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CONTENTS

ABSTRACTS OF PUBLISHED ARTICLES

UDC 669.15–194.55:621.785:539.422.22

Improving of heat treatment modes for 35KhN3MFA and 38KhN3MFA steel grades to increase resistance to brittle fracture. Part 1. Tsukanov V. V., Ziza A. I. – Voprosy Materialovedeniya, 2015, N 2(82), p. 9–16.

The paper studies overheating effects of the forging of 38KhN3MFA steel products and recommends optimum heating mode during the preliminary heat treatment. It analyzes the nature of austenite transformation, number and distribution of residual austenite in 38KhN3MFA steel type at various stages of heat treatment.

Keywords: residual austenite, secondary martensite, impact toughness, resistance to brittle fracture, structural heredity.

UDC 669.15'26–194

Structure and properties of carbide reinforced steels sintered on the Fe–Cr–C system. Masliuk V. A., Yakovenko R. V., Gripachevsky A. N., Bagliuk G. A. – Voprosy Materialovedeniya, 2015, N 2(82), p. 17–22.

The influence of production terms, metal and carbide phase composition on structure formation, phase composition and physico-mechanical properties of carbide reinforced steels sintered with hard component of chromium carbide and metal bond of iron or chromium steels has been investigated. The base mechanism of structure formation at sintering of such composites comes to one-sided chromium and carbon diffusion from carbides to metal matrix as well as iron diffusion into carbides, carbide depletion and recrystallization to Me_2C (Me_3C) and $Me_{23}C_6$ complex carbides. It is shown that high-carbon ferrochromium in the capacity of hard component for carbide reinforced chromium is much more effective than Cr_3C_2.

Keywords: carbide reinforced steel, structure formation, diffusion, ferrochromium, carbide, sintering.

UDC 669.15–194:621.039.536.2

The development of structural materials for sodium-cooled fast neutron reactor. Karzov G. P. Kudriavtsev A. S., Markov V. G., Grishmanovskaya R. N., Trapeznikov Yu. M., Ananieva M. A. – Voprosy Materialovedeniya, 2015, N 2 (82), p. 23–33.

The paper sums up the experience of high-temperature corrosion-resistant steel production for reactor vessels and internals and steam generators for sodium-cooled fast neutron reactors.

Keywords: fast neutron reactor, sodium coolant, high-temperature and corrosion-resistant steel, thermal fatigue resistance.

UDC 669.131.6

Iron surface catalytic effects on interaction between chromium oxide and carbon of ferrite-pearlite gray cast iron. Gurevich Yu. G., Frolov V. A., Sukhanov P. A., Shishkina S. V. – Voprosy Materialovedeniya, 2015, N 2 (82), p. 34–39.

Iron surface, being a good catalyst affects oxides dissociation, and the dissociation products in turn have an oxidizing and alloying impact on the surface layer structure of a ferritic-pearlitic gray cast iron. These processes may be the basis for the diffusion alloying of gray iron in the medium of the alloying oxides.

Keywords: iron, oxide, dissociation, catalysis, diffusion alloying.

UDC 669.35'11:621.785

Influence of deformation and heat treatment on Cu–Fe microcomposites structure and properties. Beloshenko V. A., Gangalo A. N., Dmitrenko V. Yu, Nepochatykh Yu. I., Pilipenko A. N., Chishko V. V. – Voprosy Materialovedeniya, 2015, N 2 (82), p. 40–46.

The effect of deformation and heat treatment by hot extrusion (1250 K) and drawing at room temperature on the structure, internal friction, strength and conductive properties of cast Cu – 43 wt. % Fe and Cu – 50 wt. % Fe microcomposites has been studied. It is shown that the hot deformation due to the effective healing of macrodefects under subsequent cold drawing promotes such structure formation that is characterized by high strength and satisfactory electrical conductivity. Fundamental difference between the temperature dependence for the internal friction of Cu–Fe microcomposites and that of each system component has been established. The paper depicts physical mechanism for the structural modification effects.

Keywords: Cu–Fe microcomposites, casting, deformation and heat treatment, hot extrusion, drawing, structure, internal friction, strength and conductive properties.

UDC 621.762.5

Structure formation characteristics during Fe–Si–B–C composite sintering. Bagliuk G. A., Napara-Volgina S. G., Kud V. K., Orlov L. N., Gripachevsky A. N. – Voprosy Materialovedeniya, 2015, N 2 (82), p. 47–53.

The structure formation characteristics at compacts sintering made of Fe-based powder mixture with boron carbide and silicon-containing additives (2–6% of boron carbide or 5–20% ferrosilicium) have been investigated. Sintering temperature has been modified in the range of 1050–1200°C. During sintering at 1100°C the beginning of boride eutectic formation is observed in a form of separate allocated impurities. At higher sintering temperatures (1150–1200°C) the boride eutectic is localized on the grain boundaries mainly forming skeleton structure, while silicon is being consumed for alloying of metal matrix phase of the composite.

Keywords: sintering, boron, silicon, composite, eutectic, structure, metal powder.

UDC 691.168

Enhancement of physical and hydro-physical properties of asphalt concrete by introducing nanodispersed additives. Urkhanova L. A., Shestakov N. I., Mognonov D. M., Buyantuev S. L., Ayurova O. Zh. – Voprosy Materialovedeniya, 2015, N 2(82), p. 54–59.

The article discusses the possibility of modifying bitumen by carbon nanomaterials and getting asphalt concrete. Carbon nanomaterials (CNM) have been obtained of coal in a plasma reactor. Bitumen basic properties are subject to change when various concentrations of CNM are introduced. With increasing amounts of CNM softening point and, accordingly, bitumen viscosity and needle penetration depth are being reduced. Bitumen viscosity decreasing in the range of technological temperatures contributes to better wetting of the stone material surface by organic binder aggregate, bitumen becomes harder. Asphalt concrete samples with improved physical and mechanical properties and deformability have been obtained on the basis of the modified CNM-bitumen. Results indicate that asphaltic bitumen possesses greater strength at 20 and 50°C. With the introduction of 0.1% CNM asphalt concrete test specimens show that ultimate compressive strength increases by 10% at 20°C, and by 50% at 50°C; with the introduction of 0.05% CNM by 20% and 30%, respectively. With the introduction of 0.1% modified additive water resistance coefficient increases, and hence the durability of asphalt covering.

Keywords: modified bitumen, carbon nanomaterials, fullerene, asphalt concrete.

UDC 678.743.41:621.384.5

Surface properties of polytetrafluoroethylene modified in glow discharge plasma. Ayurova O. Zh., Mognonov D. M., Kornopol'tsev V. N., Maksanova L. A., Buyantuev S. L. – Voprosy Materialovedeniya, 2015, N 2(82), p. 60–64.

The paper shows changes of the surface properties of polytetrafluoroethylene (PTFE) as a result of processing in plasma glow discharge with exposure range 0–600 sec, discharge currents $0–8\cdot10^2$, voltage 4200–2500 V. It has been found that these changes determine PTFE adhesiveness increase, which leads naturally to strengthening of PTFE-based bonded compounds.

Keywords: polytetrafluoroethylene, modification, glow discharge, adhesion, shear strength

UDC 678.067:620.184

Research of structure and composition of KMU-4l carbon fiber reinforced plastic after 12 years of exposure to space environment. 1. Macrostructure and composition research surfaces. Deev I. S., Nikishin E. F., Kurshev E. V., Lonsky S. L. – Voprosy Materialovedeniya, 2015, N 2(82), p. 65–75.

The paper describes the first time experimental data on macrostructure, composition and weight losses of unique KMU-4l carbon fiber reinforced plastic samples with surface modified by fiber glass fabric, subjected to long exposure (12 years) in space environment as a part of Komplast 10-1 panels on the exterior surface of the modulus of the International Space Station. Research results have been obtained by methods of visual survey, gravimetric analysis, digital photography, optical microscopy and energy-dispersive X-ray spectroscopy. It is shown that the studied macrostructural characteristics, weight losses and element composition of modified carbon fiber reinforced plastic differ slightly in the control and exposed test specimens, meaning that composite materials possess stable macrostructural and physical and chemical properties.

Keywords: carbon fiber reinforced plastic, macrostructure, composition, Komplast panel, long-term exposure, International Space Station.

UDC 678.067:620.186

Research of structure and composition of KMU-4l carbon fiber reinforced plastic after 12 years of exposure to space environment. 2. Microstructure and composition. Deev I. S., Nikishin E. F., Kurshev E. V., Lonsky S. L. – Voprosy Materialovedeniya, 2015, N 2(82), p. 76–85.

The paper studies microstructure and composition of KMU-4l sheets and glued samples consisting of KMU-4l carbon fiber reinforced plastic / VK-9 glue / AMg6 alloy with surface modified by fiber glass fabric, subjected to long exposure (12 years) in space environment as a part of Komplast 10-1 panels on the exterior surface of the ISS (International Space Station) module registered before and after return to Earth. It is established that the microstructure and element composition of the studied samples in the panels control and exhibited on ISS differs slightly. Protecting cover TR-SO-2 prevents changes of its microstructure and weakens damaging influence of micro meteoric bodies. The received results allow making the conclusion that this material owing to stability of its micro structural characteristics keeps high operational stability as refers to space factors when fiber glass fabric and/or protecting cover are present.

Keywords: carbon fiber reinforced plastic, microstructure, composition, Komplast panel, long-term exposure, International Space Station.

UDC 678.067:620.192.47

Reducing porosity manufacturing polymer composite materials by non-autoclave methods. Dushyn M. I., Khrulkov A. V., Karavaev R. Yu. – Voprosy Materialovedeniya, 2015, N 2 (82), p. 86–96.

The reasons for the porosity formation in polymeric composite materials, which are produced by non-autoclave methods, have been considered, recommendations for its reduction have been made.

Key words: porosity, prepreg vacuum molding, non-autoclave molding, infusion, moisture.

UDC 678.067:544.723.5

The stoichiometry of epoxy compositions (hardener/resin) and spheroplasts and its impact on water resistance, durability and chemisorption protection of deepwater submersible materials. Sedletsky R. V. – Voprosy Materialovedeniya, 2015, N 2 (82), p. 97–116.

The paper studies physicochemical mechanism of water mass transfer under hydrostatic pressure (0.1 and 60 MPa) in unfilled and glass-microspheres filled materials of epoxy compositions with amine and anhydride hardening at varying stoichiometry (19 alternatives), as well as their physical and mechanical properties (Young's modulus, shift and loss factors, specific initial and residual strength after hydro-testing at 60 MPa).

Keywords: submersibles, spheroplast, water resistance, durability, efficiency of chemisorption protection, water absorption.

UDC 678.4

Rubbers based on cyclic α-oxides. Specific features of structure and properties. Rumiantseva A. V., Klochkov V. I., Kurliand S. K., Glushak M. I., Khvostik G. M. – Voprosy Materialovedeniya, 2015, N 2(82), p. 117–122.

Properties of propene-oxide and epichlorohydrin rubbers and its structure-molecular characteristics have been examined by NMR and GPC. Rubber degradation has been evidenced in the course of processing and curing behavior of rubbers studied using peroxides and sulfur. Test results are presented for unfilled and carbon filled rubbers on the basis of cyclic α-oxides. Influence of carbon amount and activity has been assessed on rubber properties, physico-mechanical and low-temperature characteristics have been found. Temperature spreading through the bulky article has been shown depending on time of heating.

Key words: epichlorohydrin rubber, propene-oxide rubber, sound-proofing coats, damping coats, rubber viscosity, vulcanization, rubber modules, thermal-physic properties.

UDC 678.664:621.822.5

Experimental determination of sliding friction coefficient on abrasive surface. Yakovlev S. N. – Voprosy Materialovedeniya, 2015, N 2(82), p. 123–131.

The paper describes experimental facility for determination of sliding friction coefficient on abrasive surface. Empirical dependence for determination of sliding friction coefficient has been provided as a function of three parameters: pressure, sliding speed, hardness of polyurethane.

Key words: experimental facility, sliding friction coefficient, normalized abrasive surface, static friction coefficient, cement concrete pavement, true contact area.

UDC 621.791

Application of thermodynamic calculations to assess the total amount of hydrogen in the weld metal during arc welding. Startsev V. N. – Voprosy Materialovedeniya, 2015, N 2 (82), p. 132–142.

The estimation of dissolved hydrogen in the weld metal at different welding methods has been based on thermodynamic calculations. The calculation results are compared with experimental data.

Keywords: arc welding, weld metal, hydrogen content, thermodynamic calculation.

UDC 669.017:539.16

Hydrogen in multipass welds connecting the collector and the steam generator vessel in the WWER-1000 unit. Ozhigov L. S., Mitrofanov A. S., Ruzhitsky V. V., Tolstolutskaya G. D., Rybalchenko N. D., Krayniuk E. A. – Voprosy Materialovedeniya, 2015, N 2 (82), p. 143–150.

The relationship between the structural features and hydrogen content in the weld metal, which connects the steam generator to the collector of the WWER-1000 unit, has been established. It has been shown that hydrogen content's variations and its desorption temperature ranges correlate with structure changes. The results of microhardness measurements of the weld metal at the bottom and other layers with fine crystalline and columnar grains have been presented.

Keywords: WWER-1000 unit, steam generator, weld metal, hydrogen content.

UDC 669.14.018.293:620.194.2

Corrosion resistance problems of low magnetic shipbuilding steels. Mushnikova S. Yu., Kalinin G. Yu., Kharkov A. A. – Voprosy Materialovedeniya, 2015, N 2 (82), p. 151–160.

The paper presents results of comparative studies of corrosion resistance and corrosion-mechanical strength for low magnetic shipbuilding steels of alloying systems Mn–C, C–Mn–Ni, Cr–Ni, Cr–Ni–Mo, Cr–Ni–Mn–N, produced using various hardening mechanisms. It is shown that nitrogen-containing steels developed by CRISM "Prometey" constitute new constructional material superior in resistance to corrosion cracking in sea water comparing with low magnetic steels used in shipbuilding nowadays.

Key words: nitrogen-containing low magnetic shipbuilding steel, resistance to stress-corrosion cracking, alloying system.

UDC 669.15–194.56:620.194.2

Examples of Cr18Ni10Ti steels stress corrosion cracking caused by residual stresses in bending and pitting areas. Barakhtin B. K., Malyshev V. N. – Voprosy Materialovedeniya, 2015, N 2 (82), p. 161–166.

The paper considers the results of stress corrosion cracking tests for U-shaped test pieces with ends not secured made of Cr18Ni10Ti and 18CrNi8 steels in 1N HCl solution at room temperature and saturated NH_4Cl solution at 100°C. It has been found that corrosion cracks appear both on convex and concave sides. This fact contradicts the well known concepts, according to which, after bending and subsequent elastic stress in the surface layers residual stresses of different signs have to be initiated on opposite sides of the samples. Examples of microcracks formation by the growing pittings on smooth flat specimens made of Cr18Ni10Ti steel in the absence of external stresses have been presented.

Keywords: Cr18Ni10Ti steel, stress corrosion cracking, residual stress, pitting.

UDC 621.039.534.25:539.219.2:620.194.2

Measuring of residual stresses in the heat exchanger tubes of NPP steam generators. Shimov G. V., Rosenbaum M. A., Serebriakov Al. V., Serebriakov An. V. – Voprosy Materialovedeniya, 2015, N 2 (82), p. 167–174.

One of the main factors determining the technical condition and service life of the nuclear steam generator, is the state of the heat exchanger tubes. During operation of the steam generator effects of corrosive environment combined with operating stresses lead to stress corrosion cracking of the tubes. This is due to tensile residual stresses in the pipe wall. It is necessary to develop a methodology to manage residual stresses determining its volume and nature of their distribution in the wall.

Key words: heat exchanger tubes, steam generator, stress corrosion cracking, residual stress, measurement technique, stress distribution, elastic relaxation, electrolytic etching.

UDC 621.039.58:539.4

Criteria formulating and reasoning procedure for the safe operation of pipelines and equipment for FBR in the conditions of leaked sodium burning. Karzov G. P., Ramazanov R. M., Margolin B. Z., Petrov V. A., Vilensky O. Yu. – Voprosy Materialovedeniya, 2015, N 2 (82), p. 175–192.

The paper describes the developed procedure and calculated criteria for the safe operation of pipelines and equipment of primary and secondary circuits in the conditions of leaked sodium burning. The procedure uses methods of calculation of through-thickness crack stability and limit states of design section modified to operating conditions for sodium installations. To determine the rate and volume of leaked sodium the authors offer engineering approaches based on the Bernoulli equation, and on the calculation of the hydraulic diameter in the smallest (critical) cross-section, and estimation of the hydraulic resistance in the through-thickness crack channel.

Keywords: fast breeder reactor (FBR), equipment, safe operation, through-thickness crack channel, sodium flow.

UDC 621.039.58:539.4

Initial data and criteria for the safe operation of pipelines and equipment for FBR in the conditions of leaked sodium burning. Karzov G. P., Ramazanov R. M., Margolin B. Z., Petrov V. A., Vilensky O. Yu. – Voprosy Materialovedeniya, 2015, N 2 (82), p. 193–208.

The paper defines safety evaluation criteria for pipelines of secondary FBR circuit. The short-term and long-term properties of strength and ductility, fracture toughness, creep rate and creep crack growth rate in the temperature range 550–800°C for steel 08Cr16Ni11Mo3 have been given. The most likely scenario of burning sodium has been presented. The results of the testing procedures in a straight section of the pipeline Du 900 at the sodium flow by through-thickness cracks and burning in the outer surface have been studied. The diagram of pipeline admissible states has been built up by leaked sodium amount.

Keywords: fast breeder reactor (FBR), equipment, safe operation, through-thickness crack channel, sodium flow, evaluation criteria.

UDC 621.039.5:621.791.052:620.179.16

The method to establish the cause of destruction of welded connection of the SAOR pipeline of the reactor VK-50 installation. Trofimov M. A., Globa R. A. – Voprosy Materialovedeniya, 2015, N 2(82), p. 209–215.

The article describes the cause of the destruction of the welded joint due to an increase in grain size, as well as the determination of grain size in the heat-affected zone of the welded joint pipe reactor plant by measuring the amplitude of the backwall echo ultrasonic inspection by means of the defectoscope A 1212 Master of “PRO”.

Keywords: ultrasonic defectoscope A 1212 Master of “PRO”, direct separate-combined piezoelectric converter, average grain size, metallographic studies, heat-affected zone of the welded joint, base metal.

UDC 669.295:539.421

Influence of temperature, load ratio and load frequency on fatigue crack growth rate for titanium alloy VT8. Gorbovets M., Nochovnaya N. – Voprosy Materialovedeniya, 2015, N 2(82), p. 216–220.

Fatigue crack growth rate (FCGR) is the important characteristic of mechanical properties of alloys applied in aircraft. FCGR characterizes reliability of alloys. Influence of parameters of loading at FCGR tests was investigated on heat-resisting titanium alloy VT8. FCGR was investigated at two temperatures: 20, 450°C and two load ratios: 0 and 0.5, and two load frequencies: 7 and 15 Hz. It was shown that temperature and load ratio exert influence on FCGR but frequency does not exert.

Key words: FCGR, crack growth rate, titanium alloy, fatigue, test technique, cycle of load, Paris curve, stress intensity factor.