

# SCIENTIFIC AND TECHNICAL JOURNAL "PROBLEMS OF MATERIALS SCIENCE"

N 1(61), 2010

## CONTENTS

### METALS SCIENCE. METALLURGY

- Murav'ev V. I., Frolov A. V., Bashkov O. V., Kirikov A. V., Tarasov E. A.* The acoustic emission features during steels phase transformations ..... 5
- Nachinkin V. P.* Specific features of application of maraging steel with contents of the titanium of 0,83 and 0,42% ..... 16
- Olenin M. I., Pavlov V. N., Bykovsky N. G. Osipova I. S., Bashaeva E. N., Sorokin A. V., Fomtsov V. M., Prolomov V. V.* Development of regimes for thermal processing of materials for fixing elements used in containers for transportation and long storage of fulfilled nuclear fuel..... 25
- Ivanov I. Yu., Suliagin R. V., Orlov V. V., Kruglova A. A., Sharapova D. M., Ivanov C. Yu.* Research of structure for heat-affected zone of welded joint out of steel of a class of durability X80 after imitating modeling of heat influences ..... 31
- Barakhtin B. K., Drozdova N. F., Savenkov G. G., Fedoseiev M. L.* Structure changes in the copper flat target, caused by nanosecond impact of the concentrated stream of energy of high capacity ..... 40

### FUNCTIONAL MATERIALS

- Porozova S.E., Kulmet'ieva V. B., Zigan'shin I. R., Torsunov M. F.* The comparative characteristic of definition content results for monoclin phase in zirconium dioxide ..... 46
- Ermakov A. N., Misharina I. V., Grigorov I. G., Ermakova O. N., Beketov I V., Zaynulin U. G.* The phase formation and microstructure of compositions TiN–Ni–AlN sintered in vacuum ..... 53
- Bogun V. S., Bakhareva V. E., Anisimov A. V.* Sliding bearings out of antifrictional carbon glass plasatics for centrifugal pump of power installations..... 60
- Nasibulina L. I., Mudimela R., Nasibulin A. G., Koltsova T. S., Tolochko O. V., Kauppinen E. I.* Synthesis of carbon nanotubes and nanofibers on particles of silica and cement ..... 66
- Kornopoltsev V. N., Mognonov D. M.* Dioxide of lead as the modifier of composite materials on the basis of polytetrafluoroethylene ..... 72

### WELDING AND CLADDING, WELDING MATERIALS AND SOLDER

- Vajnerman A. E., Veretennikov M. M.* Researches of claddings of copper-nickel alloy with high content of nickel on aluminium-nickel bronze ..... 78
- Pribytkov G. A., Andreeva I. A.* Structure of soldered joints of titanium BT1-0 with sintered powder titanium ..... 86

### STRUCTURAL-WORKING STRENGTH AND SERVICEABILITY OF MATERIALS

- Viktorov N. A.* Influence of speed of deformation on resistance of deformation at a stretching steels 10X18H10..... 95
- Lebedev E. L.* Laws of fracturing in plates out of alloys AMr6 and Д16 at presence of locally applied drop of gallium. Astimation of the scale factor..... 99

### RADIATIVE MATERIALS SCIENCE

- Epov G. A., Pechenkin V. A.* Modelling of evolution for cooper-nickel abstractions in structural steels of reactors on thermal neutrons ..... 108

### CORROSION PROTECTION OF METALS

- Malyshev V. N.* Corrosion cracking of X18H10T steel in one-normal solution of hydrochloric acid at room temperature, initiated by hydrogenation ..... 117

**Author index**..... 126

**Abstracts of published articles** ..... 127

**License contract concerning entitlement for using of an article** ..... 135

**Journal of science and engineering "Voprosy materialovedenia". Design of article.**

**Recommendations** ..... 137

## ABSTRACTS OF PUBLISHED ARTICLES

UDC 620.179.17:669.14.018.29:669.017.3

**The acoustic emission features during steels phase transformations.** Murav'ev V. I., Frolov A. V., Bashkov O. V., Kirikov A. V., Tarasov E. A. – Voprosy materialovedenia, 2010, N 1(61), p. 5–15.

There are results of research of acoustic emission (AE) signals parameters that accompany the steel phase transformation during heat treatment on 5 construction steel and austenite steel instances in this paper. The research aim is creation the prerequisites of AE method as multipurpose on-line precision easily instrument for research and checking the thermal phase transformations. It will can improve the heat treatment effectiveness.

It is showed the possibility of using the AE method for phase transformation research during heat treatment and critical points determination. The AE power and AE spectrum are more information acoustic emission parameters for indicated utilization. These parameters allow to determinate the phase transformations borders and AE source types. The AE spectrums are depended on heat treatment type, material make and heat treatment conditions.

The discovering AE features during steel thermal phase transformations will able to use for steel heat treatment optimization and improve the goods operating properties. But for practical utilization of discovering phenomenon, it is necessary to research its more thoroughly and to corroborate the results on other material types and on other treatment conditions. Also it is necessary to compare the results with the results of research of classical method with aim of prepare the practical method of phase transformation borders and accuracy valuing the offer method.

*Key words:* acoustic emission, martensite, pearlite, austenite, phase transformation, 5 steel, total pulse number, total energy, activity, power, spectrum.

UDC 669.15–194.55:539.389.3

**Specific features of application of maraging steel with contents of the titanium of 0,83 and 0,42%.** Nachinkin V. P. – Voprosy materialovedenia, 2010, N 1(61), p. 16–24.

Were effected experimental researches of physical properties of maragine steel, during ageing and nitriding of which are occurred structural changes – allocation of intermetallic phases, martensite disintegration and formation of reversive austenite. Researches were held with reference to the high-speed ship tooth gearings made of steel with contents of the titanium of 0,83 and 0,42%.

*Key words:* maragine steel, high-speed tooth gearings, structural transformations.

UDC 669.15–194:621.78:621.039.746:621.642

**Development of regimes for thermal processing of materials for fixing elements used in containers for transportation and long storage of fulfilled nuclear fuel.** Olenin M. I., Pavlov V. N., Bykovsky N. G., Osipova I. S., Bashaeva E. N., Sorokin A. V., Fomtsov V. M., Prodomov V. V. – Voprosy materialovedenia, 2010, N 1(61), p. 25–30.

Are given results of researches upon development of regimes of thermal processing part blanks for fixing elements out of 38XH3MΦA and 07X16H4B steels, providing receiving of impact strength at level  $KCV^{50} \geq 59 \text{ J/sm}^2$  at observance of requirements upon category of strength: КП685 for steel 38XH3MΦA grade and КП735 for steel 07X16H4B grade. The developed regime of thermal processing allows to receive on one heat of steel 07X16H4B guaranteed upon condition of screwing distinction of hardness values (not less than 12 HB) for pair a bolt-nut.

*Key words:* steel, fixing elements, containers for fulfilled nuclear fuel, thermal processing, impact strength.

UDC 621.791.051.6:621.78:669.14.018.295

**Research of structure for heat-affected zone of welded joint out of steel of a class of durability X80 after imitating modeling of heat influences.** Ivanov I. Yu., Suliagin R. V., Orlov V. V., Kruglova A. A., Sharapova D. M., Ivanov C. Yu. – Voprosy materialovedenia, 2010, N 1(61), p. 31–39.

Are researched structure and properties of heat-affected zone of welded joint for pipes out of steel of class of strength X80. It has been established, that on a zone of large grain there is formation of bainite structures, and on a zone of full recrystallization – structure of fine-grained ferrite that is agreed with

results received at imitation of thermal influences at welding by the way of thermokinetic diagrams with heating up to various temperatures.

*Key words:* steel, welded joint, heat-affected zone, modeling of heat influences.

UDC 539.2:539.411.5

**Structure changes in the copper flat target, caused by nanosecond impact of the concentrated stream of energy of high capacity.** Barakhtin B. K., Drozdova N. F., Savenkov G. G., Fedoseiev M. L. – *Voprosy materialovedenia*, 2010, N 1(61), p. 40–45.

Is shown by methods of light metallography, electronic raster microscopy and X-ray structure analysis that as a result of the concentrated influence of electronic beam by 650 keV energy during 40 nanoseconds in a flat copper target is formed the polyscale structure in which the minimal size of crystalline particles 30–60 nanometers.

*Key words:* electronic beam, plastic deformation, destruction, structure, nanosize condition.

UDC 666.762.52:543.424

**The comparative characteristic of definition content results for monoclin phase in zirconium dioxide.** Porozova S.E., Kulmet'ieva V. B., Zigan'shin I. R., Torsunov M. F. – *Voprosy materialovedenia*, 2010, N 1(61), p. 46–52.

Content of monoclin phase in powders partially stabilized of zirconium dioxide by yttrium dioxide was determined upon ratio of intensities peaks of corresponding phases on diffraktogramms and spectrums of combinational dispersion of light and as per Ritveld method. It is shown, that changes of content of monocline phase in series of measurements on one method have the identical tendency out-of-dependence from a method of measurement. Results of calculations upon spectrum of combinational dispersion of light are overestimated in comparison with results of definition on Ritveld method. Results of calculations upon ratio of intensities peaks on diffraktogramms in comparison with results of definition upon Ritveld method are underestimated. Reduction of distinctions between results of measurements upon three methods testifies about decrease of structural heterogeneity of zirconium dioxide.

*Key words:* zirconium dioxide, monocline phase, tetragonal phase, spectroscopy of combinational dispersion of light, X-ray structural analysis, Ritveld method .

UDC 621.763:621.762.5

**The phase formation and microstructure of compositions TiN–Ni–AlN sintered in vacuum.** Ermakov A. N., Misharina I. V., Grigorov I. G., Ermakova O. N., Beketov I V., Zaynulin U. G. – *Voprosy materialovedenia*, 2010, N 1(61), p. 53–59.

The phase formation in and the microstructure of titanium nitride– nickel alloys with aluminum nitride (AlN) nanopowder additions are investigated by X-ray diffraction, electron-microscopic, and electron-probe microanalyses. The phase interaction is characterized by the redistribution of aluminum between refractory and binding phases with the formation of a nonstoichiometric titanium–aluminum  $Ti_{1-n}Al_nN$  nitride and a aluminum nickelide ( $Ni_3Al$ ) in various modifications. The number of forming phases and their compositions are controlled by the kinetic parameters of the process

*Key words:* phase formation, microstructure, liquid phase sintering, nitride titanium, nickel, X-ray diffraction, electron-microscopic.

UDC 678.067:539.538:621.822.5

**Sliding bearings out of antifrictional carbon glass plasatics for centrifugal pump of power installations.** Bogun V. S., Bakhareva V. E., Anisimov A. V. – *Voprosy materialovedenia*, 2010, N 1(61), p. 60–65.

Were developed the polymeric composite materials of new class intended for manufacturing of details of pumps for power installations. Complex of researches has shown, that the developed materials provide reliable operation of bearings with temperature of a greasing liquid 60–125°C in structure of serial (ПКБТ-230 P, КПТН-2 P, etc.) and perspective pump units СЭУ, ТЭС and atomic power stations.

*Key words:* polymeric composite materials, power installations, parts of pumps, sliding bearings.

UDC 661.66:539.2:66.091.3: 669.14.046:581.2

**Synthesis of carbon nanotubes and nanofibers on particles of silica and cement.** Nasibulina L. I., Mudimela R., Nasibulin A. G., Koltsova T. S., Tolochko O. V., Kauppinen E. I. – *Voprosy materialovedenia*,

2010, N 1(61), p. 66–71.

It was proposed a simple method of carbon nanomaterial growth directly on the surface of matrix particles. As matrix particles were used silica fume particles which were impregnated by iron salt solution. Cement particles were utilized without additions of catalyst. Acetylene was successfully utilized as a carbon source.

*Key words:* gas-phase synthesis, composite material, cement, carbon nanotubes.

UDC 678.743.41

**Dioxide of lead as the modifier of composite materials on the basis of polytetrafluoroethylene.** Kornopoltsev V. N., Mogonov D. M. – *Voprosy materialovedenia*, 2010, N 1(61), p. 72–77.

Is researched the opportunity of modifying for overmolecular structure at receiving of composite materials. Interest is represented with modifiers, chemically active at temperatures of sintering of polymer.

*Key words:* polytetrafluoroethylene, modification, spinel of cobalt, dioxide lead, physico-mechanical properties, high-filled, composite material

UDC 621.791.92:669.35'24

**Researches of claddings of copper-nickel alloy with high content of nickel on aluminium-nickel bronze.** Vajnerman A. E., Veretennikov M. M. – *Voprosy materialovedenia*, 2010, N 1(61), p. 78–85.

Are considered features of cladding a copper-nickel alloy with high content of nickel on aluminium-nickel bronze. Is effected calculated and experimental check of chemical composition for metal of claddings. It is shown, that argon-arc cladding is necessary to carry out with alternating current on minimal rate of energy input not less than in 2 layers.

*Key words:* copper-nickel alloy, aluminium-nickel bronze, cladding

UDC 621.791.3:669.26

**Structure of soldered joints of titanium BT1-0 with sintered powder titanium** Pribytkov G.A., Andreeva I.A. – *Voprosy materialovedenia*, 2010, N 1(61), p. 86–94.

Were researched microstructure, phase and element structure of soldered seam and abut diffusion zones arising at a contact-jet soldering of the titanium through layers from nickel, low-carbon steel and 79HM nickel alloy. On the basis of results of structure researches and measurements of microhardness the problem of reliability of soldered joints was discussed.

*Key words:* titanium, contact-jet soldering, reliability of soldered joints.

UDC 669.15–194.56:539.382.2

**Influence of speed of deformation on resistance of deformation at a stretching steels 10X18H10.** Viktorov N. A. – *Voprosy materialovedenia*, 2010, N 1(61), p. 95–98.

Influence of various speeds of deformation on resistance of deformation steels 10X18H10 in the range of temperatures 500–1000°C is investigated. The stretching of samples was carried out in vacuum with speeds of deformation  $\dot{\epsilon}_1 = 3.3 \cdot 10^{-4} \text{ c}^{-1}$ ;  $\dot{\epsilon}_2 = 3.3 \cdot 10^{-3} \text{ c}^{-1}$  и  $\dot{\epsilon}_3 = 3.3 \cdot 10^{-2} \text{ c}^{-1}$ . It is revealed, that the greatest resistance of deformation and strength size in all range of temperatures occurs at the most smaller speed of deformation  $\dot{\epsilon}_1 = 3.3 \cdot 10^{-4} \text{ c}^{-1}$ . The obtained data it is possible to use at carrying out to thermomechanical processing and punching.

*Key words:* сталь 10X18H10, скорость деформации, растяжение, штамповка, предел прочности.

UDC 669.715:669.871:539.219.2

**Laws of fracturing in plates out of alloys AMr6 and Д16 at presence of locally applied drop of gallium. Astimation of the scale factor.** Lebedev E. L. – *Voprosy materialovedenia*, 2010, N 1(61), p. 99–107.

Is presented law of fracturing in structural aluminium alloys at presence of gallium. The given law is explained by a competition of gallium diffusion along walls of cracks to its mouth and diffusion of gallium in volume of the sample. The estimation of the scale factor is executed. The factor of proportionality is entered.

*Key words:* aluminium alloys, diffusion of gallium, fracturing, scale factor.

UDC 669.15–194:621.039.536.2:539.422.22

**Modelling of evolution for copper-nickel precipitates in structural steels of reactors on thermal neutrons.** Epov G. A., Pechenkin V. A. – Voprosy materialovedenia, 2010, N 1(61), p. 108–116.

The increase of ductile-brittle transition temperature of structural steels of thermal nuclear reactor pressure vessels under irradiation may significantly limit its further work. This phenomenon is connected with the nucleation and growth of secondary phase precipitates with high concentrations of impurity elements in irradiated steels. It was found that copper and nickel were the most common constituents of such precipitates. A model of radiation-induced precipitate kinetic is developed in this paper. It is proposed that Cu atoms are responsible mainly for the nucleation of precipitates and Ni atoms are responsible for the growth of precipitates. In this model nickel atoms don't influence on the precipitate without copper atoms. Evolution of Cu–Ni precipitates and connected with it the increase in the shear strength of irradiated pressure vessel steels is calculated in this article. As calculations show, the increase of nickel concentration is most significant for copper levels of 0.05–0.09%.

*Key words:* radiation-induced precipitate, structural steels, irradiated pressure vessel steels.

UDC 669.14.018.8:620.193.4

**Corrosion cracking of X18H10T steel in one-normal solution of hydrochloric acid at room temperature, initiated by hydrogenation.** Malyshev V. N. – Voprosy materialovedenia, 2010, N 1(61), p. 115–125.

Are given results of tests for flat samples by thickness ~0,14 micron out of X18H10T steel on corrosion cracking in 1N solution of HCl during which were fixed current status of deformation of samples and were estimated intensity of metal hydrogenation after their destruction. It is shown, that at corrosion hydrogen introduced in steel before causing destruction because hydrogenation of superficial layers, promotes increase of creep of metal. Is offered the calculated model for estimation of hydrogenation degree for superficial layers at corrosion depending of diffusion factors of hydrogen, speed and time corrosion cracking.

*Key words:* corrosion-resistant steel, corrosion cracking, hydrogenation, creep.