

**SCIENTIFIC AND TECHNICAL JOURNAL
"PROBLEMS OF MATERIALS SCIENCE"**

N 2(58), 2009

CONTENTS

METALS SCIENCE. METALLURGY

Karzov G. P., Teplukhina I. V., Filimonov G. N., Matyusheva E. L., Zotova A. O. Prospects of development of high-chromium steels of enhanced heat resistance	5
Zotova A. O., Teplukhina I. V. Research of influence of temperature ageing on disposition to brittle fracture of hull plate with contents of 0,6–0,8% nickel	24
Olenin M. I., Pavlov V. N., Bykovsky N. G., Osipov I. S., Bashaeva E. N., Guselnikova T. M., Prijmina T. A. Influence of homogenization on cold resistance high-strength corrosion resistance steel 07X16H4B	33
Mukhacheva T. L., Dyakov I. G., Belkin P. N. The two-component saturation specify of the structural steels by nitrogen and carbon at the anodic electrolyte heating	38

FUNCTIONAL MATERIALS

Aleutdinova M. I., Fadin V. V., Durakov V. V. Influence of phase composition of rider on wear resistance of composite with a basis out of steel ШХ15 at friction with current collection	46
Peyev A. P., Kuz'min S. V., Lysak V. I., Arentraut A. A. Some regular trends in structure and properties changes of the copper-aluminum composite materials once they are and heat treated.	52
Beloshenko V. A., Matrosov N. I., Chishko V. V., Dyakonov V. P., Pavlovskaya E. A., Sennikova L. F., Szymczak H., Gajda D., Zaleski A. J., Piechota S. Properties of multifiber superconducting composite after the equal-channel multi-angle pressing	59
Motkov L. L., Sokolov L. A., Shtatckiy V. A., Anisimov A. V. Investigation of tribotechnical properties of friction pairs based on ФУТ type carbon plastic at model conditions of friction in axle bearing	66
Paznikov E. A., Petrekov P. V., Kalmykov P. I., Mishukova E. V., Nasonov A. D., Kalinin M. A. Influence of the hardener on the relaxation properties of the tetrazolecontaining polymer	75

WELDING. WELDING MATERIALS

Gorynin V. I., Popov V. O., Drozdova N. F., Chistjakova E. G., Barakhtin B. K., Nikolaev V. I. Laser cleaning against impurities of nonmetallic components of materials of fluxes and coatings for electrodes	81
--	----

STRUCTURAL-WORKING STRENGTH AND SERVICEABILITY OF MATERIALS

Margolin B. Z., Kursevich I. P., Sorokin A. A., Lapin A. N., Kohonov V. I., Neustroev V. S. To the problem of irradiation-induced swelling and irradiation embrittlement of austenite steels. Part I. Experimental results.	89
Margolin B. Z., Kursevich I. P., Sorokin A. A., Vasina N. K., Neustroyev V. S. To the problem of irradiation-induced swelling and irradiation embrittlement of austenite steels. Part II. The basic physical and mechanical regularities.	99
Margolin B. Z., Fomenko V. N., Sorokin A. A. Analysis of conditions of crack development in elements of PVI WWER subjected to strong neutron irradiation	112

Abstracts of published articles	127
--	-----

License contract concerning entitlement for using of an article	135
--	-----

Journal of science and engineering "Problems of Materials Science". Design of article. Recommendations	137
---	-----

Author index	139
---------------------------	-----

ABSTRACTS OF PUBLISHED ARTICLES

UDC 669.15–194:669.14.018.85:621.165

Prospects of development of high-chromium steels of enhanced heat resistance. Karzov G. P., Teplukhina I. V., Filimonov G. N., Matyusheva E. L., Zotova A. O. – Problems of Materials Science, 2009, N 2 (58), pp. 5–23.

An attempt was made to summarize main existing developments in the field of refractory materials for steam turbines with supercritical and over and supercritical steam parameters. Analysis of the most promising directions of the work in this field was made.

Key words: steam turbines, supercritical steam parameters, refractory materials, endurance, moderately alloyed hard solution

UDC 669.15–194:621.039.536.2:539.422.22

Research of influence of temperature ageing on disposition to brittle fracture of hull plate with contents of 0,6–0,8% nickel. Zotova A. O., Teplukhina I. V. – Problems of Materials Science, 2009, N 2 (58), pp. 24–32.

Predisposition of hull plate 15X2MΦA-A, B mod. with content of 0,6–0,8% nickel to embrittlement under influence of increased temperatures is researched. Results of definition of impact strength, results of metal-graphic, fractographical researches and analysis of thin structure of steel are resulted.

Key words: hull plate, temperature ageing, predisposition to brittle fracture, thin structure, methods of researches.

UDC 669.14.018.8:621.78

Influence of homogenization on cold resistance high-strength corrosion resistance steel 07X16H4B. Olenin M. I., Pavlov V. N., Bykovsky N. G., Osipov I. S., Bashaeva E. N., Guselnikova T. M., Prijmina T. A. – Problems of Materials Science, 2009, N 2 (58), pp. 33–37.

Regimes of heat treatment for forgings out of 07X16H4B steel are developed, providing receiving of impact strength at -50°C not below 59 J/cm^2 and strength category of KΠ70 (687 MPa) at production conditions of JSC "PO 'Sevmash'".

Key words: corrosion resistance steel, heat treatment, cold resistance.

UDC 621.765.5

The two-component saturation specify of the structural steels by nitrogen and carbon at the anodic electrolyte heating. Mukhacheva T. L., Dyakov I. G., Belkin P. N. – Problems of Materials Science, 2009, N 2 (58), pp. 38–45.

Oxygen, carbon and nitrogen concentrations in the surface layers of the low-carbon steels after its anodic nitrocarburization in the aqueous solutions of the ammonium chloride (10 mass. %) and carbamide (20 mass. %) are measured by nuclear proton backscattering. Nitrogen and carbon diffusion coefficients in the low-carbon steel in the temperature interval $650\text{--}950^{\circ}\text{C}$ including their cross-diffusion coefficient are determined.

The nitrogen and carbon diffusing flows interaction is confirmed. By the increase of saturation temperature the additional carbon diffusion acceleration is observed due to nitrogen diffusion. According to this coefficient appropriate influence of nitrogen diffusion on carbon diffusion is positive. This influence is assumed to occur due to higher carbon solubility in the austenite arising at the lower temperature as a result of nitrogen diffusion. The calculation method of the full set of the nitrogen and carbon diffusion coefficient used experimental nitrogen and carbon concentrations distribution in the surface layers of the modified low-carbon steels is recommended.

Key words: anodic carburizing, ammonium chloride, carbamide, low-carbon steel, two-component saturation, diffusion coefficient, nitrocarburization, electrolytic cell, microhardness, nuclear proton backscattering, X-ray phase analysis, cobalt X-ray radiation, method of least squares, carbonitride, ferrite, austenite.

UDC 621.763:621.77.016.2

Influence of phase composition of rider on wear resistance of composite with a basis out of steel ШХ15 at friction with current collection. Aleutdinova M. I., Fadin V. V., Durakov V. V. – Problems of Materials Science, 2009, N 2 (58), pp. 46–51.

Topography of friction surface of model riders on the basis of carbide-steel after sliding is presented at density of a current above 100 A/cm^2 . Wear resistance and electro resistance of electrocontact sliding zone of a composite on the basis of converted steel ШХ15 and rider containing corrosion resistance steel and carbide chrome are certain.

Key words: composite on the basis of steel ШХ15, rider from corrosion-resistant steel and carbide chrome, friction with current collection, wear resistance, electro resistance.

UDC 669.35'71:621.791.13:621.78

Some regular trends in structure and properties changes of the copper-aluminum composite materials once they are and heat treated. Peyev A. P., Kuz'min S. V., Lysak V. I., Arentraut A. A. – Problems of Materials Science, 2009, N 2 (58), pp. 52–58.

The article presents some regular trends in structure and properties changes of the copper-aluminum composite materials once they are explosion welded and heat treated. The heat treatment regimes which make possible to produce the composite with optimal plastic and electrophysical properties are specified.

Key words: copper-aluminum composite materials, explosion welded, plastic and electrophysical properties.

UDC 621.763:621.77.016.2

Properties of multifiber superconducting composite after the equal-channel multi-angle pressing. Beloshenko V. A., Matrosov N. I., Chishko V. V., Dyakonov V. P., Pavlovskaya E. A., Sennikova L. F., Szymczak H., Gajda D., Zaleski A.J., Piechota S. – Problems of Materials Science, 2009, N 2 (58), pp. 59–65.

Conditions for implementation of the equal-channel multi-angle pressing (ECMAP) of multifiber composite containing 210 NbTi alloy fibers have been considered. Data on ECMAP effect on physics-mechanical properties of the multifiber superconducting wire are given.

Key words: multifiber superconducting composite, equal-channel multi-angle pressing, physics-mechanical properties.

UDC 678.067:621.891:539.538

Investigation of tribotechnical properties of friction pairs based on ФУТ type carbon plastic at model conditions of friction in axle bearing. Motkov L. L., Sokolov L. A., Shtatckiy V. A., Anisimov A. V. – Problems of Materials Science, 2009, N 2 (58), pp. 66–74.

The test results of friction in water media for ФУТ phenolic carbon plastics in pair with steel 20Х13 are presented. The tests were held for different loads, at temperatures up to 80°C , sliding velocities range 14–18 m/s, different overlap coefficient.

The best friction pair according the test results is ФУТ-БФ carbon plastic – steel 20Х13, affording average wear rate 0.003–0,008 $\mu\text{m}/\text{hrs}$ and steady friction coefficient 0,009–0,018. The necessity of construction design of face friction of carbon plastic and overlap coefficient of friction pair at the range of 0.16–0.34 is approved.

Key words: tribotechnical properties, friction pair, carbon plastic, friction coefficient, contact surface area, wear rate, overlap coefficient, sliding velocity.

UDC 678.067:620.172.224

Influence of the hardener on the relaxation properties of the tetrazolecontaining polymer. Paznikov E. A., Petrekov P. V., Kalmykov P. I., Mishukova E. V., Nasonov A. D., Kalinin M. A. – Problems of Materials Science, 2009, N 2 (58), pp. 75–80.

Are investigated the dynamic viscoelastic properties both three-dimensional of the cross-linked and nonhydrogenated tetrazolecontaining polymer by the method of dynamic mechanical analysis in the temperature interval from -80 to 80°C .

As a result accomplished work it is established that during the consolidation of polymer the resultant bridges prevent internal rotation and mutual displacement of macromolecules. The rigidity of chains of polymer because of this increases, and they are given, as show the results of experiments, necessary elastic properties and thermal resistance to polymeric models. The use of the hardener leads to an increase in vitrification temperature by 27.5°C, and the width of the transition zone of the three-dimensional cross-linked polymer is shifted by 45% in the region of higher temperatures.

Key words: tetrazolecontaining polymer, dynamic relaxation properties, dynamic mechanical analysis, dynamic modulus of elasticity, the tangent of the angle of mechanical losses, vitrification temperature.

UDC 621.791.04

Laser cleaning against impurities of nonmetallic components of materials of fluxes and coatings for electrodes. Gorynin V. I., Popov V. O., Drozdova N. F., Chistjakova E. G., Barakhtin B. K., Nikolaev V. I. – Problems of Materials Science, 2009, N 2 (58), pp. 81–88.

Method of laser cleaning against impurities of nonmetallic components of materials of fluxes and coatings is offered, its regularities and peculiarities are certain. It is experimentally established, that laser processing promotes to receiving of nonmetallic welding materials of high degree of purity (up to 0.002%), and also increase in passivity of welding materials in relation to liquid glass that give prospects of use of laser emission for receiving of welding materials with increased weld-technological properties.

Key words: welding materials, nonmetallic components, method of laser cleaning against impurities, weld-technological properties.

UDC 669.15–194.56:621.039.531

To the problem of irradiation-induced swelling and irradiation embrittlement of austenite steels. Part I. Experimental results. Margolin B. Z., Kursevich I. P., Sorokin A. A., Lapin A. N., Kohonov V. I., Neustroyev V. S. – Problems of Materials Science, 2009, N 2 (58), pp. 89–98.

To investigate the effect of swelling on mechanical properties of irradiated austenitic steel the investigations were conducted with steel 18Cr–10Ni–Ti and its weld irradiated up to the same damage doses over two different temperature ranges: at the irradiation temperature of 330–340°C when swelling is practically absent and at 400–450°C when a considerable swelling level of 3–13% is observed. Basing on the investigation results the temperature dependences of tensile properties of irradiated metal were constructed. Comparative investigations of magnetization of irradiated metal at different irradiation temperatures were performed. Fracture surfaces for ruptured specimens were examined by SEM.

Key words: austenite steel, irradiation-induced swelling, irradiation embrittlement, results of experiments.

UDC 669.15–194.56:621.039.531

To the problem of irradiation-induced swelling and irradiation embrittlement of austenite steels. Part II. The basic physical and mechanical regularities. Margolin B. Z., Kursevich I. P., Sorokin A. A., Vasina N. K., Neustroyev V. S. – Problems of Materials Science, 2009, N 2 (58), pp. 99–111.

The results of mechanical test and investigations of fracture surfaces of tested specimens of austenitic steels undergone high neutron irradiation presented in the first part of the article are analyzed from the point of view of possible fracture mechanisms. The mechanisms are proposed that link the $\gamma \rightarrow \alpha$ transformation and ductile to brittle transition in austenitic steels undergone neutron irradiation. The criterion is proposed allowing one to determine the radiation conditions under which the $\gamma \rightarrow \alpha$ transformation make it possible a ductile to brittle transition in austenitic steels.

The possible causes of a sharp decrease of the ultimate tensile strength for material with high level of swelling are considered.

Key words: austenite steel, irradiation-induced swelling, irradiation embrittlement, criterion of estimation.

UDC 621.039.531:539.421

Analysis of conditions of crack development in elements of PVI WWER subjected to strong neutron irradiation. Margolin B. Z., Fomenko V. N., Sorokin A. A. – Problems of Materials Science, 2009, N 2 (58), pp. 112–126.

Conditions of stable and unstable crack growth by the mechanism of ductile fracture under quasi-static loading are analyzed. Simulation of crack growth by the finite element method based on the strain fracture criterion is performed. Investigation is carried out of the effect of the ratio of an elementary crack extension size to a plastic zone size on the character of J_R -curves. Based on these investigations conditions are determined for which unstable crack growth is possible against the backgrounds of small scale and large scale yielding. The criterion is stated for the absence of unstable crack growth in highly irradiated austenitic steels in components of internals.

Key words: elements of pressure vessel internals WWER, conditions of crack development, ductile failure, quasi-static loading, numerical modeling.