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ABSTRACTS OF PUBLISHED ARTICLES

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RESEARCH ON SUBMICRON-GRAINED STRUCTURE FORMATION IN TITANIUM ALLOYS UPON REVERSIBLE HYDROGENATION AND PLASTIC DEFORMATION

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Abstract—The effect of thermohydrogen treatment combined with hot rolling on structure formation in α- and near-α titanium alloys has been studied. The possibility of submicron-grained sheet semiproduction of VT5 (Ti–5.8Al–0.1Fe, wt.pct.) and VT20 (Ti–5.9Al–1.5V–1.2Mo–1.8Zr–0.1Fe, wt.pct.) alloys has also been shown wherein the submicron scale structure contributes to maximal flow stress decrease and gives the opportunity to perform the superplastic deformation process at lower temperatures (by 100–200°C).

Keywords: titanium alloys, hydrogen technology, submicron-grained structure, superplasticity, flow stress, electron microscopy, fine structure.

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INFLUENCE OF THE THERMAL TREATMENT MODE ON HEAT RESISTANCE OF THE ALLOY ON THE BASIS OF CHROME AT HIGH-TEMPERATURE OXIDATION ON AIR

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Abstract—Dependence of heat resistance of Cr-32Ni-1.5W-0,25V-0.5Ti alloy from initial before oxidation structure is established. Influence of an intermediate layer and porosity of Cr_2O_3 oxide on oxidation kinetics is shown. The minimum size of scale during the initial period of the oxidation, which develops according to the parabolic law, is provided with fine-grained structure of an alloy at the expense of accelerated formation of the γ-phase intermediate layer. The minimum speed of oxidation is reached at a stage of linear oxidation of an alloy at 1100°C due to delay of diffusion of oxygen when the formed oxide is possessed of the minimum porosity, i.e. the greatest density. The mechanism of formation of γ-phase (solid solution of chrome in nickel) intermediate layer is shown.

Keywords: alloy on the basis of chrome; heat resistance; oxidation of heat resisting Cr–Ni alloys; chrome and oxygen diffusion; oxide layer structure.

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WEAR-RESISTANT CERAMIC MATERIALS BASED ON Al_2O_3 WITH DIFFERENT GRAIN SIZES FOR GYRO BEARINGS

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Abstract—Wear-resistant ceramic materials have obtained on the basis of Al_2O_3 with grains of a diameter of 3 and 15 microns, a schematic diagram of manufacturing technology has been given. The structural and physical-mechanical characteristics of the ceramic material samples have been researched in comparison with a monocrystal Al_2O_3. Tribological tests of ceramics have been conducted, establishing the correlation between ceramic wear, its structural features, and determinative parameter which is the ratio of hardness to Young's modulus.

Keywords: ceramic materials have obtained on the basis of Al_2O_3, wear-resistant, structural features, physical-mechanical characteristics.

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ARAMIDE ORGANOPLASTICS FOR SOUND-PROOF DESIGNS

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Abstract—Modern sound-proof designs are inconceivable without complex multi-level structure. This structure is to provide noise decrease of aircraft engines within the broad range of frequencies, improving acoustic comfort of passengers and the crew, and also reducing noise pollution in city areas. Materials necessary for sound-proof designs have to possess certain complex of acoustic, mechanical and technological properties. The paper covers aramide organoplastics, developed for advanced sound-proof designs (multi-layer and gradient) with expanded strip of sound absorption.

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The work is executed within the framework of Strategic directions of development of materials and its production technologies for the period up to 2030 (3.2: Structural PCM).

Keywords: organoplastics, aramide fibers, sound-proof design, factor of sound absorption.

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POLYMER COMPOSITE MATERIALS BASED ON THERMOSETTING POLYIMIDE BINDERS FOR AEROSPACE ENGINEERING. Review.

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Abstract—This article analyzes the work in the field of thermostable composite materials based on fiber fillers and polyimide binders. Data on composite materials based on cross-linked polyimide have been given. Physical and mechanical properties of glass- and carbon plastics based on polyimide binders and their application have been presented.

Perspective polyimides with the structure of semi-interpenetrating networks, and properties of composites based on them have been described. The main directions of development of high-temperature composites have been outlined.

Keywords: polymer composite material, polyimide, binder, polymerization, thermal stability

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RESEARCH DATA OF THE FIBER OPTIC SENSORS EMBEDDED IN CFRP PANEL

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Abstract—The paper presents research results of fiber optic sensors embedded in CFRP panel. The efficiency of such sensitive systems for the control of the stress-strain state of the structure has been shown. Spectral characteristics have been investigated after forming panels during mechanical tests. Built-in monitoring of stress-strain state is effectuated by point and linear fiber optic sensors.

Keywords: fiber optic sensor, fiber Bragg grating, carbon fiber reinforced plastics (CFRP), large-sized composite wing panel, three-point bending.

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EFFECT OF LONG CLIMATIC AGING ON MICROSTRUCTURE AND NATURE OF FRACTURE OF ORGANOPLASTICS BASED ON EPOXY MATRIX IN THE CONDITIONS OF BEND AND COMPRESSION

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Abstract—The paper investigates influences of long (till 5 years) climatic aging on microstructure and fracture of epoxy organoplastics in the conditions of power influence (bend and compression). It is

shown that ftacture of epoxy organoplastics at mechanical loading takes place according to mixed mechanism – along fibers, and also along matrix and represents complex multiphasic process which is observed at various structural levels. The analysis of the obtained microstructure data taking into account the duration of influence of climatic factors is carried out, the main types of organoplastics fracture are established considering aging and tests on bend and compression.

Keywords: organoplastics, long climatic aging, microstructure, scanning electron microscopy, bending strength, compression strength.

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CRITERIA FOR EVALUATING THE OPERATING CONDITIONS OF THE ELECTRODES WHEN THE RESISTANCE SPOT WELDING

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Abstract—At the resistance spot welding the electrode wear resistance is determined by thermal deformation processes on the work surface. To analyze the impact of electrodes' construction and welding parameters on these processes we use physical and mathematical model, which is the basis of the electric potential of the system of equations, thermal conductivity, and plastic deformation. The paper proposes criteria for assessing the durability of the electrodes when choosing their geometry and welding conditions: the ratio of contact pressure and working surfaces hardness and surfaces temperature values, which are defined by computer simulation of the welding process.

Keywords: resistance spot welding, electrode wear resistance, thermal deformation process, physical and mathematical model, computer engineering analysis.

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DEVELOPMENT AND RESEARCH OF ELECTRODE MATERIALS MANUFACTURED FROM MINERAL CONCENTRATES AND MINING WASTE

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Abstract—The paper presents data of new electrode materials for electric spark alloying, manufactured from mineral raw materials of the Far Eastern region. Alloying layer formation and its properties have been studied. It is found that electric spark alloying by new electrode materials increases steels' heat and wear resistance.

Keywords: mining waste processing, electroslag remelting, alloys, electrodes, electric spark alloying.

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EFFECT OF FRICTION STIR WELDING PROCESS PARAMETERS ON MECHANICAL AND FRACTURE BEHAVIOR OF ALUMINUM-MAGNESIUM ALLOY

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Abstract—The paper presents results of investigation of microstructure and mechanical behavior of the aluminum-magnesium alloy made by friction stir welding. In order to choose optimal welding conditions, the main process parameters, such as tool rotating rate and welding speed, were modified. The possibility of obtaining high quality joints has been analyzed.

Keywords: friction stir welding, aluminum-magnesium alloy, microstructure, stress-strain behavior.

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INFLUENCE OF RUTHENIUM ON STRUCTURE, CRACKING CORROSION AND LOW-CYCLE FATIGUE OF TITANIUM ALPHA-ALLOYS IN CORROSIVE ENVIRONMENT

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Abstract—The paper shows research results of two types of deformed semi-finished products (forgings and tubes), made of titanium alloys PT-7M and PT-7M + 0.15% ruthenium. Basic mechanical properties, structure and ruthenium distribution on the structure of titanium alloys are presented.

The results of tests on corrosion and mechanical strength of forgings and pipes from these alloys have been considered. Samples with cracks were evaluated by static three-point bending and cyclic fatigue experiments in corrosive environment.

Keywords: titanium alloys, low-cycle fatigue, cracking corrosion**,** forging, pipe.

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DEVELOPMENT OF THE PROMETEY MODEL AND METHOD OF UNIFIED CURVE. Part 1. PROMETEY MODEL

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Abstract—The paper solves two problems that arise when modeling brittle fracture: firstly, the possibilities of using the same model parameters for describing specimens of various types, and secondly, fracture simulation under non-radial loading. Probabilistic model of brittle fracture known as a Prometey model has been upgraded to meet these challenges. Modified model (so called M-Prometey) was verified by comparing calculations with experimental data. Smooth and notched cylindrical, tensile specimens and pre-cracked specimens have been ma de of RPV steel in the initial and embrittled conditions. M-Prometey model allows us to calculate the probability of brittle fracture of specimens of various types at different test temperatures, at the same parameters of the model. The values of the parameters of the M-Prometey model have been obtained to simulate the brittle fracture of RPV steels in initial and embrittled conditions.

Keywords: reactor pressure vessels steels, modeling brittle fracture, modified model M-Prometey, prediction of fracture toughness.

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DEVELOPMENT OF THE PROMETEY MODEL AND METHOD OF UNIFIED CURVE. Part 2. UNIFIED CURVE

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Abstract—The advantages and disadvantages of engineering Unified Curve (UC) method to predict the temperature dependence of the fracture toughness K_{Jc} (T) have been considered. On the basis of the modified model of brittle fracture (M-Prometey model), discussed in the first part of the present paper, UC method has been improved and called Advanced Unified Curve (AUC). The results were obtained through an extensive database of values of fracture toughness of materials with varying degrees of embrittlement. A comparison of methods AUC and the UC, as well as the AUC and the known

engineering method, Master Curve (MC), has been made. Various statistical methods were used to compare the AUC, UC and MC.

Keywords: reactor pressure vessels steels, modeling brittle fracture, Advanced Unified Curve method, prediction of fracture toughness.

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INVESTIGATION OF RADIATION RESISTANCE AND STRUCTURAL STABILITY OF TITANIUM α- AND PSEUDO-α-ALLOYS

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Abstract—The paper discusses the results of a study of radiation resistance of advanced Ti–5Al–4V–2Zr, Ti–5AL–2MO–2ZR, Ti–4Al–Mo–20Zr titanium alloys after neutron irradiation damaging dose of 0.29 dpa at irradiation temperature 260ºC.

The paper presents results of mechanical and microstructural tests of specimens made by transmission electron microscopy. A detailed study of alloying element distributions in boundary zones and within phases has been realized by energy-dispersive X-ray spectroscopy.

Keywords: titanium, radiation resistance, fluence.

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FORMALIZATION OF 3D MODELING STRUCTURAL EQUILIBRIUM POLYHEDRAL STRUCTURE OF TITANIUM ALLOYS IN THE SYSTEM "3D MATERIALS SCIENCE (3DMS)".

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Abstract—The paper shows results of the 3D structural and geometrical modeling of polycrystalline structure of titanium, α-titanium, pseudo-α-titanium alloy VT20 and titanium α + β-alloy VT6, as a formal transformation of the real alloys structure in structural geometric spatial model, based on the notions of equilibrium homogeneous structure, as a regular packing of the crystallites (grains) in the form of polyhedra.

Keywords: titanium alloys, 3D modeling of the alloy structure.

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HYDRIDE REORIENTATION MODELING IN SPENT FUEL CLADDING DURING DRY STORAGE

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Abstract—Hydrides in the fuel cladding of water-cooled reactors are one of the degradation factors during spent fuel dry storage. Hydride orientation is dependent on external stresses, temperature, temperature history and other. The radial-oriented hydrides are most dangerous, because they give rise to cracks in the rod cladding. According to many experimental data the precipitation of zirconium hydrides leads to the formation of “stacks” of hydride plates. The stacks can grow up by the new hydride plates’ nucleation. Considering the experimental data it has been suggested that the hydride orientation is determined by the radial and tangential (circumferential) hydride nucleation rate. Based on this assumption the kinetic model has been developed. The model allows evaluating the radial and tangential hydride fraction in rod claddings under different temperature and stress history. Comparison of the model and experimental data (alloys E110, E635, E635M, Zircaloy-4 and Zr–2.5Nb) has been carried out.

Keywords: water-cooled reactor, spent fuel, dry storage, hydrides, zirconium alloys, rod claddings

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DEFORM-3D MATHEMATICAL MODELING OF MANUFACTURING OF CYLINDRICAL SHELL OF A NEW THERMALLY STABLE TITANIUM ALLOY

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Abstract—The paper presents the mathematical modeling of the manufacturing of cylindrical shell of new thermally stable and radiation-resistant Ti-5Al-4V-2Zr titanium alloy. The results of solving the problem with the help of the softw27are DEFORM-3D are based on physical and mechanical properties of the alloy material flow characteristics depending on deformation dimensions, temperature and rate. The results of the mathematical modeling of the shell forging are presented as regards the equipment of PJSC “VSMPO-AVISMA”.

Keywords: titanium alloy, mathematical modeling, PC DEFORM-3D

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