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CONTENTS

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ABSTRACTS OF PUBLISHED ARTICLES

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INFLUENCE OF MEDIUM-TEMPERATURE ADDITIONAL TEMPERING ON THE DEPTH OF NITRATED LAYER OF THE SPARE PARTS MANUFACTURED OF 38Kh3M1F1A STEEL

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Abstract—The paper proposes technology for increasing the depth of the nitrated layer of bainitic-martensitic steel. It is shown that the introduction of medium-temperature additional tempering into the technology of nitriding after thermal improvement makes it possible to increase the depth of the nitrated layer of spare parts made of 38X3M1F1A steel without changing its mechanical properties.

Keywords: bainitic-martensitic steel, nitriding, increase of the depth of the nitrated layer, medium temperature, additional tempering, mechanical properties

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INVESTIGATION AND DEVELOPMENT OF LOW-CARBON STEEL WITH DESIGNED STRUCTURE AND PROPERTIES FOR AUTOMOBILE STATORS IMPROVING ITS OUTPUT CHARACTERISTICS

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Abstract—The analysis of the properties of the cold-rolled tape made of steel 08kp-OM intended for the manufacture of stator plates was carried out and it was established that the reasons for the relatively low magnetic and electric current speed characteristics for automobile generators are the non-uniform structure of steel (ferrite grain size equals to 6–9 points) and relatively low ductility (not more than 23%). In order to increase the magnetic characteristics of the stator and the output characteristics of domestic generators low-carbon steel 035Yu with a specified structure (the grain size of ferrite 7–8 points) and increased ductility (35–41%) was developed to replace 08kp-OM steel. The steel 035Yu applied in stators assembling by the “on the rib” method made it possible to raise the magnetic and output characteristics of generators 94.3701 and its modifications to the level of KC generators Bosch.

Keywords: stator, generator, low-carbon steel, ferrite grain size, cold-rolled tape, magnetic properties

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PHASE SEPARATION CAUSED BY ACCELERATED AGING IN STRONGLY TEXTURED STRIP OF Ti – 33Nb (at. %) ALLOY DUE TO ACCELERATED AGING

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Abstract—Key physical properties of superconducting titanium-niobium alloys as regards its practical use such as current density and elastic moduli are determined by its phase composition and microstructure. In this paper we present the study of phase separation in a thin highly textured cold-rolled tape of superconducting Ti–33Nb (at%) alloy subjected to accelerated aging for 25 hours at 385°C. It is found that heat treatment leads to the precipitation of strongly textured microparticles of nonsuperconducting α-phase with a hexagonal close-packed structure (hcp) in the initial superconducting β-phase with a body-centered cubic structure (bcc). It is established that α-phase inherits the crystallographic texture of the initial β-phase in accordance with Burgers model for the martensitic transformation bcc → hcp. Based on the generalization of the experimental data, it was concluded that heat treatment of Ti–33Nb (at%) tape increases the content of α-phase in it since less than 1% to 6% by volume.

Keywords: titanium-niobium alloy, crystallographic texture, phase separation, phase transition, heat treatment, texture inheritance

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PARTICULAR THERMAL EFFECTS FEATURES OF COATINGS FABRICATED BY COLD GAS DYNAMIC SPRAYING UNDER THERMAL LOAD

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The paper presents research results of coatings made of powder mixtures on the basis of Al, Ni and Ti fabricated by cold gas dynamic spraying. The coatings were investigated by differential scanning calorimetry of thermal processes under thermal loading at temperatures from 20 to 1100°C.

Key words: coatings, powder mixtures, cold gas dynamic spraying, thermal load, differential scanning calorimetry.

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CAST MICROWIRE WITH HIGH VALUE OF THERMOELECTROMOTIVE FORCE

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Abstract—The paper considers specific features of the process of microwires casting by high-speed melt quenching. The conditions for selecting a metal–glass pair are determined to achieve the required technological and mechanical properties of microwires. The alloy of the Cu–Zr–Si–B system is investigated and its optimal composition is determined, it seems promising for casting microwires with high thermoelectromotive force (thermo e.m.f.) using standard technology. The thermoelectric power of the obtained microwires is more than 40 $\mu V \cdot K^{-1}$, showing great promise for microthermocouples manufacturing.

Keywords: cast microwire, thermoelectromotive force (thermo e.m.f.), alloy composition, casting technology

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HARDNESS AND WEAR-RESISTANCE OF ELECTRON BEAM COATINGS SURFACED WITH TITANIUM CARBIDE – TITANIUM MATRIX SYNTHESIZED COMPOSITE POWDERS

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Abstract—Electron-beam surfacing of titanium – titanium-carbide composite powders with different contents of titanium binder was used to produce coatings thick up to 3–5 mm on VT1-0 titanium substrates. Deposited coatings structure was studied. Partial or complete dissolution of the carbide phase of the initial composite powders in the melt pool was detected. So coatings' structure contains both the initial and recrystallized carbide particles. Hardness and abrasive wear resistance of the coatings were tested, as well as fracture toughness of the carbide particles. Microhardness dependence profiles for transition zone "coating-substrate" were constructed. It was established that hardness increases maximum 3.7 times in comparison with VT1-0 alloy, and wear resistance 21.6 times. Hardness increases 2.2 times and wear resistance 13.8 times compared with VT6 alloy. The obtained results could be of use to the technologies of wear-resistant coatings production when surfacing the most important parts made of titanium and its alloys.

Keywords: self-propagating high-temperature synthesis, metal-matrix composites, titanium carbide, titanium, surfacing, dissolution in the melt pool, microstructure, hardness, abrasive wear resistance, wear mechanism, fracture toughness

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ION EXCHANGE METHOD FOR PRODUCING ALUMINUM HYDROXIDE PARTICLES OF MICRON SIZE

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Abstract—Micron-sized aluminum hydroxide particles were obtained by ion exchange. This method provides dispersion and crystallization of the gel under the influence of ion exchange resins after their mixing with air, and also changes in its microstructure. In this case, the modification, dispersion and cleansing of the gel are carried out in one operation. As a result, ultrafine (1 μm) particles of ultrapure (98.5%) aluminum hydroxide were produced. The particles characteristics were obtained by scanning electron microscope, IR-spectroscopy, X-ray fluorescence analysis, etc.

Key words: micron particles, aluminum hydroxide, gel, ion-exchange method.

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INFLUENCE OF THE MICROWAVE ELECTROMAGNETIC FIELD ON THE MICROSTRUCTURE OF PRODUCTS DESIGNED BY THREE-DIMENSIONAL PRINTING FROM NON-METALLIC COMPOSITE MATERIALS

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Abstract—Additive technologies are one of the promising directions of digital multiproduct manufacturing. At the same time, these products, especially nonmetallic materials, are characterized by significant anisotropy of physical and mechanical properties and a low level of strength in a complex deformed state and under conditions of dynamic alternating loads, especially when bending. The authors study changes in the microstructure and macrogeometry of objects formed by three-dimensional printing, after exposure to microwave electromagnetic field of varying power. The technologies of 3DP powder manufacturing and fused deposition modeling (FDM) using the polymer thread have been considered. The microwave field with an average specific power of 2,450 MHz enhances the density and homogeneity of the structure of powder and polymer materials, the pore size reduces by 24% and its dispersion by almost 30%. The ABS thermoplastic samples' diameter reduces and geometric accuracy in the cross section increases significantly in comparison with the control samples. The paper investigates microstructure confirming that microwave electromagnetic field increases the strength of the binder in products obtained by 3DP and the strength of the main polymer material in products obtained by FDM.

Keywords: additive technologies, powder composite materials, polymer thread, interlayer interaction, microwave electromagnetic field, specific power, exposure time, microstructure, pores, geometric shape

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POLYMER COMPOSITES FOR CIVIL ENGINEERING FABRICATED BY PULTRUSION PROCESS

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Abstract—The paper reviews the use of various substances reducing the flammability of polymer materials. The results of studies on the development and optimization of pultrusion process conditions are presented. Electrical, thermal and physical-mechanical characteristics of samples of fiberglass are investigated. A review of the method of machining such as cutting metric thread on a fiberglass rod is given.

Keywords: pultrusion, polymer composites, epoxy resins, glass mat, fiberglass, fire safety, mechanical processing, carving, electrically insulating screed

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DEVELOPMENT OF TRIBOTECHNICAL MATERIALS BASED ON POLYTETRAFLUOROETHYLENE AND UVIS-AK-P CARBON FIBERS

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Abstract—The paper studies the development of tribotechnical materials on the basis of polytetrafluoroethylene and carbon fibers proposing polymer materials of new compositions and its production technology. New composites can be used for structural products, due to the high level of its mechanical properties.

Key words: polytetrafluoroethylene, carbon fiber, wear resistance, mechanical activation, friction.

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HEAT RESISTANT ELECTRIC INSULATION GLASS FIBER PLASTICS FOR SHIPBUILDING

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Abstract—Heat resistance of glass fiber plastics depends mostly on heat resistance of polymer matrix (binder) and technological modes of production. Increasing of heat resistance and strength of electric insulation makes it possible to improve electric machines features and prolong their working life. Hot pressing technology was developed and glass fiber plastic articles for ship electric insulation parts of ship moving complex (main and servicing diesel generators, turbo-generators, electric motors) were manufactured. Exploitation modes were settled for electric insulation from different types of binders and reinforcing materials based on alkali-free, quartz, siliceous high modulus and high strength glass fibers.

Keywords: glass fiber electric insulation plastics, heat resistant binders, reinforcing glass fibers, dielectrical properties

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EPOXYVINYLESTER BINDER FOR FIRE RESISTANT MARINE FIBERGLASS PLASTICS

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Abstract—Article deals with the problem of fire resistance for resins used in shipbuilding; the results of researching incombustible phosphorous epoxyvinylester resin VE-PHAS and vinylester binder are given. In addition, the properties of resin in accordance of curing system content, mechanical properties of fiberglass based on VE-PHAS and firesafety are presented.

Keywords: polymeric composition material, fiberglass, epoxyvinylester resin, binder, phosphorousacrilate, fire-retardant additive.

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IMPROVING SERVICE PROPERTIES OF WELDED JOINTS FOR TRANSPORT NUCLEAR POWER UNITS MADE OF HEAT-RESISTANT STEELS. Part 1. Technology of heat-resistant steels welding by carbon materials without thermal treatment and application of welding materials

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Abstract—The paper describes new technology of joints welding during power vessel manufacturing for nuclear icebreakers from heat-resistant 15Kh2MFA steels by reinforced low-carbon hardening. The metal of the reinforced low-carbon surfacing is often softened by repeated technological releases, to which the assembly units of equipment are subjected. This reliable technology is a safe way to ensure the operation of equipment for nuclear icebreakers reactors when heat treatment of welded joints is not possible.

Keywords: icebreaker’s nuclear power plants, assembly welds, reinforced low-carbon hardening surfacing

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IMPROVING SERVICE PROPERTIES OF WELDED JOINTS FOR TRANSPORT NUCLEAR POWER UNITS MADE OF HEAT-RESISTANT STEELS. Part 2. Investigation of mechanical properties of metal reinforced low-carbon surfacing depending on technological welding parameters

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Abstract—The paper investigates effect of welding modes, temperature, technological tempering, and welding flux type on the strength properties of weld metal as applied to reinforced low-carbon surfacing nuclear power units' equipment designated for transport.

Keywords: transport nuclear power units, reinforced low-carbon hardening, technological parameters of welding, welded metal, mechanical properties

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IMPROVING SERVICE PROPERTIES OF WELDED JOINTS FOR TRANSPORT NUCLEAR POWER UNITS MADE OF HEAT-RESISTANT STEELS. Part 3. Influence of alloying elements on the surfacing metal characteristics as regards the assembly welds of power plants equipment for nuclear icebreakers

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Abstract—The authors investigate influence of alloying elements of the weld metal on its characteristics regarding the performance of reinforced low-carbon surfacing and assembly welds of nuclear power plants for icebreakers. In order to increase the level of service characteristics, especially the resistance against brittle fracture of the weld metal of nuclear power units made of 15Kh2MFA steels; agglomerated flux 48AF-71 has been developed and certified instead of AN-42M fused flux. It seems rational to use a single flux grade for welding of shells, bottoms and flanges of transport nuclear power units, and for performing reinforced low-carbon surfacing. When welding is processed in combination with low-activity agglomerated flux, silicon and manganese are not reduced to the weld metal, as is takes place under fused fluxes. Therefore, it is necessary to use a welding wire containing alloying elements that ensures the formation of the necessary structure and mechanical properties of the weld metal.

Keywords: transport nuclear power units, reinforced low-carbon hardening, agglomerated flux, alloying elements, welded metal, mechanical properties

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ELECTROCHEMICAL CHARACTERISTICS OF PROTECTIVE ALLOYS IN SEA WATER AND OTHER AGGRESSIVE ENVIRONMENTS CONTAINING HYDROGEN SULFIDE

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Abstract—The paper studies electrochemical characteristics of aluminum, magnesium and zinc protective alloys (protective potential, current output, useful ratio) in sea water and other corrosive environments containing hydrogen sulfide. The electrochemical characteristics of aluminum protective alloys depend to a lesser extent on the chemical composition of the working environment, the presence of hydrogen sulfide than those of zinc alloys. Hydrogen sulfide, even at low concentrations (10%), significantly reducesthe effectiveness of zinc alloys properties (by 40% or more).

Keywords: aluminum and zinc protective alloys, electrochemical characteristics, corrosive environments, chemical composition, hydrogen sulfide

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ON THE ESTIMATED PERFORMANCE OF AVIATION MATERIALS CONSIDERING THE IMPACT OF CORROSION ENVIRONMENT

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Abstract—The article describes strength estimated values for aviation materials considering limit state materials in the structure. Solid body is presented in two states – monolithic solid body and solid body with a crack. Matrix of limit state materials is proposed, that allows identifying areas of research to evaluate strength estimated values under external factors impact, in particular, when exposed to the corrosive environment.

Keywords: limit state materials, strength estimated values, evaluation, corrosive environment

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EVOLUTION OF METAL MICROSTRUCTURE OF THE MAIN CIRCULATION PIPELINE OF THE WWER-1000 REACTOR AT LONG-TERM OPERATION

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Abstract—The paper presents results of the investigation of the metal of the main circulation pipeline of the WWER-1000 reactor after operation at the South Ukraine NPP during 200 thousand hours. Structure changes of the 10GN2MFA steel with signs of metal aging were revealed by metallography, scanning electron microscopy, micro-X-ray spectral analysis. It is also shown that in the problem of extending the life of the pipeline, it is promising to use the technique of small-scale cuttings to determine the properties of the metal by direct methods without violating the integrity and strength of the structure.

Keywords: main circulation pipeline, operational life-time, 10GN2MFA steel, properties, structure, aging of metals

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INVESTIGATION OF STRESS CORROSION CRACKING MECHANISMS TYPICAL FOR WWER INTERNALS STEEL BY TESTING OF MODELED MATERIAL

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Abstract—Different hypotheses of irradiation assisted stress corrosion cracking for internals materials in the light water reactor environment have been analyzed. Irradiation-induced grain-boundary chromium depletion, localized deformation, material hardening were considered. Heat treatment and cold working of 18Cr–10Ni–Ti steel were made to simulate the influence of neutron irradiation. Autoclave tests in the light water reactor environment at a temperature 290°C and at a strain rate of $3 \cdot 10^{-7}$ s^{-1} were carried out. 18Cr–10Ni–Ti steel specimens in the initial state, after heat treatment and after heat treatment followed by cold working were used. Fracture surfaces and lateral surfaces of specimens were examined by scanning electron microscopy. The microstructure of the material was also examined using transmission electron microscopy. It was shown that the grain-boundary chromium depletion and the material hardening are not the main causes of corrosion cracking of 18Cr–10Ni–Ti steel in the primary coolant deoxygenated environment. The localization of deformation has a profound effect on corrosion cracking in the absence of the grain boundary sliding. The conditions determining the crack propagation by the corrosion cracking mechanism are defined.

Keywords: stress corrosion cracking, WWER internals, 18Cr–10Ni–Ti steel, autoclave tests, testing of modeled material

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MATHEMATICAL MODELING OF STRESS-STRAIN STATE IN TITANIUM ALLOYS CONSIDERING THE MICROSTRUCTURE AND CRYSTAL ORIENTATION MEASURED BY EBSD ANALYSIS

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Abstract—Virtual structures of titanium alloys fragments are created by EBSD analysis based on microstructural research and local crystal orientations. Uniaxial deformations are calculated by finite element method considering crystallographic characteristics, anisotropic elastic moduli and crystallographic slidings. Schmid factor mapping is carried out for structure fragments. Influence of the measured orientations on intensity of theoretical pressure and deformations in the loaded elements of polycrystalline material is considered.

Keywords: titanium alloys, crystal plasticity, EBSD-analysis, finite element method, microstructural analysis.

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