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DEPENDENCE OF THE MICROSTRUCTURE AND MECHANICAL PROPERTIES OF COLD-RESISTANT STEEL SHEETS WITH A GUARANTEED YIELD STRENGTH OF 420 MPa ON THE THERMOMECHANICAL PROCESSING

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Abstract—For the production of sheets with a thickness of 5 and 15 mm from cold-resistant steel with a guaranteed yield strength of 420 MPa, continuous rolling was developed and tested in laboratory conditions. The present study considers the influence of the parameters of thermal deformation treatment (temperature of the end of rolling and cooling rate) on the formation of the final microstructure. The mechanical properties of the sheets were analyzed taking into account the formed structural features. Technological recommendations for hot rolling of low-carbon low-alloy steel sheets with a guaranteed yield strength of 420 MPa are proposed.

Keywords: cold-resistant steel, rolled sheets, continuous rolling, thermal deformation treatment, microstructure, mechanical properties

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EFFECTS OF HOMOGENIZING ANNEALING ON THE REDUCTION OF CRACK FORMATION IN FORGINGS OF STEEL GRADE 08Kh18N10T

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Abstract—Experimental data on crack formation of forgings made of austenitic steel grade 08Kh18N10T are presented. It has been established that the process of crack formation is determined by the process of homogenizing annealing, which is carried out during heating of ingots and forgings before the first and second removals. The development of a technology for forging large ingots made of austenitic steel grade 08Kh18N10T, taking into account these results, leads to an increase in the quality of forging and makes it possible to achieve forging without cracking.

Keywords: austenitic steel, forging technology, homogenizing annealing, crack formation

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STUDY OF THE COMPOSITION AND PROPERTIES OF THE INTERMETALLIC LAYER OF Al–Ti AND Ni–Ti OBTAINED ON A TITANIUM ALLOY FOR LASER PROCESSING

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Abstract—The results of a study of intermetallic coatings of the Al–Ti and Ni–Ti systems obtained using the method of cold gas-dynamic spraying on a titanium alloy substrate and laser processing are presented. The precursor coating was obtained by cold spray deposition of aluminum and nickel and then it was processed by a laser. The change in the composition and properties of the coating under different laser processing modes is shown. The structure and microhardness of the coating are investigated, and the results of X-ray phase analysis are presented.

Keywords: cold gas-dynamic spraying, precursor coating, laser processing, intermetallic compound, titanium alloy

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STRENGTHENING OF A Ni–W COATING BY LASER PROCESSING

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Abstract—Calorimetric studies show that the nanocrystalline coating Ni–37 wt. %W produced by electrodeposition does not undergo phase transformations up to a temperature of 1000°C. Laser processing affects the properties of coatings, and in the selected mode leads to a significant grain growth in the coating, without affecting its chemical composition. At a certain energy input, a notable increase in the microhardness of the coating was revealed.

Keywords: Ni–W coating, laser processing, electrodeposition, calorimetric studies, microhardness

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EXPERIMENTAL AND THEORETICAL INVESTIGATION OF THE FORMATION OF THE SURFACE LAYER HIGHLY ALLOYED WITH ALUMINUM

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Abstract—Laser surface treatment is a complex process in which, under the influence of a laser, the surface of material melts, while changing its structure and properties. In this paper, we consider the simulation of the process and present the results of studying the influence of laser processing parameters on the dimensions of the melt pool. The main purpose of the study is to reveal the dependence of the depth of the melt pool, namely the thickness of the layer in which the mixing process of the components takes place, on the laser parameters. As a result of the study, it was found that after laser treatment of the surface of samples with a coating thickness of 20, 40 and 80 μm at a beam speed of 100 mm/s and power of 180 W, the coating material is completely mixed with the substrate. It is also shown that with the laser travel speed 400 and 800 mm/s and the power 180 W, there is no mixing of the components in the impact zone, since the energy input is not enough.

Keywords: laser surface treatment, thermal modeling, finite element method, aluminum, melt pool, gas dynamic spraying

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RESULTS OF STUDYING THE PROFILE OF SINGLE TRACKS OF COATINGS PRODUCED FROM ALUMINUM AND NICKEL-BASED POWDERS

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Abstract—The profiles of individual tracks were experimentally studied considering the powder flow rate, nozzle speed and temperature when creating a coating from a monometallic aluminum powder, a mixture of two monometallic powders of the aluminum-nickel and nickel-titanium systems, as well as composite powder from a mixture of monometallic powder of aluminum and corundum. Aluminum and nickel powders were chosen as the investigated ones, since they are the basis for most functional coatings. The dependence of the track profile on the scanning speed is established, the step between the tracks is determined, which ensures uniform coverage.

Keywords: cold gas-dynamic spraying, powder metallurgy, track profile, nozzle movement speed

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COHESIVE STRENGTH OF CATALYTIC COMPOSITE COATINGS OF THE Ni–Al–Al_2O_3 SYSTEM ON A METAL SUBSTRATE

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Abstract—Porous composite coatings based on the Ni–Al–Al_2O_3 system on a metal substrate were obtained by the method of cold gas-dynamic spraying and subsequent annealing. The maximum content of aluminum hydroxide $Al(OH)_3$ is 70% in the initial powder mixture, at which a high-quality coating is formed. The dependences of the influence of the composition of metal and ceramic components on the cohesion of coatings under ultrasonic treatment are obtained.

Keywords: cold gas-dynamic spraying, catalytic carrier, porous coating, aluminum hydroxide, ultrasonic treatment, cohesion, mass loss

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PHYSICAL AND MECHANICAL PROPERTIES OF COMPOSITES LOW DENSITY POLYETHYLENE/POLYBUTYLENE TEREPHTHALATE/ COMPATIBILIZER

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Abstract—Polymer composites based on low-density polyethylene and polybutylene terephthalate have been obtained. It has been established that the use of a compatibilizer makes it possible to improve the compatibility of initial thermodynamically incompatible polymers. It is shown that polymer composites containing a compati-bilizer are superior in their physical and mechanical characteristics to the original polymers and mixtures based on them.

Keywords: composites, low density polyethylene, polybutylene terephthalate, compatibilizer, physical and mechanical properties

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NFLUENCE OF THERMAL MOISTURE IMPACT ON THE STRUCTURE AND PROPERTIES OF POLYIMIDE CARBON FIBER

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Abstract—The article studies influence of laboratory-simulated external influencing operational factors – water and moisture saturation, combined effect of elevated temperature and humidity, exposure in a tropical climate chamber on the properties of high-temperature carbon fiber based on a melted thermosetting polyimide binder. Studies of the structure, glass transition temperature and elastic-strength characteristics of carbon fiber after exposure were carried out, the change in the mass of carbon fiber samples during long-term exposure to water and moisture was estimated.

Keywords: polymer composite materials, high temperature carbon fiber reinforced plastics, polyimide binders, thermal and moisture effects, structure, properties

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WELDING OF ULTRA-HIGH MOLECULAR WEIGHT POLYETHYLENE AND ITS COMPOSITE TO INCREASE THE SEALING OF LINING COATINGS

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Abstract—This article proposes the use of magnetic induction for ultra-high molecular weight polyethylene (UHMWPE) welding. The conducted mechanical and structural studies confirm the high efficiency of the method of welding ultra-high molecular weight polyethylene and its composite using magnetic induction with a ferromagnet in the form of a steel mesh. The chosen optimal welding mode allows obtaining a high-quality weld. It has been established that the preservation of the strength properties of the weld at the selected welding mode at the bulk level of UHMWPE is due to the controlled local heating of the material in the welding zone and increased adhesion at the UHMWPE-metal mesh interface.

Keywords: ultra-high molecular weight polyethylene, lining, welding, ferromagnet, steel mesh, electromagnetic induction, weld strength, supramolecular structure, adhesion

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STUDY OF THE STRUCTURE AND PROPERTIES OF THE METAL OF REACTOR PRESSURE VESSEL WELDED JOINTS MADE OF Cr–Mo–V STEEL IN THE PROCESS OF MANUFACTURE AND OPERATION

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Abstract—The paper presents a study of changes in the structure and mechanical properties of the metal of the welded joints of steel 15Cr2MoVA-A mod. A during post weld heat treatment (PWHT) at the reactor pressure vessel (RPV) manufacturing and also as a result of thermal exposure during its operation. It has been established that in as-welded state, the weld metal has a satisfactory level of plastic characteristics and high values of impact strength, but an excessively high level of strength properties. PWHT at 655°C reduces the strength properties, but does not lead to a significant increase of impact strength level. The final properties are formed by PWHT at 670°C. At the indicated temperatures, the low sensitivity of the heat affected zone (HAZ) metal and the base metal to tempering as well as to thermal exposure at 350°C, has been revealed.

Keywords: weld metal, heat affected zone, structure, post weld heat treatment, embrittlement, reactor pressure vessel, impact strength, hardness

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INFLUENCE OF MACROSTRUCTURE AND PHASE COMPOSITION ON PERFORMANCE CHARACTERISTICS OF WELDED JOINTS OF WWER TYPE REACTOR VESSELS

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Abstract—The influence of the grain structure and phase composition of welded seams of WWER-type reactors on their operational characteristics in the initial state is analyzed. Comprehensive studies of welds with various structures formed as a result of welding using various technologies have been carried out. It is shown that differences in the phase composition and morphology of the grain structure of the weld metal in the initial state, which is characterized by an increased proportion of columnar grains and a higher density of carbide phases, lead to an increase in the yield strength and critical brittleness temperature of welded joints.

Keywords: reactor vessel, weld metal, grain structure, phase composition, critical brittleness temperature, yield point

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ON THE FATIGUE STRENGTH CALCULATION OF THE WELDED SHELL STRUCTURES FROM HIGH-STRENGTH STEELS UNDER LOW-CYCLE LOADING. Part 2: Development of the assessment methodology

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Abstract—The first part of this work substantiates the procedure for estimating the number of cycles before the appearance of a detectable fatigue crack in weld joints (stress concentrators) which are the usual places of crack occurrence in the absence of major technological defects. It is based on a physical model of the initial stage of fatigue failure, generalized data on the fatigue failure resistance of high-strength steels and their welded joints and FEM calculations. It is reduced to interpolation formulas summarizing the results of numerical modeling. This (second) part of the study presents information necessary to perform practical assessment of fatigue strength in the field of low-cycle loading, including the choice of reserve coefficients when calculating the resource of welded structures. The results of the assessments are compared with the data obtained during fatigue tests of welded joints of large thicknesses performed by multi-pass welding.

Keywords: high-strength steels, welded shell structures, low-cycle loading, fatigue strength, estimation

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PROFILE EVALUATION OF THE ION IRRADIATION-INDUCED SWELLING IN AUSTENITIC STAINLESS STEEL WITH VARYING NICKEL CONTENT

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Abstract—Comparative studies of porosity and calculation of the swelling profile in samples of austenitic stainless steel with a nickel content of 10 and 20 wt.%. The samples were irradiated at the Tandem-3M accelerator to the same doses of 300 dpa with Ni ions with an ion energy of 11.5 MeV at a temperature of 550°C with preliminary implantation of He. To calculate the swelling profile, digitally processed images were obtained by scanning transmission electron microscopy (STEM). In addition, comparative studies of the phase composition and radiation-induced segregations at grain boundaries, pore/matrix interfacial boundaries, and on the surface of phase precipitates were carried out on irradiated samples with varying nickel contents.

Keywords: austenitic stainless steel, ion irradiation, porosity, swelling, phase composition, radiation-induced segregations, scanning electron microscopy, transmission electron microscopy

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FRACTURE PROPERTIES AND MECHANISMS FOR IRRADIATED AUSTENITIC STEELS OVER HIGH TEMPERATURE RANGE AND FORMULATION OF FRACTURE CRITERION. Part 1. Experimental results

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Abstract—The experimental study results of the fracture properties and mechanisms are represented over temperature range from 200 up to 600°C for austenitic 304 steel (18Cr–9Ni steel) in the following conditions: (1) after neutron irradiation at temperature of 400°C up to damage dose of 30 dpa; (2) after neutron irradiation and subsequent aging at 550°C for 3000 hours. The fracture properties and mechanisms are determined under uniaxial tension of standard smooth cylindrical specimens and notched cylindrical specimens, i.e. for various stress triaxialities. Sharp decrease in the fracture strain and transition to intergranular fracture are revealed over high temperature range for standard smooth cylindrical specimens. Over the same temperature range the fracture strain is larger for notched cylindrical specimens than for smooth cylindrical specimens, moreover a portion of intergranular fracture is also larger. This finding is rather abnormal as the fracture strain usually decreases when stress triaxiality and intergranular fracture portion increase. The obtained results are used for formulation of fracture criterion and elaboration of fracture model for high temperature radiation embrittlement that is considered in the second part of the paper.

Keywords: fracture mechanisms, fracture strain, neutron irradiation, high temperature radiation embrittlement, chromium-nickel steel.

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FRACTURE PROPERTIES AND MECHANISMS FOR IRRADIATED AUSTENITIC STEELS OVER HIGH TEMPERATURE RANGE AND FORMULATION OF FRACTURE CRITERION. Part 2. Fracture criterion and model

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Abstract—On the basis of experimental data considered in the first part of the paper the fracture criterion and fracture model are represented for high temperature radiation embrittlement of irradiated austenitic steels. The proposed model allows one to explain larger value of the fracture strain for notched cylindrical specimens as compared with smooth specimens as it has been found in the first part of the paper and also to predict fracture toughness over range of high temperature radiation embrittlement. The formulated criterion and model are verified by comparison of the calculated and experimental values of fracture toughness for 18Cr-9Ni steel irradiated up to damage dose of (24–30) dpa. Experimental values of fracture toughness are obtained from compact tension CT-0.5 specimens tested at 200°C and 600°C. The fracture toughness data for irradiated steel are represented also over temperature range from 20°C and 600°C.

Keywords: fracture criterion, high temperature radiation embrittlement, fracture toughness, chromium-nickel steel

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