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CONTROL OF DELTA-FERRITE NATURE IN NITROGEN-CONTAINING CHROMIUM-NICKEL-MANGANESE STEELS

A. A. KAZAKOV[1], Dr. Sc., A. S. ORYSHCHENKO[2], Dr. Sc., O. V. FOMINA[2], PhD (Eng.), A. I. ZHITENEV[2], T. V. VIKHAREVA[2]

[1]Peter the Great St Petersburg Polytechnic University, 29, Polytechnicheskaya St, 195251 St Petersburg, Russian Federation

[2] NRC "Kurchatov Institute" – CRISM "Prometey", 49, Sphalernaya St, 191015 St Petersburg, Russian Federation. E-mail: mail@crism.ru

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Abstract—Behavior of δ-ferrite during crystallization, solidification and subsequent cooling of solid nitrogen-containing stainless steel of different compositions has been studied by thermodynamic simulation methods. The results were confirmed experimentally and can serve as a basis to justify the composition and processing parameters of steel at all stages, for example, to provide the controlled δ-ferrite content during the hot plastic deformation and welding or most complete dissolution of δ-ferrite during the austenitization.

Keywords: nitrogen-containing stainless steel, δ-ferrite, crystallization, austenitization, thermodynamic simulation.

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CALCULATING THE KINETICS OF DIFFUSION LAYERS AT BORIDING OF STEELS ON MODELING BASIS

V. I. GRYZUNOV[1], Dr. Sci. (Chem), T. V. EMELIANOVA[2], E. Yu. PRIYMAK[1], PhD (Eng)

[1] Orsk Humanitarian Technology Institute (branch of the Federal State Budget Institution of Higher Professional Education Orenburg State University), 15a, Prospekt Mira, 462403, Orsk, Orenburg Region, Russian Federation

[2] JSC Heavy Engineering ORMETO-YUMZ, 12, Prospekt Mira, 462403, Orsk, Orenburg Region, Russian Federation, E-mail: tatyana.emelyanova.90@mail.ru

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Abstract—The kinetics of boriding in steels has been studied. The paper states that the thickness of the boride layer at all temperatures depends on the diffusion mobility of atoms of boron, carbon and alloying elements.

Keywords: diffusion, boriding, temperature, steel, carbon, kinetics, adsorption, extension.

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NITROCARBURIZED STEEL ShKh15 (ШХ15) FOR PUNCH TOOLS MANUFACTURING

N. A. KOSTIN, PHD (Eng), E. V. TRUSOVA, PhD (Eng)

Federal State Budget Institution of Higher Professional Education “Kursk State University”
33, Radishcheva St., 305000, Kursk, Russian Federation, E-mail: info@kursksu.ru

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Abstract—The paper carefully studies nitrocarburizing of steel ShKh15 (ШХ15) inside of carbonitriding paste for punch tools manufacturing. Results of testing and microstructures of nitrocarburized steel layers have been presented. The carbon concentration changes in depth of the diffusion layers have been analyzed.

Keywords: steel ShKh15 (ШХ15), nitrocarburizing, carbonitriding paste, punch tools.

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CONCENTRATION REDISTRIBUTION OF ALLOYING ELEMENTS BY ITS IN THE PSEUDO-ALPHA TITANIUM ALLOY UNDER PLASTO-ELASTIC DEFORMATION

L. A. IVANOVA[1], PhD (Eng), G.V. BENEMANSKAYA[2], Dr. Sci. (Phys-math),
V. V. TRAVIN[3], PhD (Eng)
[1]NRC "Kurchatov Institute" – CRISM "Prometey", 49, Shpalernaya St, 191015, St Petersburg, Russian Federation. E-mail: mail@crism.ru
[2]Federal State Budgetary Institution of Science 'Ioffe Physical-Technical Institute of the Russian Academy of Sciences', 26, Politekhnicheskaya St., 194021, St Petersburg, Russian Federation
E-mail: post@mail.ioffe.ru
[3]Kaluga Turbine Works (KTZ), 241, Moskovskaya St., 248010, Kaluga, Russian Federation
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Abstract—The paper studies alloying elements (Al, V, Mo) redistribution in the pseudo-alpha titanium structure under graded stretching until sample's destruction. Local sections of titanium structure and of fracture surface have been scanned by electron microscopy and X-ray microanalysis. The change in the chemical and phase composition of the alloy has been compared with the initial state stimulated by deformation influence. Structural-phase state of the material under high plastic strains is metastable, fixed by system of deformation of the crystal lattice defects.

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MAIN FEATURES OF THE DISPERSE NIOBIUM CARBIDE PARTICLES STRUCTURE IN THE HEAT-RESISTANT Fe–25Cr–35Ni ALLOYS

S. Yu. KONDRATIEV[1] Dr. Sc. (Eng), E. V. SVIATYSHEVA[2], S. N. PETROV[2], PhD (Chem)

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[1]Peter the Great St Petersburg Polytechnic University, 29, Polytechnicheskaya St, 195251, St Petersburg, Russian Federation

[2] NRC "Kurchatov Institute" – CRISM "Prometey", 49, Shpalernaya St, 191015, St Petersburg, Russian Federation. E-mail: mail@crism.ru

Abstract—The structure of niobium carbide particles dispersed in a cast heat-resistant alloy based on the Fe–Cr–Ni–C system, modified with Nb and Ti, has been studied by optical and electron microscopy. The particles can generally be considered as multiphase polycrystalline clusters with heterogeneous chemical composition and crystal structure. The paper presents probable reasons of the polycrystalline nature of niobium carbide.

Keywords: cast heat-resistant alloys, heat-resisting castings, microstructure, phase composition, electron microscopy, carbide phases

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DEVELOPMENT OF Ni-BASE SUPERALLOY WITH OPERATION TEMPERATURE UP TO 800°C FOR GAS TURBINE DISKS

M. M. BAKRADZE., PhD (Eng), S. V. OVSEPYAN, PhD (Eng), A. A. BUIAKINA, B. S. LOMBERG, Dr. Sc.

Federal State Unitary Enterprise "All-Russian Scientific Research Institute of Aviation Materials" (FSUE VIAM), 17, Radio St, 105005 Moscow, Russian Federation. E-mail: admin@viam.ru

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Abstract—The results of development of new nickel-base superalloy having an operation temperature up to 800°C for gas turbine disks have been presented. Structures, mechanical properties and phase transformations of six experimental compositions have been researched. Physical and chemical modeling has been used to make a right choice of an alloy; with parameters as composition equivalents (they were based on equations of non-polarizing ionic radii). The highest level of strength, ductility, toughness, and heat resistance was exhibited at 750°C by Ni–Co–Cr–W–Mo–Ta–Al–Ti–Nb experimental composition with the total of aluminum, titanium and niobium equal to 10 wt. % and containing 4 wt. % of tantalum.

Keywords: nickel-base superalloy, alloy composition, microstructure, strengthening γ'-phase, mechanical properties, heat treatment.

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ALLOYING EFFECTS ON THE INTERMETALLIC NICKEL ALUMINIDE MELTING POINT

N. V. PETRUSHIN, Dr. Sc. (Eng), E. S. ELYUTIN

Federal State Unitary Enterprise “All-Russian Scientific Research Institute of Aviation Materials” (FSUE VIAM), 17, Radio St, 105005 Moscow, Russian Federation. E-mail: admin@viam.ru

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Abstract—The paper investigates the alloying effect on intermetallic melting temperature based on Ni_3Al (γ'-phase) in which the aluminum (up to 5% at.) was replaced by one of the following elements – titanium, tantalum, tungsten, molybdenum, niobium and rhenium, as well as by a complex of these elements. Chromium was replaced by nickel. Experimental studies were conducted on polycrystalline samples after homogenization. The melting temperature (solidus temperature) of intermetallic alloys has been determined by differential thermal analysis. It is found that addition of rhenium (0.4 at. %) and tungsten (1.3 at. %) increases Ni_3Al melting temperature (1372°C) to 1386 и 1380°C respectively. The introduction of elements – molybdenum (1.6 at. %), tantalum (2.3 at. %), titanium (4.5 at. %), chromium (4.9 at. %) and niobium (4.9 at. %) – lowers the melting temperature up to 1371, 1368, 1360, 1355 и 1338°C respectively. The complex of alloying elements (titanium, tantalum, tungsten, molybdenum, niobium, chromium and rhenium) decreases γ'-phase melting temperature.

Keywords: intermetallic alloys, intermetallic compound Ni_3Al, γ'-phase, melting temperature.

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THE STRUCTURE AND MECHANICAL PROPERTIES OF FLAT BLANKS OF ALLOY AD1 OBTAINED BY THE COMBINATION OF CONTINUOUS CASTING AND DEFORMATION IN THE SOLID-LIQUID STATE

A. M. SERGEEVA[1, 2], PhD (Phys.-math), N. S. LOVIZIN[1], PhD (Phys.-math), A. A. SOSNIN[1], PhD (Eng)

[1] Federal State Budget Institution of Science Institute of Engineering and Metallurgy of Far Eastern Branch of Russian Academy of Sciences, 1, Metallurgov St., 681005, Komsomolsk-na-Amure, Khabarovsk Region, Russian Federation. E-mail: mail@imim.ru

[2] OOO “Institut nauchno-tehnicheskikh innovatsiy” (Institute of Scientific and Technical Innovations) (participant of Skolkovo project), 24, Kalinin St., 681014, Komsomolsk-na-Amure, Khabarovsk Region, Russian Federation, E-mail: info@inti.su

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Abstract—The crystallization of melts under the action of external factors leads to improved mechanical properties of the finished metal wares. The paper presents results of research of metal wares of aluminum alloy AD1 obtained by a new way of combination of continuous horizontal casting and deformation in the solid-liquid state. The scheme of device for realizing combined process shown and the functioning of the device has been reviewed. The description flat blanks obtaining and preparation of samples for the study of mechanical properties and microstructure of blanks has been presented. The obtained metal wares have a fine grain structure, with dense arrangement direction of dislocations. The grain boundaries are irregular, wide, consisting of a wreath of dislocation loops and grids. This internal structure of metal ware is formed directly in the crystallization process and enhances the mechanical characteristics of blanks. No internal defects (pores, microporosity) have been detected. The paper shows the possibility of obtaining lengthy metal wares with a fine-grain structure, the absence of internal defects and improved mechanical properties in a short production cycle with reduced power impact on the melt more than 50%.

Keywords: aluminum alloys, microstructure, continuous casting, mechanical properties, crystallization, combined processes.

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INFLUENCE OF SEVERE PLASTIC DEFORMATION ON THE STRUCTURE AND PROPERTIES OF COPPER M0B

L. F. SENNIKOVA, PhD (Eng), A. A. DAVIDENKO, PhD (Eng),
V. M. TKACHENKO, PhD (Phys.-Math), L. S. METLOV, Dr Sci (Phys.-Math)

Donetsk Institute for Physics and Engineering named after A.A. Galkin (DonIPE) of the National Academy of Sciences of Ukraine. 72, R. Luxembourg St, 83114, Donetsk, Ukraine.
E-mail: sennikova_lf@ukr.net

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Abstract—The results of the investigation of the grain structure and deformation porosity of copper M0b obtained by shear deformation by the method of angular hydroextrusion (UGE) are presented. The evolution of the grain and defect structure (micropores) in the process of nonmonotonic deformation is shown. The influence of angular hydroextrusion on the mechanical properties of copper is investigated on the basis of the obtained experimental data.

Keywords: microstructure, angular hydroextrusion, hardness, deformation porosity, intense plastic deformation, dynamic recrystallization.

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INCREASING WEAR RESISTANCE OF CARBON STEEL BY ANODE PLASMA ELECTROLYTIC NITRIDING

S. A. KUSMANOV, PhD (Eng), M. N. KASATKINA, S. A. SILKIN, PhD (Eng), P. N. BELKIN, Dr Sc (Eng)

Kostroma State University named after N. A. Nekrasov, 14, 1st of May St, 156961, Kostroma, Russian Federation. E-mail: sakusmanov@yandex.ru

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Abstract—The features of carbon steels 20, 45 and U8 saturation with nitrogen plasma electrolytic treatment in an aqueous electrolyte based on carbamide and ammonium chloride, and tribological properties of their surfaces after inoculation are tested. Anode plasma electrolytic nitriding of carbon steels is shown to result in formation of oxide and nitride-martensite layers with increase in their microhardness up to 1000–1050 HV according to data of X-ray and scanning electron microscopy. It is proposed an electrolyte containing 10% ammonium and 15% carbamide and processing regime (700°C, 5 min) which enable to decrease in the lubricant friction coefficient of low-carbon steel from 0.17 to 0.12 and its weight wear 50 times in comparison with untreated sample. This testing was conducted using hardened medium carbon steel (50 HRC) as counter-body under normal load of 209 N and sliding rate of 0.5 m/s.

Keywords: plasma electrolytic nitriding, carbon steel, carbamide, wear.

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SLIP-MAGNETIC SHIELDS OF SPECIAL DESIGN ASSEMBLED OF AMORPHOUS ALLOYS SHEETS

M. V. DORONIN[1], G. V. GRESHNIAKOV[1, 2], PhD (Eng)

[1]Peter the Great St Petersburg Polytechnic University, 29, Polytechnicheskaya St, 195251 St Petersburg, Russian Federation

[2] Research Institute "SEVKABEL", 40, Liniya Kozhevennaya, 199106, St Petersburg, Russian Federation

E-mail: mviduka@yandex.ru

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Abstract—The paper describes a fundamentally new cable accessory, which is not structural element of the cable. It will be referred to as a slip-magnetic shield of special design. The results of the study of the magnetic shielding properties of MAR1-K screen, made from soft magnetic AMAG-172 alloy have been presented. Numerical simulation of shielding effectiveness, depending on the design parameters of the structure (thickness, slip screen position, opening angle) has been carried out. It is shown that unconfined screens can effectively redistribute the magnetic field and to shield the single conductors. Models of slip-magnetic shields have been made and tested on the basis of calculations. The results showed a decrease in the magnetic field level more than twice at a current of 500 A. The paper overviews existing materials for shielding, providing foundation for the selected material, as well as optimization of the results of calculations and experiments. The results of these studies could be useful for specialists in various fields of science and engineering: materials science, electrical engineering, power engineering, medical technologies and others.

Keywords: amorphous soft magnetic alloys, shielding of magnetic field, shielding ratio, shield attenuation ratio, genetic algorithm, magnetic screen MAR-1K, ferromagnetic materials, cable lines..

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ON FORMATION OF COATINGS OF Ti–Ru–O SYSTEM BY MAGNETRON DIRECT CURRENT SPUTTERING

E. N. ESHMEMETYEVA, A. N. BELIAKOV, R. Yu. BYSTROV, A. F. VASILIEV,
P. A. KUZNETSOV, Dr. Sc. (Eng), B. V. FARMAKOVSKY, PhD (Eng)

NRC "Kurchatov Institute" – CRISM "Prometey", 49, Shpalernaya St, 191015 St Petersburg, Russian Federation. E-mail: mail@crism.ru

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Abstract—The paper shows results of the study of Ti–Ru–O coatings obtained by the vacuum magnetron direct current sputtering. Titanium and ruthenium were deposited simultaneously under different partial pressures of oxygen.

Keywords: titanium anodes, Ti–Ru–O active coating, vacuum magnetron sputtering, oxygen partial pressure, structural state change.

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EFFECT OF SODIUM HYPOPHOSPHITE CONCENTRATION IN PYROPHOSPHATE ELECTROLYTE ON THE COMPOSITION AND PROPERTIES OF ELECTRODEPOSITED Ni–P COATINGS

A. V. KRASIKOV, PhD (Chem)

NRC ”Kurchatov Institute” – CRISM “Prometey”, 49, Shpalernaya St, 191015 St Petersburg, Russian Federation. E-mail: npk3@crism.ru

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Abstract—The process of electrodeposition of nickel-phosphorus alloys from a pyrophosphate electrolyte with various concentrations of sodium hypophosphite has been studied. The relationship between the concentration of sodium hypophosphite in the electrolyte and the deposition of the Ni–P coating from the pyrophosphate electrolyte with a change in its structure and properties has been described, and the conditions under which the composition of the coating does not depend on the current density have been determined.

Keywords: coatings of the Ni–P system, products with complex geometric shape, electrodeposition, hypophosphite concentration, pyrophosphate electrolyte.

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THE INFLUENCE OF FRICTION ON WEAR OF ELECTROLYTIC NIP COATINGS

I. R. ASLANYAN, Dr. Sc. (Eng)

Federal State Unitary Enterprise “All-Russian Scientific Research Institute of Aviation Materials” (FSUE VIAM), 17, Radio St, 105005 Moscow, Russian Federation. E-mail: admin@viam.ru

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Abstract—The results of studies of the effect of reinforcing additives silicon carbide and heat treatment on the wear of the nickel-phosphorus coatings under continuous friction sliding, fretting wear and fretting corrosion were done (subject to changes in load and the oscillation amplitude). Coating’s wear during fretting is 1.3–3.5 times higher than during sliding. At the same time fretting corrosion occurs 1.3–1.6 times more intensely than fretting wear. The heat-treated NiP coating without additives exhibited the lowest wear at the sliding, fretting and fretting corrosion.

Keywords: coatings, friction, fretting, fretting corrosion.

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LOW-POROSITY POLYMER COMPOSITE MATERIALS MADE BY RESIN FILM INFUSION

M. I. VAVILOVA, PhD (Eng), I. I. SOKOLOV, K. R. AKHMADIEVA, G. A. YAMSCHIKOVA

Federal State Unitary Enterprise “All-Russian Scientific Research Institute of Aviation Materials” (FSUE VIAM), 17, Radio St, 105005, Moscow, Russian Federation. E-mail: admin@viam.ru

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Abstract—The article considers low-porosity polymer materials made by RFI (Resin Film Infusion). The basic requirements to the rheological properties of film binding are provided. Physical and mechanical properties (density, porosity, compressive strength) of glass-reinforced plastic are investigated. The properties of plastics made by RFI have been compared with those made by autoclave molding and direct compression. It is shown, that RFI-technology allows manufacturing materials with high values of physical and mechanical properties. The principles of power efficiency and ecological safety are observed.

Keywords: polymer composite materials, resin film infusion (RFI), thermosetting epoxy resins, bismaleimide-epoxy resins, rheology of resin, glass fillers, fiberglass.

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MODIFICATION OF EPOXY POLYMERS WITH HEXAGONAL BORON NITRIDE

A. S. MOSTOVOY, PhD (Eng.), A. N. LEDENEV

Engels Technological Institute (branch of Yuri Gagarin State Technical University of Saratov), 17, Svobody Sq., 413100, Saratov Region, Engels, Russian Federation. E-mail: eti@techn.sstu.ru

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Abstract—The aim of this work was to improve the physical, chemical and mechanical properties of epoxy composites by using fine powder of hexagonal boron nitride. Studies have shown that its introduction into the epoxy increases the physico-mechanical properties of the composite: the breaking stress increases 2.5 times and flexural modulus by 15%, breaking stress in compression has been improved by 27%, breaking stress and the tensile modulus of elasticity by 20–25%, toughness increases 4 times and hardness by 85%, while maintaining heat resistance. The introduction of boron nitride changes the parameters of the kinetics of epoxy oligomer hardening shortening gelation from 45 to 36 minutes and the duration of hardening from 53 to 48 minutes, but maximum hardening temperature is practically unchanged. Introduction of boron nitride into the epoxy composition enhances the thermal conductivity by 50–80% and decreases its thermal resistance. Thus, the developed materials may be used in aircraft and electronic engineering, shipbuilding, automotive industry.

Keywords: epoxy resin, modification, filler, hexagonal boron nitride, mechanical properties.

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RESEARCH OF INTERFACE OF THE POLYMER MATRIX WITH OPTICAL FIBERS IN SMART MATERIALS

M. Yu. FEDOTOV[1], A. M. SHIENOK[2], R. R. MUKHAMETOV[2], PhD (Eng), I. N. GULYAEV[2], PhD (Eng)

[1]NITs "IRT" Ltd (Scientific and Innovation Center "Institute for the Development of Research, Development and Technology Transfer") 3, Bd. 2, Krymsky Val St, 119049, Moscow, Russian Federation
E-mail: fedotovmyu@gmail.com

[2]Federal State Unitary Enterprise "All-Russian Scientific Research Institute of Aviation Materials" (FSUE VIAM), 17, Radio St, 105005 Moscow, Russian Federation. E-mail: admin@viam.ru

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Abstract—The article reports research results evaluating interface of the polymer matrix and silica-based optical fibers covered with protective layer by microstructural analysis. The data of the analysis of the protective layer has been obtained by IR-spectroscopy on the subject of compatibility with polymer matrix considering curing regimes.

Keywords: polymer matrix, optical fiber, fiber optic sensor, quantitative microstructural analysis, smart materials.

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NEW HIGH-EFFICIENCY ARC WELDING METHODS

B. F. YAKUSHIN, Dr. Sc. (Eng)

Bauman Moscow State Technical University, 5, 2nd Baumanskaya St, 105005, Moscow, Russian Federation. E-mail: jakushinbf@mail.ru

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Abstract—The paper presents results of the comparative analysis of new high-efficiency submerge arc welding methods. Operational properties of joints welded by these methods have been investigated.

Key words: submerge arc welding; productivity and quality of welding process; arc column; saturation with hydrogen; weld pool temperature; introduction point of the additional hotwire; relative number of input additives; factor of transition of the alloying elements.

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EFFECT OF INTERSTITIAL ELEMENTS ON PITTING AND INTERGRANULAR CORROSION OF AUSTENITIC CHROMIUM-NICKEL STEELS

A. S. KUDRIAVTSEV, PhD (Eng), K. A. OKHAPKIN, PhD (Eng), S. A. SUVOROV

NRC "Kurchatov Institute" – CRISM "Prometey", 49, Shpalernaya St, 191015, St Petersburg, Russian Federation. E-mail: mail@crism.ru

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Abstract—The possibility of increasing resistance of austenitic chromium-nickel 09Kh18H9 and 08Kh16H11M3 steels to pitting and intercrystalline corrosion has been studied within standby mode of the fast breeder reactor. Passive film resistance to chlorides could be improved by increasing the contents of elements with high affinity towards oxygen.

Keywords: austenitic chromium-nickel steels, reactor installation, pitting and intergranular corrosion, interstitial elements.

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ANALYSIS OF EMERGENCY DAMAGE TO EXPLORATORY DRILL PIPES

E. Yu. PRIYMAK[1], PhD (Eng); A. P. FOT[2], Dr. Sci (Eng); A. V. STEPANCHUKOVA[3]

[1]Orsk Humanitarian and Technological Institute (Branch of the Federal State Budget Educational Institution of Higher Education "Orenburg State University")
15a, Mira prospekt, 462403, Orsk, Orenburg Region, Russian Federation

[2]Orenburg State University (OSU), 13, Pobedy prospekt, 460018, Orenburg, Russian Federation, E-mail: post@mail.osu.ru

[3]ZBO Drill Industries, Inc., 118, Pobedy prospekt, 460026, Orenburg, Russian Federation

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Abstract—The paper gives an analysis of emergency damage to pipes intended to drilling for solid minerals with a removable core receiver. It is shown that tubular Drillmax 850 of foreign production are

not suitable for drill pipes (with surface hardening by carbonitriding) to operate in the Russian climate. It is established that the carbonitriding contributes to increase the cold-brittleness threshold of the material applied for Drillmax 850 and, thus, to decrease the resistance to cracks propagation.

Keywords: emergency damage, drill pipe, threaded area, carbonitriding, operational crack, toughness, cold-brittleness threshold, brittle fracture.

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