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CONTENTS

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MODELING OF STEEL HARDENING PROCESS AT THERMAL AND MECHANICAL TREATMENT

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Abstract—The article deals with modeling of thermomechanical processing of high-strength steels at the Gleeble 3800 research complex, simulating thermomechanical processing with various temperature and deformation parameters of rolling and with accelerated cooling to a predetermined temperature. The identity of steel hardening processes at the Gleeble 3800 complex and specialized rolling mills, as well as the possibility of obtaining steels of unified chemical composition, are shown.

Keywords: thermomechanical processing, plastic deformation, nanostructuring, fragmentation, alloying, chemical composition unification.

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SCIENCE AND TECHNOLOGY BASICS OF COLD-RESISTANT STEEL WITH 315-750 MPa GUARANTEED YIELD STRENGTH LIMIT CREATION FOR ARCTIC. Part 2. Technology of production, structure and properties of sheet hire performance

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Abstract—On the basis of the conducted research, a complex of scientific and technological methods has been developed for various technological processes (thermomechanical processing with accelerated cooling, quenching from rolling and separate furnace heating with high-temperature tempering). The developed method provides the formation of the structure of acceptable heterogeneity and anisotropy according to different morphological and crystallographic parameters throughout the thickness of rolled products up to 100 mm from low alloy steels with a yield strength of at least 315–460 MPa and up to 60 mm from economically alloyed steels with a yield strength of at least 500–750 MPa.

The paper presents results of the industrial implementation of hot plastic deformation and heat treatment schemes for the production of cold rolled steel sheet with yield strength of at least 315–750 MPa for the Arctic. The structure of sheet metal thickness is given, providing guaranteed characteristics of strength, ductility, cold resistance, weldability and crack resistance.

Keywords: low alloy steel, economically alloyed steel, Arc index, thermomechanical processing, hardening, rolling heating, tempering, mechanical properties, cold resistance, serviceability, crack resistance, structure parameters, ferrite, bainite, martensite.

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BASIC PHYSICAL AND CHEMICAL CONCEPTS FOR CONTROLLING δ-FERRITE CONTENT WHEN WELDING WITH AUSTENITE-FERRITE MATERIALS

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Abstract—The paper shows the influence of steel chemical composition on δ-ferrite behavior throughout the entire range of temperature considering welding consumables. Materials for joints are manufactured of the 10Kh19N11M4F, currently used for welding high-strength low-alloy steels. This steel prospects for welding high-nitrogen corrosion-resistant steels saving their non-magnetism, including the zone of welded joint, were analyzed on the basis of these studies. Using thermodynamic modeling, critical parameters were found that determine the behavior of δ-ferrite during solidification and subsequent cooling of solid steel. The most important parameters are the depth of the σ-ferritic transformation and the maximum equilibrium temperature of austenitization, which were used to interpret the experimental data obtained during hot physical modeling of welding. The areas of promising compositions of materials for welding of low-alloyed high-strength and high-nitrogen corrosion-resistant steels without hot cracks and providing, if necessary, the non-magnetic seam were found and depicted on a fragment of an improved Scheffler – Speidel diagram.

Keywords: welding wire, high-strength low-carbon steel, high-nitrogen corrosion-resistant steel, δ-ferrite, σ-phase, crystallization, austenitization, thermodynamic modeling.

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RESEARCHING NITROGEN SOLUBILITY IN NITROGEN-CONTAINING AUSTENITIC STEELS AT MELTING AND RECRYSTALLIZATION BY CALPHAD METHOD

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Abstract—The CALPHAD method has been employed to compose thermodynamic description of the Fe–Cr–Mn–Ni–Si–C–N system. Using an algorithm based on finding a global minimum of Gibbs energy, the calculations of system phase composition were performed in the temperature range from 1750°C to hardening and in the range of compositions corresponding to 04Kh20N6G11M2AFB steel. Calculations showed that at temperatures above liquidus line, Cr and Mn increase nitrogen solubility in the melt, while Ni and Si reduce it. With an increase in the content of Cr, Mn, Ni, and Si in steel in the studied composition range, both liquidus and solidus temperature decrease. The degree of influence on these temperatures of Cr, Mn, Ni and Si within the steel grade is different and ranges from ~3 to ~14°C. Calculations taking into account the possibility of nitrogen transfer between steel and the atmosphere of air showed that the amount of fixed nitrogen in the alloy under study varies, depending on the composition of the steel and temperature, from ~0.3 to ~0.6 wt%. As the temperature decreases from liquidus to solidus, the amount of fixed nitrogen increases, with the exception of those steel compositions when ferrite and not austenite is released from the liquid phase.

Keywords: alloy of the system Fe–Cr–Mn–Ni–Si–C–N, thermodynamic modeling, liquidus, solidus, nitrogen solubility.

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TECHNOLOGY DEVELOPMENT AND MATERIAL SCIENCE SUBSTANTIATION OF COLD BENDING FOR SHIP HULLS PARTS OF HIGH-STRENGTH STEELS AND ALLOYS BY LOCAL DEFORMATION

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Abstract—At JSC “PO “Sevmash” a technology of cold bending for ship hull parts from high-strength steels and alloys has been developed by the method of local deformation. A material science substantiation of its implementation has been given. In addition to the practical positive side of parts manufacturing, the local deformation is cost-effective and can significantly reduce the cost of manufacturing parts.

Keywords: cold bending, local deformation, economic efficiency, high-strength steels.

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METALLOGRAPHIC ANALYSIS OF M2 HIGH SPEED STEEL GRANULES

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Abstract—The article is devoted to the metallographic analysis of the M2 high-speed steel granules. The study is based on the investigation of the microstructure of the M2 high-speed steel granules obtained by melt atomization. It is demonstrated that granules of similar size can harden both by chemically separating and chemically non-separating mechanism. These last ones have supersaturated solid solution structure of the liquid melt composition, a dispersed dendritic-cellular structure and an increased microhardness HV = 10267±201 MPa.

Keywords: high speed crystallization, powder metallurgy, molded structure

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STUDYING MECHANICAL CHARACTERISTICS OF FIBER-METAL LAMINATE BASED ON ALUMINUM SHEETS AND LAYERS OF CARBON FIBER REINFORCED PLASTICS

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Abstract—Results of tensile strength test of layered metal-polymer composite material on the basis of aluminum alloy sheets and layers of carbon fiber reinforced plastics were analyzed. The efficiency of complex anticorrosive protection from the influence of external factors was studied.

Keywords: carbon fiber, CFRP, aluminum alloys, fiber-metal laminates.

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RESEARCHING STRUCTIRE AND PROPERTIES OF METAL-POWDERED COMPOSITIONS MADE OF CORROSION-RESISTANT STEELS OBTAINED BY GAS ATOMIZATION OF ALLOY AND INTENDED FOR DETAIL PRODUCTION BY SELECTIVE LASER ALLOYING

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Abstract—Investigations of the microstructure and technological properties (such as flow ability, bulk density, tapped density etc.) of novel Fe–Cr–Ni, Fe–Cr–Ni–Mo and Fe–Cr–Ni–Co–Mo stainless steel metal powders were carried on. These powders are intended for use in additive manufacturing processes. Morphology of the powders was researched and the dendritic parameter was estimated for powder particles with various sizes (diameters). Dependence of gas impurities contamination on particles size was determined. Complex of these investigations allows confirming high quality of metal powders for additive manufacturing processes. In particular, minimal value of flow ability was determined as 14 sec while standard requirements for additive technologies are within 20 sec.

Keywords: metal powders, corrosion-resistant steels, melt atomization, additive manufacturing, selective laser fusion.

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EFFECT OF POWDERED LASER SURFACING MODES ON STRUCTURE AND PROPERTIES OF WEAR-RESISTANT COATING AND NEW MEDIUM CARBON STEEL WITH YIELD STRENGTH 1500 MPa

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Abstract—This paper studies coatings obtained by laser cladding of M2 powder material (Hoganas, Belgium) on a new B1500 medium-carbon steel. The analysis of defects (pores, cracks), microstructure, phase composition, microhardness of the deposited coatings depending on heat input of laser radiation was performed. The results of tests for wear resistance of coating samples, which allow selecting the optimal modes of laser deposition, are presented.

Keywords: powdered laser cladding, wear-resistant coatings, medium carbon steel

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STUDYING THE INFLUENCE OF HIGH-SPEED DISINTEGRATOR ACTIVATION ON THE PROPERTIES OF RADIOCONTRAST AGENTS

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Abstract—Under the initiative and direct scientific supervision of academician I.V. Gorynin, researchers of CRISM "Prometey" began to study effects of high-energy shock disintegrator technology for processing materials of various classes and different purposes. In particular, much attention was paid to the activation of biomaterials in supersonic action in the working zone of disintegrators. This article studies effects of high-energy activation on biological activity of pharmaceutical and medical products.

Keywords: high-speed disintegrator, high-energy activation of materials, biological activity, radiocontrast agent.

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TECHNOLOGY OF CASTING AND PROPERTIES OF NICKEL MICROWIRES

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Abstract—The article presents results of comprehensive studies on the development of technology for the production of thermoresistant cast microwires from nickel with addition of small quantities of chromium (0.2–0.6%). The specific characteristics of the casting process were studied from the standpoint of stability and achieving high values of temperature coefficient of resistance.

Keywords: thermal resistive element, cast microwire in glass insulation, temperature coefficient of resistance, interphase tension

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RESISTIVE ALLOYED MICROWIRES BASED ON Ni–Cu AND Pd–Cu SYSTEMS WITH ALTERNATING TEMPERATURE COEFFICIENT OF RESISTANCE

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Abstract—The article presents the results of comprehensive studies on the development of precision alloys for casting microwires with alternating temperature coefficient of resistance (TCR) based on Ni–Cu and Pd–Cu systems. The features of the appearance of negative TCR values in microwires are studied. The optimal compositions of the alloys of these systems, which ensure the steady flow of a specific casting process, have been experimentally determined. Recommendations on the practical application of the microwires are given.

Keywords: microwires, precision alloys, alternating temperature coefficient of resistance

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APPLYING NICKEL-COBALT DIFFUSION COATINGS FROM DUMP CONVERTER SLAG

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The application of stale and newly formed dump converter slags as raw materials for the creation of diffusion protective Nickel-Cobalt coatings is considered. The possibilities of chlorination of Nickel-containing phases, the chemical composition and diffusion parameters of the process are investigated.

Keywords: nickel, slag, diffusion Nickel-Cobalt coatings

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ON THE DEFECTS OF ENAMEL COATINGS

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Abstract—The defects destroy the integrity of the enamel, and the paper examines the influence of the physical-mechanical and corrosion properties of frits and heat treatment on the defectiveness of the enamel coating. The surface defects were scanned by electron microscope. It has been established that the defectiveness of enamel coatings depends on the melting index, temperature coefficient of linear expansion, surface tension of the frits, and heat treatment conditions. When burning rate of the enamel coating decreases, the fine-meshed structure of the enamel changes, and the size of the defects decreases.

Keywords: frits, enamel coatings, enameling defects, bubbling, physical and mechanical characteristics, heat treatment conditions.

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THERMAL CHARACTERISTICS AND PHYSICAL AND MECHANICAL PROPERTIES OF AROMATIC POLYAMIDINES AND MATERIALS BASED ON THEM

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Abstract—Aromatic polyamidines were synthesized by polycondensation of equimolecular amounts of bis-imidoyl chlorides with diamines in organic solvents. The obtained polymers are dissolved with organic solvents (N, N'-dimethylacetamide, N-methyl-2-pyrrolidone, etc.), and characterized by a large interval between the temperature of plastic deformation and heat resistance, that is a good possibility of processing polyamidine products with new industrial methods.

Keywords: polyamidines, heat resistance, heat resistance, solubility, physical and mechanical properties

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INVESTIGATION OF THE MECHANICAL PROPERTIES OF POLYMER MATRICES BASED ON ADHESIVE BINDERS

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Abstract—The paper considers methods for manufacturing polymer-matrix samples for the determination of mechanical properties outlining the basic approach to the development of modes for pouring and curing of polymer blocks. Samples were made of cured adhesive binders VSK-50, VSK-14-2m, VSK-14-2mR, VSK-14-2mRm, and tests were carried out to determine the following characteristics: tensile and flexural strength, elongation, tensile modulus when stretching and bending.

Keywords: thermosetting binders, adhesive binders, mechanical properties of polymer matrices, strength, tensile modulus, elongation, adhesive prepregs, PCM

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EFFECT OF LONG CLIMATIC AGING ON MICROSTRUCTURE AND FRACTURE FEATURES OF EPOXY CARBON-FIBER-REINFORCED PLASTICS UNDER BENDING AND COMPRESSION LOAD

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Abstract—The paper describes results of microstructural and fractographic research of fracture features for epoxy carbon-fiber-reinforced plastics under static bend and compression load after long (till 5 years) climatic aging in different climatic zones of Russia (industrial zone of temperate climate of Moscow – MTsKI; temperate warm climate of Gelendzhik – GTsKI; warm humid climate of Sochi – GNIP, Russian Academy of Sciences). Changes of microstructure and main types of destruction in the volume of carbon fiber reinforced plastics have been established. It is shown that changes of structure and torsion nature of fracture in volume epoxy carbon-fiber-reinforced plastics are typical for all zones of climatic aging and are defined by processes of complex manifestation of mechanical stresses and chemical destruction of materials.

Keywords: carbon fiber reinforced plastics, long aging, climatic zones, bending strength, compression strength, macro- and microstructure, scanning electron microscopy.

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ELECTROCHEMICAL PROTECTION AGAINST CORROSION FOR STEEL BARS IN REINFORCED CONCRETE STRUCTURES EXPOSED TO SEAWATER

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Abstract—The paper analyzes ways to ensure long service life (up to 50 years) of reinforced concrete marine structures. It has been established that durability and maintenance-free operation of floating and coastal offshore structures for 50 and more years depend on corrosion of steel reinforcement which could be avoided by applying electrochemical protection. The parameters of electrochemical protection against corrosion of steel fittings are given.

Keywords: electrochemical protection, corrosion, marine structures.

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BASIC PRINCIPLES FOR STRUCTURAL INTEGRITY AND LIFETIME ASSESSMENT OF BN-TYPE FAST REACTORS COMPONENTS WITH REGARD FOR MATERIAL DEGRADATION

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Abstract—The present paper overviews the basic principles of Russian Standard elaborated by authors for justification of lifetime prolongation of BN-600 fast reactor (FR) and for justification of design lifetime of BN-800 and BN-1200 FR. These principles are based on the analysis of the main mechanisms of material embrittlement and damage under service and formulation of the limit conditions for different components of FR of BN type.

Keywords: fast reactor, structural integrity, embrittlement and damage mechanisms.

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ADHESION CONTROL OF PLATINUM COATINGS AT MANUFACTURING PLATINIZED NIOBIUM ANODES BY MAGNETRON SPUTTERING

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Abstract—The paper describes methods and results of determining the values of adhesion at manufacturing platinized niobium working electrodes for cathodic protection against corrosion. The factors influencing these values are determined.

Keywords: platinum coating, platinized niobium anodes, magnetron spraying

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