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ABSTRACTS OF PUBLISHED ARTICLES

UDC 669.14.018.295:629.5

Alloying principles and requirements for production technologies of new generation high-strength vessel steels. Oryshchenko A. S., Khlusova E. I., Golosienko S. A. – Voprosy Materialovedeniya, 2014, N 2 (78), p. 9–25.

Alloying principles for new high-strength cold-resistant steels for marine equipment with the yield strength of 500–800 MPa are developed. The technology is based on the lower amount of expensive alloying elements.

Optimum structure requirements to high-strength steels used for marine engineering are discussed. The paper shows hot plastic processing schemes for industry with direct hardening and tempering aiming at nanosized structural elements forming. The results of industrial testing of new high-strength steels and their comparison with the known properties of the hardened and tempered steels are presented.

Keywords: high-strength vessel steel, niobium and vanadium microalloying, nanosized structural elements, hot plastic processing.

UDC 669.15'786–194.56:620.193

High-strength austenitic welded steel for shipbuilding. Malyshevsky V. A., Kalinin G. Y., Teplenicheva A. S., Mushnikova S. Y., Fomina O. V., Kharkov A. A. – Voprosy Materialovedeniya, 2014, N 2(78), p. 26–35.

The paper depicts long-term research resulting in creation of high-nitrogen austenitic steels for shipbuilding. It shows the influence of the chemical composition and technology on the crystal lattice and steel structure, mechanical and corrosion properties, weldability and other characteristics.

The paper studies nitrogen austenitic steels fine structure and shows the important role of nitrogen that impacts on strength and corrosion resistance more effectively than carbon, while maintaining a high level of plastic properties, resistance to cyclic and dynamic loading. Magnetic and vibrodamping characteristics are evaluated.

High-strength nitrogen austenitic steel with the yield strength of 650 MPa has been successfully adopted by the domestic industry. Its implementation for the heavy duty structures is in the final stage. A prognostic for further development of nitrogen austenitic steels for various industries is given.

Keywords: high-strength nitrogen austenitic steels, structure and properties, heavy duty structures, prospects of application.

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Marine titanium alloys: present and future. Gorynin I. V., Oryshchenko A. S., Leonov V. P., Kudryavtsev A. S., Mikhailov V. I., Chudakov E. V. – Voprosy Materialovedeniya, 2014, N 2 (78), p. 36–47.

CRISM "Prometey" was the first in the world who used titanium alloys as structural materials for marine equipment. Specialized titanium alloys for ship hulls, marine power systems and ship engineering are widely used in shipbuilding and other industries. "Prometey" created titanium alloys with the yield strength of 785 MPa and technologies of large semi-products manufacturing: boards, plates with thickness up to 160 mm, sheet billets for stamping and blank forgings.

A 50-year experience in titanium hull structures operation showed pseudo-α-alloys to have the best composition of welded titanium alloys for marine equipment. These alloys as parts of welded structures are characterized by good weldability and adaptability, high corrosion and mechanical resistance in metallurgical works and shipbuilding.

Currently, the company is working to improve the yield strength of pseudo-α-class alloys to 950 MPa, as well as developing the ultra-strong titanium alloy for autonomous manned submersibles, allowing the hydro-geological studies and works at depths up to 11 km. Work is in progress on the titanium alloys designed for marine equipment operating in extreme conditions of the Arctic offshore.

Keywords: titanium alloys, pseudo-α-alloys, development work, prospects of application.

UDC 669.018.44:669.187.56:621.74.042

Titanic alloys in steam turbine construction. Gorynin I. V., Leonov V. P., Kudryavtsev A. S., Ivanova L. A., Travin V. V., Lysenko L. V. – Voprosy Materialovedeniya, 2014, N 2 (78), p. 48–62.

The main results of complex researches of properties of high-strength welded titanic pseudo-α-alloys are considered. Its composition 6%Al, 1,5%V, 1,0%Mo, 0,5%Zr, 0,1%C и 6%Al, 2,0%Mo, 0,5%Zr, 0,1%C define its effective use in parts and products of transport turbine steamers. The durability of titanic elements of the power equipment is estimated.

Keywords: titanic pseudo-α-alloys, turbine steamers, static durability, low-cyclic and multi-cyclic endurance, thermal stability.

UDC 669.295:629.5

Titanium tubes production in factories of Russian Federation. Leonov V. P., Kopylov V. N., Rtischeva L. P., Smirnov V. G., Egorov M. V. – Voprosy Materialovedeniya, 2014, N 2(78), p. 63–72.

After the breakup of the Soviet Union the titanium tubes production for shipbuilding and nuclear power equipment was relocated outside Russia in the Ukraine, production ties were lost, production and supply of titanium tubes stopped, technical documentation for the supply of titanium tubes was also focused in the Ukraine (specification holder Ukrainian NITI, Dnepropetrovsk). For Navy orders and supply of nuclear power equipment, it was necessary to organize titanium tubes production at the enterprises of the Russian Federation.

CRISM “Prometey” analyzed the domestic enterprises adaptable for producing tubes from titanium alloys. The assessment criteria for these enterprises were the available equipment, the level of technical and technological support, availability of qualified personnel and experience of industrial activity in the organization of high-quality cold drawing pipes production. The analysis indicated that the best prepared for such works were the plants of TVEL Corporation: Chepetsky Mechanical Plant, Ltd. in the town of Glazov, and Machine-Building Plant (ELEMASH-SPETSTRUBOPROKAT, LLC) in the town of Elektrostal. The unique production technology of titanium ingots, titanium slabs and hot-quality titanium tubes for nuclear energy and shipbuilding were developed by the abovementioned plants.

Keywords: titanium tubes, manufacturing, technology features.

UDC 669.295:621.774

Macrocrystalline structure of centrifugal cast tubes and quantitative analysis of dispersed phases in interborder space of the alloys base composition 50X32H43 (50Kh32N43) at the operating temperatures. Oryshchenko A. S., Utkin Yu. A., Petrov S. N., Ptashnik A. V. – Voprosy Materialovedeniya, 2014, N 2 (78), p. 73–84.

The paper shows a large group of heat-resistant alloys for high temperature pipe coil systems for various purposes developed by CRISM “Prometey”. The main research directions for the improvement of alloys were determined. Macrocrystalline structure of centrifugally cast tubes and quantitative analysis of dispersed phases in interborder space alloys of 50H32N43 base composition at operating temperatures was investigated. The optimum methods of cast products and structures manufacturing were proposed to ensure the stability of phases in high-temperature equipment operation.

Keywords: heat-resistant alloys, alloying, pipe coil systems, high-temperature installations, centrifugal cast pipes, macrocrystalline structure.

UDC 678.067:621.891

Heat resistant antifriction carbon plastics with super-thermoplastic polymer matrix. Gorynin I. V., Anisimov A. V., Bakhareva V. E., Lishevitch I. V., Nikitina I. V. – Voprosy Materialovedeniya, 2014, N 2(78), p. 85–95.

For the first time in Russia new antifriction carbon plastics based on super-thermoplastic matrix, made of polyheteroarylenes, have been developed by CRISM “Prometey”. These carbon plastics combine high strength and wear resistance at friction with lubricants made of water, including overheated up to 200°C, aggressive liquids, condensed gases, gasoline, oils, and in some cases without lubricants.

The important advantage of new antifriction carbon plastics is the significant range of working temperatures from cryogenic (–240°C) up to 200°C. The paper describes successful experience of sliding bearings exploitation in centrifugal “hot” pumps of ship energy machines and vapor turbines.

Keywords: antifriction carbon plastic, sliding bearings, super thermoplastics, polyheteroarylenes, heat resistance, range of working temperatures.

UDC 621.762:621.891:620.178.16

Carbon and friction filler effect on powder frictional material properties research. Shakina A. V., Shtanov O. V. – Voprosy Materialovedeniya, 2014, N 2 (78), p. 96–102.

Carbon and friction fillers (aluminium oxide and silicon oxide) effect on powder materials properties is studied to elaborate efficient frictional metal-ceramic material of wagon braking shoe on the iron base. The results of powder materials 'iron – carbon' and 'iron – friction filler' friction tests for friction coefficient and volume wear determination are shown. Researched materials surface layer peculiarities are described to explain obtained dependences of volume wear and friction coefficient from carbon and friction fillers concentration.

Key words: frictional material, powder metallurgy, friction coefficient, volume wear, surface layer.

UDC 621.793.7

Adhesive durability of the composite reinforced 'metal – nonmetal' coatings, produced by gas dynamic cold spray. Gerashchenkov D. A., Farmakovsky B. V., Samodelkin E. A., Gerashchenkova E. Yu. – Voprosy Materialovedeniya, 2014, N 2 (78), p. 103–117.

The influence of reinforcing components concentration and of the method of powder composition manufacturing on the adhesive durability of composite 'metal – nonmetal' coatings is investigated. An alloy of Al-Zn-Sn system was chosen as matrix material, Al_2O_3 aluminum oxide was chosen as reinforcing components.

The paper presents studies' results of adhesive durability of the coatings consisting of matrix Al-Zn-Sn material and reinforced coatings of Al-Zn-Sn and Al_2O_3 system, received by various methods.

Keywords: composite reinforced coverings, system metal – nonmetal, adhesive durability, method of cold gasdynamic dusting.

UDC 669.017:620.1

Advanced research and development of scientific nanotechnology center CRISM "Prometey" in the sphere of new nanomaterials. Gorynin I. V., Oryshchenko A. S., Farmakovsky B. V., Kuznetsov P. A. – Voprosy Materialovedeniya, 2014, N 2 (78), p. 118–127.

The article provides information about the facilities of scientific nanotechnology center CRISM "Prometey", considering nanodispersed materials, functional and functionally gradient coatings on their basis, as well as 3D-volume products of particularly complex forms. The paper shows nanocenter unique advantages such as the most advanced technological equipment and on the other hand the operational methods of structure and properties control of nanomaterials. Results of complex studies for specific high-tech products are also shown.

Keywords: nanosized materials, nanotechnology center CRISM "Prometey", advanced research and development.

UDC 669.14.018.295:621.791.04

Welding materials and technology of high strength steels. Bishokov R. V., Baryshnikov A. P., Gezha V. V., Melnikov P. V. – Voprosy Materialovedeniya, 2014, N 2 (78), p. 128–137.

The review of welding materials, techniques and methods used for high-strength steels welding is given. Further priorities of automation development and concentrated energy sources application along with traditional welding technologies are defined. Most promising is to create volumetric structural metallic materials with finely dispersed structures for providing a unique combination of high level of strength, ductility, toughness, and resistance to fatigue and corrosion-mechanical failure due to the formation of equidistributed or spatially textured nanoscale structures.

Keywords: high-strength steels, welding materials, welding technology priorities.

UDC 621.791:669.715′721

Assessing the impact of structural and technological factors on properties of aluminum-magnesium welded joints at cryogenic temperature. Pavlova V. I., Zykov S. A., Osokin E. P. – Voprosy Materialovedeniya, 2014, N 2 (78), p. 138–154.

The influence of the main factors of welding (filler composition, welding process, welding repeated heatings, weld character) on the properties of the weld metal and welded joints of alloys 1550 and 1565ch at temperatures of 293–77 K has been researched. The tendency of metal alloy joints in 1550 (as well as the alloy itself) to the low temperature hardening has been registered; meanwhile 1565ch alloy strength corresponds at low temperatures to the strength at room temperature. Hardening at cryogenic temperatures of 1565ch alloy welding joints can be achieved by forming fine-grain structure of the weld metal due to the filler material containing scandium, solid-phase welding, also important is the constructive and technological seam design.

Keywords: aluminum-magnesium alloys, butt joints, weld metal, welding structural and technological factors, mechanical properties, cryogenic temperature.

UDC 669.14.018.44

The calculation of permanent joint of nickel superalloy and intermetallic nickel-based alloy stability. Ovsepyan S. V., Bazyleva O. A., Letnikov M. N., Arguinbaeva E. G. – Voprosy Materialovedeniya, 2014, N 2 (78), p. 155–162.

The permanent joints (brazing, rotary friction welding and deformation on the Bridgman anvil) of cast intermetallic nickel-based alloys (VKNA-4U, VKNA25, VKNA-1V) and wrought nickel-based superalloy EP975-ED (ЭП975-ИД) were investigated. The local chemical composition of the joint zone was detected; the physical-chemical modeling of the joint zone as in the initial state and after heat treatment was performed.

According to the calculation results the phase composition of the joint zone EP975 – VKNA is stabile; the risk of topologically closed packed (TCP) phases forming is low. This result suggests the possibility of applying couples: EP975 and nickel intermetallic VKNA-type alloys as a materials for permanent joints ‘disc-blade’.

Keywords: nickel superalloy, nickel-based intermetallic alloy, alloying, chemical composition, permanent joint, heat treatment, phase stability, modeling.

UDC 669.14.018.295:621.791.04

Electrochemical protection against corrosion of ships and offshore structures. Oryshchenko A. S., Kuzmin Yu. L. – Voprosy Materialovedeniya, 2014, N 2(78), p. 163–183.

The paper presents main domestic systems of electrochemical protection against corrosion of ships, vessels and offshore structures and presents criteria of electrochemical protection of shipbuilding structural metallic materials against corrosion and corrosion-mechanical damages in seawater. CRISM “Prometey” created new anode materials, anodes, and other elements of cathodic protection systems in shipbuilding and national economy.

Keywords: protection against corrosion, electrochemical protection system, anodes, sacrificial anodes, main directions of research.

UDC 669.15–194:621.039.536.2

Upgrading the safety of WWER power plants by improving steels for reactors. Karzov G. P., Margolin B. Z., Teplukhina I. V., Piminov V. A. – Voprosy Materialovedeniya, 2014, N 2(78), p. 184–198.

Materials science aspects of improving operational safety of promising WWER reactors are reviewed. The requirements for materials of reactor structures and the analysis of vessel steel 15Kh2NMFA kl.1 (15Х2НМФА кл.1) and 15H2MFA-A (15Х2МФА-А) (modifications A and B) brands applicability for reactors with enhanced security exploitation. The results of studies on radiation and thermal embrittlement of steel 15H2MFA A (modifications A and B) are shown.

Keywords: power plant WWER-type, vessel steel, irradiation and thermal embrittlement, operation safety.

UDC 669.295:621.039.536.2

Titanium alloys for the nuclear reactors vessels of small and medium power. Oryshchenko A. S., Gorynin I. V., Leonov V. P., Schastlivaya I. A. – Voprosy Materialovedeniya, 2014, N 2 (78), p. 199–210.

The main direction of development of nuclear power in Russia and abroad in the 21st century is the increased use of water-cooled reactors with increased life time but with guaranteed reliability and maximum environmental safety. Today on the agenda is the problem how to prolong the life of reactor facilities to 60–100 years.

Based on studies of the possibility of using titanium alloys as a construction material equipment NEI new generation of compact water-water heater made a prediction about the prospects of development of this area for the NPP power units small and medium power. The physical-mechanical and operational characteristics of titanium alloys in respect of technical requirements for a new generation of nuclear power facilities. Assessed the weight and size characteristics of hull structures, technology and efficiency in the manufacture of circuit equipment NPU are presented preliminary data on the radiation resistance of titanium alloys under neutron irradiation to a fluence of $2 \cdot 10^{20}$ neytr./cm^2 and identified a new class of low-activated titanium-based materials for nuclear power plants.

Keywords: water-water reactors, radioactive waste disposal, titanium alloys, application prospects.