheva

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Structural-phase state and mechanical properties of radial-shear rolled and subsequently aged pseudo- β -titanium alloys

The structure and mechanical properties of β titanium Ti-15V-3Cr-3Al-3Sn-1Zr-1Mo alloy wire produced by combined radial-shear and groove rolling with subsequent aging by tensile test and three-point bending methods was studied. During the work, several processing modes were carried out. Using the fractography, the bending surface was studied the nature of destruction was heterogeneous.

Keywords: *titanium alloy, deformation-heat treatment, mechanical properties, structure*

8. Tatyana Nevzorova

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Broadening and shift coefficients of SO₂ lines perturbed by CO₂

Broadening and shift coefficient of sulfur dioxide lines by carbon dioxide are calculated at room temperature for the $\nu_1 + \nu_3$ and A-type bands from HITRAN database with the rotational quantum numbers J and Ka varying in the ranges up to 100 and up to 45, respectively. Parameters of the semi-empirical method are determined from the analysis of experimental data. The broadening and shift coefficients computed are in a good agreement with the literature data.

Keywords: *line profile parameters, line broadening, line shifting, sulfur dioxide, carbon dioxide*

9. Kristina Sharybkina

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Empirical rovibrational line lists of sulfur dioxide

This work presents an empirical line list of vibrational-rotational transitions of molecules ³⁴SO₂ and ³³SO₂ in the 0-4000 cm⁻¹ and 0-2750 cm⁻¹ spectral ranges, respectively. The line centers in the empirical list are determined from high-accuracy experimental and predicted energy level data using the effective Hamiltonian method, while the intensities are derived from variational calculations.

Keywords: *sulfur dioxide, infrared spectroscopy, empirical, isotopologues*

10. Anton Sagun

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Development of a thermoplastic corundum feedstock for FGF 3D-printing

Additive technologies have gained significant relevance in the production of ceramics. Among the various 3D printing methods, Fused Granulate Fabrication (FGF) stands out as one of the cheapest and easiest to implement for ceramic product manufacturing. The developed feedstock allows us to produce 3D printed parts on the FGF printer. Tensile strength requirements for corundum ceramics VK95.

Keywords: *corundum ceramics, fgf-printing, feedstock*

11. Anfisa Rechkunova

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Cellulose microfibers modified with ZnO-Ag nanoparticles with high antibacterial activity

In the present study we consider the possibility of using materials treated with ZnO/Ag nanoparticles as dressings for the treatment of wounds of various etiologies. The results of the study showed that the modified gauze has an antibacterial effect against S.aureus and inhibits the growth of pathogenic microflora. In addition, the samples do not lose their antibacterial activity after washing cycles.

Keywords: *antibacterial ZnO/Ag nanoparticles, cellulose fibers, electro-explosive nanoparticles*

12. Marianna Lukyanets

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The Cook-Gordon mechanism in composites of the TiB₂-ZrB₂-SiC-h-BN system

The investigation studied implementation of the Cook-Gordon mechanism in the bulk TiB₂-ZrB₂-SiC-h-BN composites consolidated by hot pressing. The effect of low-modulus h-BN content on mechanical properties of ceramic composites (flexural strength, fracture toughness K_{1C}) was evaluated using three-point method. The greatest increase in fracture toughness K_{1C} was obtained by TiB₂-ZrB₂-SiC-h-BN bulks with 5 vol. % of h-BN.

Keywords: *boride ceramics, fracture toughness, cook-gordon mechanism*

END OF SESSION I

SESSION II

14.00 PM – 16.30 PM

Chair: **Maria Pupysheva** (IMCES), **Alexandr Komlev** (IMCES)

13. Mikhail Kovtunov

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Hydrogen fixation for ethylene-targeted plasma methane conversion

The present work proposes new methods for increasing the selectivity towards ethylene in the course of plasma-catalyzed methane conversion. The approaches suggested are based on hydrogen fixation by means of either non-metal hydride formation or a competing gas-phase process. The experiments conducted using competing NH₃ synthesis show that proportional mixing of methane and nitrogen in the gas flow diminishes the weight yield of ethylene.

Keywords: *plasma, methane conversion, ethylene, dielectric barrier discharge*

14. Anastasiia Saidentsal

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Acid chemical oil-displacing composition with improved properties

Easy-to-prepare new acid oil displacing composition based on surfactant, inorganic acid adduct (boric acid) and polyatomic alcohol (pentaerythritol) has been proven to have the capacity to increase the production of heavy and high-viscosity oil. The solid form of the obtained composition enables its easy transportation and application even in northern regions and the Arctic.

Keywords: *deep eutectic solvents, enhanced oil recovery, surfactant compositions, high-viscosity oil, phase equilibrium*

15. Ekaterina Sidelnikova

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Scaling the ethylene oxo-synthesis technology

Currently, "dry gas" from catalytic cracking, which contains ethylene, is flared. At the same time, ethylene

can be processed into valuable oxygen-containing products. Ethylene can be processed into valuable products using oxosynthesis. There is no ethylene oxo-synthesis in Russia. The development of the Oxosynthesis Process will allow valuable raw materials to be used more efficiently.

Keywords: *ethylene, oxosynthesis, cobalt carbonyls, scaling*

16. Roman Tomashpolskii

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Assessment of hazardous geological processes at the Talakan oil and gas field

The purpose of this work is to "assess the features of engineering and geological conditions that may interfere with the normal functioning of the Talakan oil and gas field". To achieve this goal, it is necessary to solve such tasks as: collection, systematization and analysis of available territorial geological, hydrogeological information, results of engineering surveys on the Talakan oil field. To determine the boundaries of the spread of dangerous geological processes, their danger to economic activity. Identify the most significant dangerous geological phenomena. To analyze the available methods for assessing the development of hazardous geological phenomena. Development of monitoring recommendations.

Keywords: *geological hazard, research, karst, gis, talakan*

17. Alexander Kryazhev

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Hydrogasogeochemical studies of surface waters on the Angara river

Hereby we consider examples of zones of ascending deep faults. Surface hydrogeochemical anomalies on the Angara River. The results of hydrogeochemical studies performed during hydrogeological routes along tectonic fault zones are shown. Portable devices were used to determine micro-components and sampling. All the data collected, express analyses, laboratory analyses, are very valuable for building up knowledge of the mineral resource base.

Keywords: *bottom testing, HQ-40D analyzer, active faults, mineralized waters, mineral resource base*

18. Maksim Mokeev

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Adhesive properties of polyethylene films modified by an electron beam

Today, composite materials based on polymer films are used in medicine, engineering, electronics and other fields. One of the key features of polymers is that they don't get along well with water, so you need to take extra steps to make them more adhesive. Today, we use glow discharge, corona and gliding arc plasmas to modify adhesive properties of polymers. The study shares the results of modification of polyethylene films by atmospheric-pressure electron beam.

Keywords: *electron beam, adhesive properties, polymers, adhesive*

19. **Nikita Smirnov**

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A new home for the bark beetle: pest comfort zone at the cost of deforestation

The study presents the results of a research into patterns of development of a new invasive pest, the small spruce bark beetle *Ips amitinus* (Eichh). The studies were conducted in the field and controlled conditions. Patterns linked to the constant average daily temperature and the timing of the development of the bark beetle family have been revealed.

Keywords: *bark beetle, ips amitinus, invasive, phenology, western siberia*

20. **Parviz Khodzhaev**

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Synchronous frequency-controlled electric drive of regulating valves

The synchronous frequency-controlled electric actuator of regulating valves at low temperatures is investigated, the influence of temperature on mechanical characteristics of the actuator is shown, the power of heating of the actuator is calculated and the temperature to which the actuator can be heated is calculated.

Keywords: *synchronous motor, frequency converter, control system, low temperatures, operation stability*

21. **Anastasiia Zelentsova**

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The chemical composition of soil concretions and nodules from the South taiga and subtaiga subzones of the Tomsk region

The results of the analysis of the salt content and gross composition of soil concretions and nodules from the South taiga and subtaiga subzones of the Tomsk Region are presented. The study revealed a higher concentration of salts and certain chemical elements compared to the host soil mass. A hypothesis has been put forward about the evolution of soils of the studied area through the arid stage.

Keywords: *soil, concretions, nodules, chemical composition, water extract, salt content, evolution of soils, south taiga*

22. **Erika Maslennikova**

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The role of high cyclone activity in the formation of the ozone hole over Antarctica according to the ERA5 reanalysis data

Erebus volcano is the southernmost active volcano on Earth, whose volcanogenic emissions include components that play a significant role in catalytic cycles of stratospheric ozone depletion. High cyclones contribute to the rise of gas emissions from Erebus volcano from the troposphere to the altitudinal range of ozone hole formation in the stratosphere. The effect of HCl accumulation in the stratosphere was shown: the correlation coefficient between 5-year averages of the frequency of occurrence of high cyclones and 5-year

averages of the ozone hole area with a time shift of the series 4 years ahead relative to the series of the frequency of occurrence of high cyclones, calculated for the period from 1980 to 2022, amounted to 0,78.

Keywords: *high cyclones, antarctic ozone holes, erebus volcano, antarctic polar vortex*

END OF SESSION II

Closing word: Chair