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## ABSTRACTS OF PUBLISHED ARTICLES

UDC 669.15–194:661.666:621.785.36

**Empirical formulas for calculation of temperatures and concentration of carbon adequating paraequilibrium of the basic phases in steels.** Sokolov D. F., Vasiliev A. A., Kolbasnikov N. G., Sokolov S. F. – Voprosy Materialovedeniya, 2012, N 1(69), p. 5–13.

Calculations of the austenite–ferrite and austenite–cementite paraequilibrium temperatures, as well as paraequilibrium carbon concentrations in the austenite and ferrite, as a function of temperature and substitution alloying elements (Mn; Si; Cr; Mo; Ni) content were performed using the Thermo-Calc software. On the basis of the obtained data set the empirical formulas were developed that provide high accuracy calculations for a corresponding phase equilibrium temperatures and carbon concentrations.

*Keywords:* austenite, ferrite, cementite, carbon concentrations, phase paraequilibrium.

UDC 669.14.018.58'786:621.771.016

**Effect of warm rolling on low-magnetic corrosion-resistant nitrogen-alloyed steel.** Gromova N. B., Drozdova N. F., Kalinin G. Yu., Yampolsky V. D. – Voprosy Materialovedeniya, 2012, N 1(69), p. 14–17.

The paper studies an effect of warm rolling on the properties of corrosion-resistant steel alloyed with nitrogen. Warm rolling at 700°C gives rise to lattice microdistortions in austenitic 04X20H6Г11M2AФБ steel quenched at 1200°C that are due to strain-induced lattice defects with precipitated fine-dispersed phase nuclei (nitrides). The steel properties vary with the degree of strain and time of warm rolling over a wide range:  $\sigma_Y = 520–1360$ ;  $A_5 = 18–57\%$ ;  $Z = 62–71\%$ ;  $KCV^{20} = 51–240 \text{ J/cm}^2$ . It has been suggested that the precipitation of fine-dispersed nitride phases at the dislocation genesis stacking faults forms a nanostructure.

*Keywords:* low-magnetic corrosion-resistant steel, nitrogen alloying, warm rolling, lattice microdistortions, mechanical properties.

UDC 669.15–194.2:669.046.554:621.643

**New out-of-furnace technology of low-alloyed tube steels treatment.** Mileikovsky A. B. – Voprosy Materialovedeniya, 2012, N 1(69), p. 18–28.

The paper shows the new technology of out-of-furnace treatment developed for tube steels (categories of durability K60, X70 and X80), and designed for the manufacture of large diameter pipes for offshore and onshore major gas and oil pipelines with high operability. The reasons of the increased impurity of tube steels by nonmetallic inclusions are established. They have examined aspects of out-of-furnace treatment providing increase of cleanliness of steel on nonmetallic inclusions. The data of corrosion-mechanical testing of tubes metal and dependence of impact strength of metal on a level of impurity by nonmetallic inclusions is presented.

*Keywords:* ladle treatment, tube steel, strip, the main pipeline, nonmetallic inclusions, vacuum-carbon deoxidation.

UDC 669.295:539.374.6

**Improvement of mechanical properties of titanium by a method of dynamic channel-angular pressing.** Zeldovich V. I., Frolova N. Yu., Kheifets A. E., Khomskaya I. V., Shorokhov Ye. V., Nasonov P. A. – Voprosy Materialovedeniya, 2012, N 1(69), p. 29–37.

The technical titanium has been subjected to severe plastic deformation by means of new method of dynamic channel-angular pressing at elevated temperature. Deformation rate was  $10^3–10^5 \text{ s}^{-1}$ . The obtained bimodal (duplex) structure consisted of a heterogeneous mix of recrystallized grains with the size of 1–2 microns and the deformed fields having polygonal structure with the size of subgrains of 200–300 nanometers. After dynamic channel-angular pressing at 530°C by two passes the tensile strength 650 MPa has been obtained at elongation of 19%. Additional rolling 50% at 300°C and low-temperature annealing had raised the tensile strength up to 790 MPa at preservation of high values of elongation of 15%.

*Keywords:* titanium, high-speed deformation, submicrocrystalline structure, mechanical properties.

UDC 666.792.32:621.762.5

**Properties of the sintered materials on the basis of micropowders of silicium carbides.** Perevislov S. N., Chupov V. D., Ordanyan S. S. – Voprosy Materialovedeniya, 2012, N 1(69), p. 38–43.

Ceramic materials based on micron silicon carbide powder were obtained by liquid phase sintering in argon with oxide promoters  $Y_2O_3$ ,  $MgO$ ,  $Al_2O_3$ . The oxide composition corresponded to the eutectic oxides in the ternary system in the sequence of garnet – spinel oxides concentration was 5–20%. It has been achieved strength flexural  $\sigma = 660 \pm 30$  MPa, compressive strength  $\sigma = 1600 \pm 35$  MPa, the coefficient of crack  $K_{IS} = 5,0 \pm 0,2$  MPa·m<sup>1/2</sup>. It is shown that sintered materials of SiC significantly softening bending strength at a temperature of  $\geq 1300^\circ C$  ( $\sigma \sim 350$  MPa).

*Keywords:* liquid-phase sintering, silicon carbide, mechanical properties.

UDC 666.792.5:661.865.4:539.23:535.34

**Influence of the surface treatment of lanthanum hexaboride nanoparticles on the composite material optical properties.** Didenko A. L., Riabchinskaya L. V., Tolochko O. V., Ahn Joon Mo, Kudriavtsev V. V. – Voprosy Materialovedeniya, 2012, N 1(69), p. 44–51.

Thin-film samples of the hybrid nanocomposite material based on the polymer matrix were obtained and contain from 0.1 to 1.0 wt. % of nanoparticles of lanthanum hexaboride. These samples have high absorption capacity in the near infrared region with a maximum transmittance in the visible range, the structure and optical properties of the samples were studied. Properties comparison of films filled with nanoparticles of lanthanum hexaboride with surface modification carried out in different ways were made. The samples with the particles treated with 3-aminopropyltriethoxysilane in ethanol solution show the best optical properties.

*Keywords:* nanocomposite, optical properties, lanthanum hexaboride, encapsulation.

UDC 669.35:539.213.27:537.621

**Research of influence of the copper content on high-frequency and static magnetic properties of Finemet-type alloy.** Yuranova T. Yu., Mazeeva A. K., Muhamedzianova L. V., Furmon M. S., Kuznetsov P. A., Peskova A. S. – Voprosy Materialovedeniya, 2012, N 1(69), p. 52–57.

The influence of the copper contents (varying from 0 up to 3.2 mas. %) on high-frequency and static magnetic properties of AMAГ-200 alloy (Russian analogue of Finemet-type alloy) has been researched at different regimes of heat treatment. The opportunity of these properties increasing was analysed by producing nanocrystal structure in the amorphous matrix. On the basis of the established dependences the temperature interval of heat treatment was determined. Under these temperatures the receiving of amorphous-nanocrystal structure with the volumetric content of crystal phase 20–80 % and the average size of crystal grains 10–30 nanometers is probable.

*Keywords:* AMAГ-200 alloy, copper content, magnetic properties, heat treatment, amorphous-nanocrystal structure.

UDC 669.295'786:539.234:539.62

**Structure and phase composition of TiN-based films and its role in the formation of mechanical and tribological properties.** Kameneva A. L. – Voprosy Materialovedeniya, 2012, N 1(69), p. 58–67.

The mechanism of the influence development of structural and phase characteristics and stresses in the TiN-based films is researched. The effect of technological and thermal parameters of the arc evaporation on its mechanical and tribological properties, wear ability has been established. It is revealed that in the low-temperature deposition a nanocrystalline film with a unique complex of physic, tribological properties and the minimum of wearing out ability of a film would be an optimal combination of structural characteristics and the phase composition, technological and temperature conditions of deposition.

*Keywords:* production and temperature formation parameters, TiN-based films, arc evaporation, electron microscopic examination, X-ray diffraction phase analysis, mechanical and tribological tests, the optimum range of technological options, a unique set of properties.

UDC 669.24'27:621.359:621.793

**Research of technological parameters of Ni–W alloy deposition from pyrofosphate-ammonium electrolyte.** Krasikov A. V. – Voprosy Materialovedeniya, 2012, N 1(69), p. 68–73.

The regularities of Ni-W alloy deposition from the electrolyte have been researched for coatings producing and the pH range providing electrolyte stable existence chosen for the deposition of the alloy. The paper describes the influence of pH electrolyte on the current efficiency. It is shown that the kinetics of electrochemical deposition for Ni-W coatings varies sharply in a narrow range (pH 9.0–9.5), due to the mixed pyrophosphate ammine complex of nickel forming in the electrolyte. The morphology and the microhardness of the coatings obtained from electrolyte at pH 9 and pH 9.5 are analyzed: the use of an electrolyte with a pH of 9.5 allows to get better coverage with a higher hardness.

*Keywords:* Ni–W alloy, coatings, electrolyte, deposition, current efficiency, quality coatings.

UDC 669.24'27:621.359:621.793

**Composition, microhardness and structure of coatings from alloy of system nickel-tungsten, obtained by electrochemical deposition method.** Furmon M. S, Krasikov A. V., Drozdova N. F. – *Voprosy Materialovedeniya*, 2012, N 1(69), p. 74–79.

The paper studies effects of current density and pH electrolyte upon microhardness, structure and contents of tungsten in Ni–W alloy. It is shown, that pH increase (range 8,6–10,0) causes the decrease of tungsten, and coatings achieve the maximum of microhardness when produced from electrolyte with pH 9,5 at density of current equal to 4–5 A/dm<sup>2</sup>. X-ray structure research of coatings received from electrolytes with various pH value at various current density, has shown, that alloy represents nanocrystal solid solution of tungsten in face-centered cubic lattice nickel with size of grain 10–20 nanometers. In samples of the coatings deposited from electrolytes with pH 8,6–9,5 at density of a current 1–2 A/ dm<sup>2</sup> they found out the impurity, probably, no stoichiometric oxides of tungsten, formed as a result of incomplete tungsten reduction. It is shown, that presence of impurity phase correlates with dependences of tungsten contents, microhardness and current efficiency from current density at various values of pH electrolyte.

*Keywords:* alloy Ni-W, coatings, electrodeposition, microhardness, pH, contents of tungsten.

UDC 621.762.2:621.763:669.018.25

**High-speed mechanosynthesis with desintegrator units for nanostructured powder materials wear resistant class of metal – ceramics.** Burkanova E. Yu., Farmakovskiy B. V. – *Voprosy Materialovedeniya*, 2012, N 1(69), p. 80–85.

The paper presents the basic technology of high speed mechanosynthesis for obtaining nanostructured composite powder materials of wear-resistant metal – ceramics.

*Keywords:* composite powder materials, mechanosynthesis, wear resistance.

UDC 669.14.018.8:621.762.5

**Analysis of properties of specimens manufactured by selective laser sintering of stainless steel 15-5PH.** Kudriavtseva I. V. – *Voprosy Materialovedeniya*, 2012, N 1(69), p. 86–90.

The research of influence of technological processes on structure, phase structure and mechanical properties of specimens was carried out in order to obtain high quality complex-shaped parts manufactured by selective laser sintering of high-strength stainless steel 15-5PH powder. The paper shows that the quality of specimens manufactured by laser sintering does not concede, and in some cases surpasses quality of the specimens manufactured by traditional technological processes.

*Keywords:* selective laser sintering, laser synthesis, high-strength stainless steel.

UDC 669.35:669.14:621.791.92

**Research of the intercrystalline penetrations of copper alloys into steel AB2 at weld deposition.** Veretennikov M. M., Vainerman A. E. – *Voprosy Materialovedeniya*, 2012, N 1(69), p. 91–98.

The paper shows the mechanism of copper and copper-nickel alloys of various structures penetrations into AB2 steel during surfacing. It is established, that at deposition of copper alloys upon AB2 steel the depth of intercrystalline penetrations depends on chemical composition of deposited copper alloy – at bronze Бр.ОЦ 4-3 surfacing it makes 1227 microns, copper M006 makes 473 grade microns, bronze Бр.АЖНМц 8,5-4-5-1,5 – 350 microns. At weld deposition of copper-nickel alloys (concentration of nickel increases up to 40%) depth of intercrystalline penetrations of copper-nickel alloy decreases up to 22 microns. If the concentration of nickel equals to 68% (and above) intercrystalline penetrations into steel are absent.

*Keywords:* AB2 steel, copper alloys, copper-nickel alloys, deposition, chemical composition, depth of intercrystalline penetrations.

UDC 669.35'24:621.791.052

**Research of the formation of chemical composition and metal structure in various zones of welded joints of ship pipelines from copper-nickel alloy МНЖМц 11-1.1-0,6.** Vainerman A. A., Vainerman A. E. – *Voprosy Materialovedeniya*, 2012, N 1(69), p. 99–106.

The paper studies the characteristic formation of composition and structure of pipes welded joints from copper-nickel alloy (10–12% nickel) with each other and with weld details from aluminium bronze Бр.А9Ж4Н4Мц1 and brass Л90.

*Keywords:* copper-nickel alloy, metal of welded connections, composition and structure, welded details, aluminium bronze Бр.А9Ж4Н4Мц1, brass Л90, ship pipelines.

UDC 678.067:621.315.61:620.197.5

**High-strength chemical resistant composite material for the anodes of the impressed current cathodic protection systems.** Stavitsky O. A., Kuzmin Yu. L., Troschenko V. N., Medianik T. E., Podshivalov A. V. – *Voprosy Materialovedeniya*, 2012, N 1(69), p. 107–113.

Methods to increase the term of service of insulating bases of the anodes used in the impressed current cathodic protection (ICCP) systems of metal constructions which are operated in sea water were considered. Research to increase the chemical resistance of the anodes bases by means of using different polymer materials as well as modification of currently used hot hard fiberglass STET type were carried out. As a result a new high-strength chemical resistant composite material was developed. Using of this material in the manufacturing of insulating bases will increase the term of service of a Pt–Nb anodes used in ICCP systems up to 30 years.

*Keywords:* anode, chemical resistant material, cover layer, active chlorine, rubber mixture of Pentasil-1513 type.

UDC 669.231'293:621.3.035.2:621.197.5

**Nanostructure platinum-niobium working electrodes for anodes of cathodic protection systems of vessels from corrosion.** Kuzmin Yu. L., Troschenko V. N., Lashevsky V. O., Smirnov S. M. – *Voprosy Materialovedeniya*, 2012, N 1(69), p. 114–119.

New perspective direction in the field of creation of systems of cathodic protection against corrosion is application of nanostructure platinum-niobium working electrodes of anodes of systems of cathodic protection. Development of industrial technology for laying of nanostructure platinum coating is one of the major problem in the field of creation of new generation materials.

*Keywords:* system of cathodic protection of vessels from corrosion, platinum-niobium electrodes for anodes, nanostructure coatings.

UDC 669.35'71:621.79:621.787.6:539.388.1

**Research of shot peening in zones of defects correction by welding in bronzes with reference to manufacturing and repair of ship rowing screws.** Chernobaev S. P., Vainerman A. E. – *Voprosy Materialovedeniya*, 2012, N 1(69), p. 120–125.

The paper researches influence of surface strengthening by method of shot peening on resistance of weariness of samples from bronzes with welding zones with reference to manufacturing and repair of ship rowing screws.

*Keywords:* bronze, surface strengthening, shot peening, resistance of weariness.

UDC 669.15–194.56:621.039.531:539.421.5

**Prediction of neutron irradiation effect on ductile fracture characteristics of austenitic steels.** Margolin B. Z., Sorokin A. A. – *Voprosy Materialovedeniya*, 2012, N 1(69), p. 126–147.

Equations have been formulated to describe the voids nucleation and growth in irradiated austenitic steels under deformation with different stress state triaxiality. Fracture criteria of material have been proposed for fracture by a plastic collapse mechanism due to voids coalescence and for channel fracture mechanism due to shear of ligaments between voids.

The formulated equations take into consideration two void populations: voids nucleated under deformation and irradiation-induced voids resulting in swelling.

Modeling of the effect of different factors (test temperature, neutron irradiation dose, stress state triaxiality, irradiation-induced swelling) on the fracture strain and fracture toughness have been carried out with comparative analysis of the calculated and experimental data. The effect of stress triaxiality on the plasticity of irradiated material has been determined. A relationship between the strain hardening parameters and the fracture strain and fracture toughness has been revealed.

*Keywords:* ductile fracture model, fracture strain, fracture toughness, irradiation induced swelling, stress state triaxiality, austenitic steel, neutron irradiation

UDK 669.15–194.56:621.039.531:539.4

**On the nature of effect of irradiation-induced swelling on the ultimate strength of irradiated austenitic materials.** Margolin B. Z., Sorokin A. A. – *Voprosy Materialovedeniya*, 2012, N 1(69), p. 148–162.

The mechanism providing an explanation for a sharp decrease of ultimate strength of austenitic steels at high level of irradiation induced swelling has been proposed. This mechanism called as “the running collapse” is caused by inhomogeneous swelling void distribution and unstable microcrack initiation under low stress.

A physical-and-mechanical model has been developed describing sharp decrease of ultimate strength. Model is based on the analysis of ductile fracture of material with vacancy voids and “the running collapse” mechanism.

*Keywords:* irradiation induced swelling, ultimate strength, austenitic steel, ductile fracture model, neutron irradiation.

UDC 669.018:413.001.4

**Glossary of words and definitions used in structural nanomaterials.** Kudriavtseva I. V., Kuznetsov P. A., Filimonov G. N. – *Voprosy Materialovedeniya*, 2011, N 1(69), p. 163–178.

An attempt for compilation of a glossary is undertaken due to the necessity to improve and put in order all the terms and definitions dedicated to “Structural nanomaterials” theme. The uniformity of terminology could help the experts to work and provide unequivocal recognition of published data upon development in the field of structural nanomaterials and nanotechnologies. The first part of a glossary (two first headings) is offered to the attention of material engineers.

*Keywords:* structural nanomaterials and nanotechnologies, glossary, terms and definitions.