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MICROALLOYING EFFECTS ON STRUCTURE-FORMING PROCESSES DURING HOT PLASTIC DEFORMATION

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Abstract—The kinetics of austenite grains' growth upon heating has been investigated, and the processes of dynamic and static recrystallization occurring under different modes of plastic deformation (reduction pattern, deformation temperature) of high-strength steels with various microalloying complexes have been studied. The research made it possible to reveal the thermal deformation conditions for the formation of a finely dispersed homogeneous structure of steel. Technological recommendations have been developed for the production of high-strength steels depending on their microalloying (vanadium, niobium).

Keywords: high-strength steel, vacuum etching, austenite grain, static recrystallization, dynamic recrystallization, hot rolling, bainite-martensite structure, Gleeble 3800

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CORRELATION OF STRUCTURE PARAMETERS AND PERFORMANCE CHARACTERISTICS OF ALLOY STEELS FOR SHIPBUILDING

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Abstract—The article presents the results of a study of the relationship between strength and performance (temperatures of ductile-brittle transition T_{db} and zero plasticity NDT, critical opening at the crack tip CTOD at a test temperature of –40°C) on the structure parameters of thick plate products made of low-carbon low-alloy steels with different contents of basic alloying and microalloying elements.

Keywords: low-alloy steel, thermomechanical treatment, carbon equivalent, strength, cold resistance, crack resistance, structure parameters

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DIGITAL TECHNOLOGIES IN DETECTING INHOMOGENEOUS CONCENTRATION ZONES IN HEAT-RESISTANT NICKEL ALLOYS STRUCTURE, INCLUDING THOSE OBTAINED BY SELECTIVE LASER MELTING

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Abstract—This work presents the experimental data obtained using an integrated approach in the study of the chemical, crystallographic and morphological homogeneity of the structure of a heat-resistant material on a nickel base with carbide-intermetallic hardening and an increased content of the γ'-phase, synthesized on single-crystal substrates of various compositions with CHO <001> in Z-direction. Using the proposed method for studying the capabilities and certification of different-level structural structures of samples in the initial state and after thermal study of the impact. The analysis was carried out using the system for EBSD analysis integrated into the scanning electron microscope and the software package for the analysis of electron microscopic images.

Keywords: selective laser melting, SEM, concentration inhomogeneities, γ'-phase, image analysis, microtexture, EBSD analysis, single-crystal samples, crystallographic orientation, structural transformations

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INVESTIGATION OF THE FATIGUE CRACK GROWTH RATE IN HEAT-RESISTANT NICKEL ALLOYS

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Abstract—The results of tests on the FCGR (fatigue crack growth rate) of compact specimens of eccentric tension using a crack opening (COD) sensor under conditions of an asymmetric loading cycle $R = 0.1$ at room and elevated temperatures are presented. The relationship between the conditions of force loading of preliminary growth of the initial fatigue crack is considered. The values of the effective stress intensity factor K_{eff} were obtained, which is an important estimate for interpreting the observed character of crack growth. A comparison of the properties of the cyclic crack resistance of the VZh175-ID alloy with the properties of foreign analogues Rene 88DT, Inconel 625 SLM and domestic ones – EP741NP, EK151-ID is presented. The influence of the test temperature on the growth rate is shown. The hypothesis about the linear dependence of the parameters of the Paris equation is tested.

Keywords: mechanical properties, fatigue characteristics, heat-resistant wrought nickel alloys, kinetic diagram of fatigue fracture, effective stress intensity factor, crack closure, Paris equation

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PROSPECTS FOR THE CREATION OF HIGH-TEMPERATURE HEAT-RESISTANT ALLOYS BASED ON REFRACTORY MATRICES AND NATURAL COMPOSITES

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Abstract—The paper presents the scientific, technical and technological aspects in the field of creating new high-temperature materials for parts of the hot section of gas turbine engines (GTE) with operating temperatures exceeding those existing in GTE. More refractory metallic materials for the creation of new high-heat-resistant alloys used for the manufacture of rotor and nozzle blades and other parts of promising gas turbine engines based on NiAl-Ni_3Al, Co–Cr–Re, Pt–Al, Nb–Si, Mo–Si–B systems have been investigated. It is shown that, depending on the composition of the selected matrix, the working temperature of heat-resistant alloys increases to 1300–1500°C, which is significantly higher than the existing nickel heat-resistant alloys.

Keywords: high-temperature alloys, refractory matrices, hardening phases, eutectic composite, microstructure, short-term and long-term strength, gas turbine engines

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INFLUENCE OF THE COMPOSITION OF α-TITANIUM ALLOYS ON THERMAL CONDUCTIVITY

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Abstract—Among titanium alloys, modern α- and pseudo-α-alloys occupy a special place due to the unique combination of their mechanical properties, corrosion resistance, low density and high specific strength, which determines their effectiveness in various industries. Analysis of structural materials used for heat exchange equipment of nuclear power plants showed that the increase in the efficiency and compactness of tube systems made of α-titanium alloys is constrained by their thermal conductivity characteristic, which does not exceed 8–9 W/(m·K) at a temperature of 20°C. An exception is the VT1-0 grade alloy, the scope of which is limited to a maximum operating temperature of no more than 250°C. The paper considers the results of studies of a new titanium alloy of the Ti–Zr–Al–O composition with increased thermal conductivity for pipe systems of power equipment.

Keywords: titanium, thermal conductivity, titanium α- and pseudo-α-alloys

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CASTING GLASS COATED MICROWIRES OF ALLOYS BASED ON SILVER AND NICKEL

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Abstract—This work presents the results of studying the features of the casting process of glass-coated microwires of alloys based on silver, which has a near-zero TCR, and nickel, which has a high thermo emf.

Keywords: glass coated cast microwire, temperature coefficient of resistance (TCR), thermo emf, linear resistance

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STRUCTURE AND MICROHARDNESS OF BINDING FOR DIAMOND TOOLS BASED ON TUNGSTEN CARBIDE OBTAINED BY IMPREGNATION OF IRON–CARBON MELT

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Abstract—In this work, an experimental modeling of the technology for producing a matrix by sintering a diamond-containing briquette with a filler of tungsten monocarbide powder impregnated with a Fe–C eutectic melt in a vacuum is carried out. The microstructure, elemental and phase compositions of the products formed in the process of sintering a diamond-containing matrix with impregnation with a Fe–C eutectic melt in vacuum have been studied by scanning electron microscopy, X-ray spectral and X-ray phase analyzes, and Raman spectroscopy. It was found that the matrix consists of 61.0% tungsten carbide phases, 17.0% of iron carbide, 16.5% of α-Fe, and 5.5% of graphite. The eutectic Fe–C alloy, which serves as a matrix binder, consists of a ferrite-pearlite metal base with graphite inclusions. It is shown that at the diamond – matrix interface, graphite inclusions are formed not as a continuous layer, but as discontinuous areas along the perimeter of diamond grains. The microhardness of the WC-based matrix impregnated with the Fe–C melt is ~11 GPa, which is more than 3 times higher than the microhardness of the WC–Co–Cu hard alloy matrix obtained by sintering with copper impregnation.

The research results can be used in the development of technology for the manufacture of wear-resistant matrices of diamond tools of a wide class used in the processing of materials with a high level of hardness.

Keywords: diamond, matrix, iron-carbon alloys, eutectic melting, microstructure, graphitization, diamond retention

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ALLOY BASED ON THE Al–Mg SYSTEM FOR DEVELOPING A TARGET FOR MAGNETRON THIN FILMS SPUTTERING

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Abstract—The article presents research results on the development of a precision alloy of the Al–Mg–Ce–La–Y system for obtaining thin films by magnetron sputtering. Thin films are used to create electronic components on their basis.

Keywords: lanthanides, target, magnetron sputtering, plasma panel, cathode

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DEVELOPMENT OF AN ALLOY IN THE TELLURIUM – COPPER – CERIUM SYSTEM FOR MANUFACTURING FUNCTIONAL COATINGS FOR PHOTOCATHODES OF PHOTOELECTRONIC DEVICES

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Abstract—This paper presents the results on the development of an alloy in the tellurium – copper – cerium system used for the manufacture of functional coatings using the technologies of supersonic cold gas-dynamic spraying. Coatings from the specified alloy are used for the manufacture of photocathodes of photoelectronic devices operating in the UV spectral region.

Keywords: mechanosynthesis, disintegrator treatment, functional coating, photocathode, photoelectronic device

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DEVELOPING GLASS COMPOSITION FOR GLASS COATED In AND Sn CAST MICROWIRES

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Abstract—The paper presents the results of research and development of glasses for insulation of cast microwires of the PbO – SiO_2 – Na_2O – InO_2 – SnO_2 system. The optimal composition has been determined, which makes it possible to establish a stable process of casting microwires from indium and tin with a length of more than 1000 meters. It is shown that from such microwires it is possible that small base fusible fuses with a high melting current density could be manufactured.

Keywords: glass-coated cast microwire, small base fuses, melting current density

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STUDY OF PHASE TRANSFORMATIONS IN THE SYNTHESIS OF CATALYTIC COATINGS ON METAL CARRIER

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Abstract—The article presents the results of a study of the catalytically active system Ni–Al–$Al(OH)_3$–$Ca(OH)_2$–$Mg(OH)_2$ for efficient synthesis gas production. A technology for obtaining volumetric porous functional coatings has been developed using the method of supersonic cold gas-dynamic spraying. The advantages of this method and its possibilities from the point of view of producing synthesis gas with high activation energy are shown.

Keywords: catalyst, synthesis gas, reforming, activation energy, hydroxides, phase transformations, diffraction spectrum, specific surface area

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EFFECT OF Al_2O_3 NANOFIBERS ON COMPACTION, PHASE COMPOSITION, AND MECHANICAL PROPERTIES OF ZrO_2-BASED COMPOSITES OBTAINED BY VACUUM PRESSURELESS SINTERING

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Abstract—This work studies the effect of the relative content of Al_2O_3 nanofibers on the compaction, phase composition, and physicomechanical properties of composites based on ZrO_2 obtained by free vacuum sintering. It was found that in the process of manufacturing composites, nanofibers are sintered into Al_2O_3 grains of complex, elongated shape, which form a solid, frame-reinforcing structure. The relative density of composites with 5 wt. % and 10 wt. % of nanofibers, decreases up to 95%. It is shown that in all sintered samples the tetragonal modification of ZrO_2 acts as the main phase, and the different content of nanofibers affects the amount of cubic and monoclinic modifications of ZrO_2. It was found that addition of 5 wt. % and 10 wt. % of Al_2O_3 nanofibers increases the microhardness of the composite by 11% and crack resistance by 46%.

Keywords: composite, ceramics, zirconium dioxide, Al_2O_3 nanofibers, microstructure, phase composition, mechanical properties

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INFLUENCE OF CLIMATIC FACTORS ON THE PROPERTIES OF BALLISTICALLY RESISTANT ORGANOPLASTICS

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Abstract—Ballistic-resistant organoplastics made from layers of aramid fabric, adhesively bonded by a binder film, exhibit an increased tendency to absorb moisture, water and technical fluids in comparison with organoplastics monolithic structures. The absorption of liquids is anisotropic and manifests itself most intensively through the butt ends of the samples. The use of protective paintwork ensures stability of the characteristics of ballistic-resistant materials when exposed to environmental factors (environment, water, fuel, oil, natural climatic conditions).

Keywords: organoplastics, moisture absorption, climatic impact, environmental factor

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INFLUENCE OF THE INITIAL ROUGHNESS OF THE ANTIFRICTION CARBONS SURFACE ON TRIBOTECHNICAL CHARACTERISTICS AND RUNNING-IN COATING EFFICIENCY

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Abstract—The roughness of the friction surface of antifriction carbons used in sliding friction units lubricated with water affects the tribotechnical characteristics during the running-in process. This article experimentally substantiates the range of optimal surface roughness formed during mechanical cutting of carbon plastics in terms of tribotechnical efficiency. The results of a series of tribotechnical tests using various methods under various conditions (contact pressure, sliding speed, counterbody materials) are presented. The relationship between the initial roughness and the effectiveness of a running-in coating based on FORUM® poly-tetrafluoroethylene powder is established.

Keywords: antifriction carbon plastics, friction and wear, sliding, running-in, roughness

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RESEARCH AND ANALYSIS OF METHODS FOR PREVENTING SILVER ALLOYS FROM TARNISHING

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Abstract—This paper examines factors causing the darkening of items made of silver alloys in showcases and storehouses of museums, the authors analyze methods to prevent this undesirable process. The results of studies of different methods for preventing tarnishing of silver alloys are also presented.

Keywords: silver, tarnishing of silver, corrosion of silver, cultural heritage

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FEM ASSESSMENT OF THE LOCAL SIDE COMPRESSION TECHNIQUE EFFICIENCY AS APPLICABLE FOR NOTCHED PRISMATIC SPECIMENS

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Abstract—A crack front straightness is one of the test result validity criteria for fatigue precracked static fracture toughness specimens. Actually, the ideally straight crack front cannot be reached due to the presence of residual stress. This is particularly actual for specimens cut out of welded joints containing the residual welding stress (RWS). One of the techniques allowing to lower the RWS effect is a local side compression of specimens. Its efficiency has been proved in physical testing however no quantitative assessments are known in the literature. This work comprises FEM simulation of welding, sampling and side compression processes. The effect of local compression on base metal containing no residual stress is also investigated.

It has been found that in the course of local side compression the initial residual stress field caused by welding and specimen making is replaced by another field showing stress gradients more favourable for getting the fatigue crack shape meeting the validity criteria of test results as per approved test methods. The calculation results show that the complete removal of residual stress as in base metal as in welded specimens is not feasible in the range of actual practicable degrees of compression.

Keywords: fracture mechanics, welded fracture toughness specimens, crack front straightness, local side compression

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STUDY OF NOZZLES' METAL OF VVER-440 PRESSURE VESSEL AFTER 45 YEARS OF EXPLOITATION

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Abstract—The paper presents the research results on determining the mechanical characteristics of the metal samples cut out from the nozzles and the cylindrical shell at the nozzles zone of the VVER-440 reactor vessel after 45 years of operation.

Keywords: shell of the nozzle zone, critical brittleness temperature, yield strength, ultimate strength, RPV material.

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