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CONTENTS

ABSTRACTS OF PUBLISHED ARTICLES

UDC 669.14.018.29:539.422.22

Carbide phase transformation method as a factor in increasing brittle-fracture resistance of structural steels. Gorynin V. I., Olenin M. I., Khliamkov N. A., Timofeev B. T. – Voprosy Materialovedeniya, 2013, N 1(73), p. 7–19.

The effect of temperature and time parameters of ferrite ageing on the mechanical properties and structural changes in 09Г2СА-А (09G2SA-A), 38ХН3МФА (38KhNZMFA) and 10ГН2МФА (10GN2MFA) steels has been studied. The paper offers carbide phase transformation as a method, which provides high resistance of these steels to brittle fracture.

Keywords: steel, ferrite ageing, carbide phase, brittle-fracture resistance.

UDC 669.14.018.294.2:621.9.048.7

Rail steel treated by electron beam, its phase composition, structure, and fatigue life. Ivanov Yu. F., Gromov V. E., Grishunin V. A., Konovalov S. V. – Voprosy Materialovedeniya, 2013, N 1(73), p. 20–30.

The investigation of phase composition, structure and defect substructure of rail steel in initial state, after electron beam irradiation and after fatigue failure has been carried out by scanning and transmission electron microscopes. The operating mode of rail steel surface treatment by high intensive electron beam allowing multiplying the fatigue life (~ by 2.5 times) has been found. The physical mechanisms of fatigue life increase have been established.

Keywords: structure, phase composition, fatigue life.

UDC 669.14.018.41:539.389:621.77.016.2

Effects of microalloying with niobium on austenite recrystallization process in low-carbon steels. Soshina T. V., Zisman A. A., Khlusova Ye. I. – Voprosy Materialovedeniya, 2013, N 1(73), p. 31–36.

The threshold value of deformation degree for dynamic austenite recrystallization and end time of static recrystallization have been defined for high-strength low-carbon cold-resistant steels 09ХН2МДФ (09KhN2MDF) and 09ХН2МДБ (09KhN2MDB) microalloyed with vanadium and niobium in a wide temperature range. Basing on these data the paper determines conditions of hot plastic deformation required for the formation of a homogeneous fine-dispersed austenite structure in the fractional rolling.

Keywords: low-carbon cold-resistant steels, microalloying, hot plastic deformation, recrystallization, austenite structure.

UDC 669.14.018.41:539.389: 621.77.016.2

Structural changes' maps in austenite low-carbon steel 09ХН2МДФ (09KhN2MDF) at hot deformation formed and used for technological optimization. Zisman A. A., Soshina T. V., Khlusova Ye. I. – Voprosy Materialovedeniya, 2013, N 1(73), p. 37–48.

The paper defines the temperature threshold T_{nr} of static recrystallization at different degrees of prior deformation and threshold deformation p_{ε} of dynamic recrystallization depending on the temperature and strain rate for austenite in low-carbon ship-building 09ХН2МДФ (09HN2MDF) steel. On the basis of these data, obtained with the help of thermo-mechanical simulator Gleeble 3800, temperature and deformation maps have been built determining the range of technological parameters of thermomechanical processing, with different mechanisms of polycrystalline structure formation.

Keywords: low-carbon cold-resistant steel, hot plastic deformation, recrystallization, temperature and deformation maps, mechanisms of polycrystalline structure formation.

UDC 669.295

Additive technology in titanium of required structure and properties. Polkin I. S. – Voprosy Materialovedeniya, 2013, N 1(73), p. 49–57.

The paper describes certain technology of parts production: the traditional machined deformation of billet (technology of “deducting”) and manufacturing of titanium alloys parts by melting pellets layer by layer to obtain the final form (technology of “adding”). The appearance of parts, produced by “adding”, its structure and mechanical properties are presented, as well as the time required to its manufacture. Comparative calculations of the production cost of 1 kg of parts according “adding” and “deducting” technologies are shown. The possibility of creating of the pre-programmed structure in different areas in order to obtain certain mechanical properties to resist stresses developed in these areas. The created structure – in the various zones of detail – could be called “tailored” structure – structure with required properties.

Keywords: “adding” and “deducting” technologies, pellets, electron-beam melting, “tailored” structure, required properties.

UDC 669.018.44:620.172.251.2

Phase composition of refractory alloy 45Х26Н33С2Б2 (45Kh26N33S2B2) in the stabilization process. Dushin Yu. A., Oryshchenko A. S., Utkin Yu. A., Krasilnikov A. Z., Petrov S. N. – Voprosy Materialovedeniya, 2013, N 1(73), p. 58–71.

The paper studies the material ageing in the operational temperature range of pyrolysis equipment. The experimental part consisted in EBSD analysis of the alloy phase composition after isothermal hardening or long-term strength tests at 800–1100°C during 1000–5000 h. A crucial role of niobium in the stabilization (close to thermodynamic equilibrium) has been established. Two stable forms of its existence have been determined – at temperatures below 900°C it is G-phase $Nb_6Ni_{16}Si_7$; above 1000°C it is carbide NbC. Approximate dependence for the limit of carbon solubility and carbides concentration corresponds well with numerical modeling and at the same time reveals temperature and doping effects – either directly (through the equilibrium constant and specified concentrations of carbon, chromium, niobium), or via activity coefficients of elements and its components.

Keywords: pyrolysis equipment, refractory alloy, phase composition, EBSD analysis, ageing, thermodynamic equilibrium.

UDC 669.018:621.77.016.2

Oscillation structure transpositions according to the dissipation maps data due to the hot compression of 04Х20Н6Г11М2АФБ (04Kh20N6G11M2AFB) alloy. Barakhtin B. K., Lebedeva N. V., Markova Yu. M., Nemets A. M. – Voprosy Materialovedeniya, 2013, N 1(73), p. 72–80.

The distribution maps of the mechanical energy dissipation coefficients have been built in η(έ, ε) coordinates and based on the data of the compression of 04Х20Н6Г11М2АФБ (04Kh20N6G11M2AFB) alloy samples up to ε = 0.3 at έ (10^{-3}–10 s^{-1}) and *T* (900–1200°C). The constant level “centered” lines and saddle-to-saddle connections by a separatrix have been obtained on the maps for the temperatures: 900–950°C at η ~ 0, *T* = 1200°C near η ~ 20% and *T* ~ 1050–1100°C by η → 40%. Typical for periodic motion, these particularities were analyzed in terms of oscillation theory. The conclusion about the practicability of the dissipation maps has been drawn basing on the published and experimental data.

Keywords: hot plastic deformation, mechanical energy dissipation, oscillations, dissipation maps.

UDC 621.793:621.891

Wear-resistant refractory coating for friction pairs of fuel regulatory unit. Antsiferov V. N., Dudkin Yu. P., Smetkin A. A. – Voprosy Materialovedeniya, 2013, N 1(73), p. 81–87.

They have obtained coatings of Ti–Al–N on steel padding, excluding its heating above 200°C, by method of vacuum magnetron sputtering. The estimation of morphometric parameters of the structure, chemical and phase composition of coatings has been made with the help of scanning electron microscopy, X-ray analysis and microhardness measurements. Application of coatings in a friction pair with steel 20Х3МВФ-Ш (20KhZMVF-Sh) with carbonitriding layer decreases the friction factor and bondability, and provides a low-wear power.

Keywords: nanostructural coatings Ti–Al–N, column structure, wear resistance.

UDC 661.8.022:66.097.3

Formation copper-molybdate catalytic compositions on nano-sized oxides SiO_2 and TiO_2. Lebukhova N. V., Karpovich N. F., Kirichenko E. A., Makarevich K. S., Pugachevsky M. A. – Voprosy Materialovedeniya, 2013, N 1(73), p. 88–94.

The oxidic compositions for catalytic soot oxidation have been formed by pyrolysis of the equimolar mixture of Cu and Mo organic extracts supported on nanopowders (50–100 nm) of TiO_2 and SiO_2. It has been shown, that the activity of copper molybdate catalyst applied on the surface of TiO_2 is considerably above, than on the surface of SiO_2. The copper molybdate phase grains with diameter up to 50 nm have been observed in the structure of the composition $CuMoO_4/TiO_2$, which is including 2 wt. % of the catalyst but has the catalytic ability for soot oxidation comparable with bulk catalyst $CuMoO_4$.

Keywords: nanostructural oxide compositions, copper molybdate, catalytic soot oxidation.

UDC 621.793:539.217.1

Study of the porous characteristics of nanocatalysts based on aluminum oxide and intermetallic compounds of nickel–aluminum. Yakovleva N. V. – Voprosy Materialovedeniya, 2013, N 1(73), p. 95–101.

The characteristics of the porosity and specific surface area of the porous coatings based on aluminum oxide and intermetallic compounds of nickel–aluminum have been studied through physical sorption of gases. The positive influence of the chemical and thermal treatment on the characteristics of porosity has been established. The paper shows that the porous coatings could be considered mezoporous materials.

Keywords: porous coating, method of physical sorption of gases, adsorption-desorption isotherms, specific surface area, BET method, pores' volume, average pore size, pores' distribution per size.

UDC 621.762

Study of the mechanism of universal superfast disintegrator-activator treatment for production of soft magnetic powder materials from amorphous tape of Fe-Cu-Nb-Si-B alloy. Gerashchenkova E. Yu., Samodelkin Ye. A., Kuznetsov P. A., Pervukhina M. S., Yakovleva N. V. – Voprosy Materialovedeniya, 2013, N 1(73), p. 102–112.

The paper presents morphological analysis of powders produced by universal disintegrator-activator treatment from amorphous tape of Fe–Cu–Nb–Si–B alloy (AMAG-200).

Keywords: soft magnetic powder materials, disintegrator-activator treatment, morphological analysis.

UDC 621.762

Research of mechanical alloying and subsequent sintering of powder intermetallic composition Ti–Al–Nb. Smetkin A. A. – Voprosy Materialovedeniya, 2013, N 1(73), p. 113–119.

Multiphase powders and sintered materials Ti–14Al–20Nb (wt %) have been received by a mechanical alloying technique of elementary powders. Features of forming composition particles have been revealed at high-energy ball milling using SEM, XRD analysis. It is shown that the increase of mechanical alloying leads to the crushing of the layered structure of composite particles containing alloying elements. The powders are multiphase, consisting of O-Ti_2AlNb, α_2-Ti_3Al (DO_{19}), γ-TiAl. Features of shrinkage processes of samples at consolidation are revealed during heating up to 1250°C. The microstructure of sintered aluminides is bimodal with grain size 13.0–17.0 μm.

Keywords: mechanical alloying, composition particles, titanium aluminides, sintering, shrinkage, phase composition.

UDC 621.762

Process of powder materials production by shock-and-activator treatment for porous nanostructured coatings based on intermetallic compounds of nickel – aluminum. Gerashchenkova Ye. Yu., Ramaldanova A. A., Krasikov A. V., Samodelkin E. A. – Voprosy Materialovedeniya, 2013, N 1(73), p. 120–126.

The paper studies grain-size composition and morphology of the powder particles ПМ-НЮ50 (PM-NYU50), as received. It is shown that the material contains about 0.5% vol. of fractions suitable for sputtering cathodes for chemical sources of electric current and heat by microplasma method. Shock-and-activator treatment leads to production of powder with high contents of 50–80 microns fractions used in the microplasma spraying, while the attritor refines the powder to the particles less than 50 microns size, which do not allow producing valid cathodes.

Keywords: chemical source of electric current and heat, porous coating, shock-and-activator treatment, grinding.

UDC 678.743.41

Nanocomposites based on polytetrafluoroethylene and serpentinite. Kirillina Yu. V., Sleptsova S. A. – Voprosy Materialovedeniya, 2013, N 1(73), p. 127–135.

The structural changes that occur during the formation of polymer-silica composite material, its physical, mechanical and tribological properties were studied. The efficiency of the integrated development of modified PTFE tribological materials was shown: simultaneous administration of serpentinite and nanospinel of magnesium as a filler of PTFE has significantly improved wear resistance of the material (up to 2500), while maintaining high values of deformation and strength characteristics. Additional introduction of magnesium nanospinel contributed to the formation of polymer-silicate intercalated structure.

Keywords: polymer, nanocomposite, filler, polytetrafluoroethylene, serpentinite, layered silicate.

UDC 678.743.41

Development of technological methods of controlling of composites' properties based on polytetrafluoroethylene, containing nanomodifiers. Okhlopkova A. A., Petrova P. N., Gogoleva O. V., Parnikova A. G. – Voprosy Materialovedeniya, 2013, N 1(73), p. 136–145.

This paper presents the results of research on the technological methods development of polymeric composites based on polytetrafluoroethylene containing nanomodifiers. Polymer composite nanomaterials with increased performance characteristics have been designed on the basis of the developed technologies. It was established that the increase of the wear resistance up to 250 times with improved plasticity heightens the reliability, safety and operational efficiency of transport and process equipment.

Keywords: polytetrafluoroethylene, nanofiller, mechanical activation, structure formation, coefficient of friction.

UDC 621.791.048

Influence of metallic mineral and synthetic components on weldability and mechanical properties of the flux and the weld metal. Pimenov A. V., Shekin S. I. – Voprosy Materialovedeniya, 2013, N 1(73), p. 146–153.

The effect of metallic mineral and synthetic components on welding characteristics of agglomerated flux and mechanical properties of the weld metal have been studied as applied to the slag system MgO-CaF_2-Al_2O_3-SiO_2. Basic slag flux composition has been defined. It was found that the metal welded with welding wire Sv-10GNA under agglomerated flux possesses the highest values of impact energy at low temperatures (down to −60°C). The basic composition of flux in this case is characterized by synthetic slags: CaF_2–Al_2O_3 plus CaF_2–Al_2O_3–CaO with component ratio 13:5 and 55:23:19 respectively.

Keywords: welding, agglomerated flux composition, components, low-alloyed wire, weld metal, properties, cold resistance.

UDC 621.791.042.4

Hydroxy compounds in the coating of welding electrodes. Gorynin I. V., Malyshevsky V. A., Brusnitsyn Yu. D., Kalinnikov V. T, Nikolaev A. I., Avvakumov Yu. V., Bykov A. N. – Voprosy Materialovedeniya, 2013, N 1(73), p. 154–165.

The paper consideres technological aspects of consumer properties of welding electrodes by preventing the development of the formation of hydroxide compounds in coating masses, and improving on that basis, the whole process of welding of structural steels.

Keywords: welding electrodes, coating mass, hydroxide compounds.

UDC 621.791.053:[669.014.018.8+669.295]

Welded seams' structure of Cr18Ni10Ti (12X18H10T) steel and VT1-0 (BT1-0) titanic alloy with an intermediate copper plate after laser melting. Pugacheva N. B., Trushina Ye. B., Pugacheva Ye. I., Orishich A. M., Cherepanov A. N. – Voprosy Materialovedeniya, 2013, N 1(73), p. 166–174.

The laser welding modes influence on formation and structure of welded seams after laser melting of corrosion-resistant steel Cr18Ni10Ti and titanic alloy VT1-0 through an intermediate copper plate has been investigated. Methods of an optical metallography, phase X-ray diffraction and micro spectral analyses, microhardness measurements, static stretching and fractures classification have been used for research. It is shown that the material of a welded seam consists of a supersaturated firm solution of alloying elements in copper with regular distributed disperse particles of intermetallides $Ti(Fe,Cr)_2$ and $TiCu_3$. The paper determines welding modes which enable to form strong compounds with undendritic structure, the most homogeneous as refers its chemical composition and the character of microhardnes values distribution.

Keywords: laser, welding, speed of a beam movement, radiation power, focal length, chemical homogeneity, dendrite, intermetallide, microhardness.

UDC 669.295:620.193

Strengthening of titanium corrosion resistance in concentrated aqueous chloride at high temperatures. Leonov V. P., Shcherbinin V. F., Malinkina Yu. Yu. – Voprosy Materialovedeniya, 2013, N 1(73), p. 175–181.

The paper studies the possibility of improving the corrosion resistance of titanium of industrial grade 5B (5V) by cathodic doping with ruthenium. The high efficiency of the doping to prevent crevice and general corrosion in chloride-containing environments at elevated temperatures has been shown.

Keywords: industrial titanium alloy, corrosion resistance, cathodic doping with ruthenium.

UDC 669.715:620.193:620.17

Comparing the corrosion resistance of wrought aluminum alloys according to the results of field and field-accelerated in doors testing. Kurs M. G., Karimov S. A., Makhsidov V. V. – Voprosy Materialovedeniya, 2013, N 1(73), p. 182–190.

A comparative evaluation of the characteristics of climatic resistance of aluminum alloy 1370T1 and B-1461T1, used in aircraft industry, during full-scale field-accelerated testing in a warm-temperate climate has been made. When testing, the rate of corrosion, intercrystalline depth and pitting corrosion, loss of mechanical properties have been supervised. Effects of the alloys structure on their corrosion properties have been analyzed.

Keywords: aluminum alloys, corrosion, intercrystalline corrosion, field-accelerated testing.

UDC 669.018.44:620.172.251.2

Calculation of soakers' pipe components in pyrolysis furnaces EP-300, made of alloy 45X26H33C2Б2 (45Kh26N33S2B2). Analysis of methodical features. Popova I. P., Oryshchenko A. S., Margolin B. Z., Utkin Yu. A., Gromova N. B. – Voprosy Materialovedeniya, 2013, N 1(73), p. 191–211.

The paper analyzes methodical features of calculating for soakers' pipe components in pyrolysis furnaces EP-300, made of alloy 45X26H33C2B2 **(**45Kh26N33S2B2), under thermomechanical loading in a high-temperature creep. The pattern of temperature increasing inside the pipe wall during operation due to coking has been found. The possible causes of premature failure of the soakers are based on the calculations of temperature fields and stress-strain state of pipes, as well as on the data of the deformation capacity and fatigue resistance of the material. The authors suggest the computational procedure of analyzing reaction tube temperature and its stress-strain state considering the growth of coke layer, as well as the calculation of its performance according to the criteria of the deformation capacity of exhaustion and fatigue strength.

Keywords: soakers, pyrolysis furnace, thermomechanical loading, fatigue resistance, temperature fields, computational procedure.

UDC 669.018.296:539.4

The strength characteristics of airframe materials under the impact of moisture. Lutsenko A. N., Grinevich A. V., Karimova S. A. – Voprosy Materialovedeniya, 2013, N 1(73), p. 212–219.

The paper considers the characteristics that are commonly used to estimate the strength and reliability of aircrafts based on statistics. The authors discuss the requirements reflected in the latest edition of Aviation Regulations, as the law for certification of aircraft. It is shown the necessity of evaluation of strength characteristics (such as fatigue, fracture toughness) for metallic and composite materials in the presence of moisture. The criterion of corrosion evaluation has been suggested.

Keywords: strength characteristics, calculated values, moisture, corrosion environment.

UDC 669.018.296:620.193

Durability and corrosion fatigue of structural materials. Grinevich A. V., Lutsenko A. N., Karimova S. A. – Voprosy Materialovedeniya , 2013, N 1(73), p. 220–229.

Durability of the products, subject to variable loads, is characterized by operation time, i. e. by the number of flights. It is shown that the only coefficients, which until now do not have methods of their determination are the coefficients of reliability, taking into account the effects of the corrosive environment. It is proposed and experimentally confirmed the criterion of corrosive damage under the effect of corrosion environment. Developed methods allow assessing the damage to the corrosion and open up the possibility of fatigue-test for materials exposed to corrosive environment in real time, which reflects operating conditions.

Keywords: corrosion, fatigue, durability, reliability coefficients.

UDC 669.017.1:621.039.531

Modeling of cluster formation in alloys based on Fe–Cr during thermal annealing and under irradiation. Svetukhin V. V., Lvov P. E., Gaganidze E., Krestina N. S. – Voprosy Materialovedeniya, 2013, N 1(73), p. 230–240.

A model of radiation-stimulated formation of second phase particles in binary alloys under irradiation. The model describes the growth of second phase particles in the alloys Fe–*X*Cr (*X* = 12, 14, 16, 20 at.%), determining diffusion coefficient of chromium under irradiation, which is almost seven orders of magnitude higher than the corresponding value, conditioned by thermal processes.

Keywords: nucleation, kinetics, decomposition of solid solution, impact of reactor irradiation, radiation-enhanced diffusion.