SCIENTIFIC AND TECHNICAL JOURNAL
"Voprosy Materialovedeniya", 2021, № 2(106)

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UDC 669.14.018.41:669.15–194.2:621.771.23:539.4

DEVELOPMENT OF THERMAL ROLLING REGIMES OF LOW-ALLOY "ARC"-STEEL WITH QUASI-HOMOGENEOUS FERRITE-BAINITIC STRUCTURE

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Received March 30, 2021
Revised May 4, 2021
Accepted May 5, 2021

Abstract—In this work, the kinetics of the growth of austenite grains upon heating, the features of the processes of dynamic and static recrystallization occurring at various temperature-deformation modes of plastic deformation are investigated. Phase transformations have been studied during continuous cooling of hot-deformed austenite in low-alloy "Arc"-steel with a yield point of at least 420 MPa. The studies carried out made it possible to determine the thermal deformation parameters that ensure the formation of a finely dispersed homogeneous ferrite-bainitic structure, on the basis of which technological recommendations for industrial production were developed and sheet products were manufactured. Presented are the structure and properties of sheet metal from shipbuilding "Arc"-strength category 420 MPa.

Keywords: low-carbon low-alloy shipbuilding "Arc"-steel, thermo-mechanical treatment, vacuum etching, austenite grain size, Gleeble 3800, dynamic recrystallization, static recrystallization, phase transformations, sheet metal, structure, properties

DOI: 10.22349/1994-6716-2021-106-2-07-20

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UDC 669–412:621.771.22:669.14.018.295

TECHNOLOGY OF PRODUCTION AND RESEARCH OF QUALITY OF SUPER-THICK SHEETS OF HIGH-STRENGTH STRUCTURAL STEEL AB2R MADE OF LARGE FORGING INGOTS

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Received April 12, 2021
Revised May 19, 2021
Accepted May 20, 2021

Abstract—The manufacturing technology was tested and the quality study of super-thick sheets made of high-strength structural cold-resistant steel AB2R made from large ingots was carried out. Ingots are poured with siphon using modern pouring and heat-insulating mixtures while protecting the metal with argon. The use of the developed technology for casting large ingots together with the use of out-of-furnace refining and metal modification with aluminum and calcium provides a high level of quality of super-thick rolled products.

Keywords: large forging ingot, siphon casting, inoculation, super-thick rolled stock, quality, mechanical properties, impact strength, non-metallic inclusions

DOI: 10.22349/1994-6716-2021-106-2-21-28

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UDC 621.891

ON SELF-ORGANIZATION OF THE SURFACE LAYER OF STRUCTURAL STEEL IN DRY SLIDING AGAINST QUENCHED STEEL UNDER ELECTRIC CURRENT

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Received April 19, 2021
Revised May 25, 2021
Accepted May 25, 2021

Abstract—Using optical and confocal laser microscopes it was shown that dry sliding of structural steel against hardened steel under electric current of density higher 250 A/cm^2 was accompanied by the formation of composite tribolayers. By X-ray phase analysis of the surface layers of the sample and counterbody was shown that they contain α-Fe, γ-Fe, and FeO. It is noted that the self-organization of the tribosystem under conditions of dry sliding under electric current can be represented as a hierarchy of structural states of the surface layers of contacting materials. It was found that the nominal sample area had two sectors. The character of the contact interaction in the sectors differs from each other.

Keywords: self-organization of the surface layers, structural hierarchy of tribolayers, sliding electrical contact, sliding surface, phase composition of tribolayer, wear mechanism

ACKNOWLEDGEMENTS

The work was carried out within the framework of a state assignment of ISPMS SB RAS, theme No FWRW-2021-0006.

DOI: 10.22349/1994-6716-2021-106-2-29-37

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UDC 669.245.017.165:621.762.5

ON THE INTERMETALLIC NICKEL ALLOY FOR THE MANUFACTURE OF PARTS BY EQUIAXIAL CASTING AND ADDITIVE TECHNOLOGIES

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Received April 19, 2021
Revised April 30, 2021
Accepted April 30, 2021

Abstract—The article presents the results of studies of compositions of intermetallic nickel alloy based on casting single-crystal rhenium containing VKNA-25 grade alloy for the manufacture of parts by the methods of additive technologies. It is shown that an increase in the carbon content, as well as carbide-forming elements, while observing the known conditions for the balance of chemical and phase compositions, made it possible to find the composition of the material for which the patent of the Russian Federation was obtained.

Keywords: intermetallic nickel alloy, additive technologies, single crystal, strength, carbide, heat treatment, experiment

ACKNOWLEDGEMENTS

The work was carried out within the framework of the implementation of complex scientific direction 7.3: Creation of intermetallic nickel alloys and composite materials based on them ("Strategic directions for the development of materials and technologies for their processing for the period up to 2030").

DOI: 10.22349/1994-6716-2021-106-2-38-46

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UDC 669.15'26–194.55:621.785.3

INFLUENCE OF HOMOGENIZING ANNEALING ON REDUCING THE CONTENT OF δ-FERRITE IN HIGH-STRENGTH HIGH-CHROMIUM MARTENSITIC STEEL GRADE 07KH15N5D4B OBTAINED BY SELECTIVE LASER ALLOYING

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Received May 24, 2021
Revised June 1, 2021
Accepted June 4, 2021

Abstract—The work studies effects of temperature – time parameters of homogenizing annealing and related structural changes on the content of δ-ferrite in high-chromium martensitic steel grade 07Kh15N5D4B, obtained by selective laser alloying. It is shown that homogenizing annealing at a temperature of 1150°C with a holding time for 8 hours reduces the content of δ-ferrite, eliminates the cellular structure, and also increases the strength properties of the above-mentioned steel.

Keywords: high-chromium martensitic steel, selective laser alloying, homogenizing annealing, δ-ferrite content

ACKNOWLEDGEMENTS

Experimental studies were performed on the equipment of the Center for Collective Use "Composition, Structure and Properties of Structural and Functional Materials" of the NRC "Kurchatov Institute" – CRISM "Prometey".

DOI: 10.22349/1994-6716-2021-106-2-47-54

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UDC 621.746.6:669.24'27

PRODUCTION OF SINGLE-CRYSTAL SEEDS [001] FROM NICKEL-TUNGSTEN ALLOYS BY DIRECTIONAL CRYSTALLIZATION

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Received May 28, 2021
Revised June 8, 2021
Accepted June 11, 2021

Abstract—The problem of obtaining priming materials from Ni-W alloys arose in connection with the development of technology for casting single-crystal turbine blades of gas turbine engines (GTE) from high-temperature alloys. This technology uses a seed method for producing single-crystal castings with a crystallographic orientation [001] using seedings from alloys of the Ni-W system with a melting point 120–140°C higher than the casting alloy. The use of such primers greatly simplifies the casting process of turbine blades with a single-crystal structure, increases its reliability both in pass-through furnaces of the PMP-2 type and in high-gradient furnaces of the UVNK-9A type. The article presents the results of the study of the influence of temperature-velocity parameters of directional crystallization, namely, the temperature gradient G_Z on the structure of the obtained single-crystal seed blanks, as well as the study of effects of tungsten and carbon on the structure of single-crystal seed blanks, and makes recommendations for optimizing the technological process of single-crystal casting of Ni–W seed blanks adjusting the alloy composition for the seed blanks.

Keywords: seed, seed blank, single-crystal structure, crystallographic orientation, growth gradient G_Z, misorientation, banding

DOI: 10.22349/1994-6716-2021-106-2-55-65

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UDC 621.762.2:621.763:621.793.7

RESEARCH OF THE PROCESS OF SYNTHESIS AND PROPERTIES OF THE OBTAINED METAL-MATRIX COMPOSITE POWDERS OF THE Ti/TiB_2 SYSTEM

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Received April 2, 2021
Revised April 7, 2021
Accepted April 8, 2021

Abstract—The paper proposes a method for preparing composite powders of the Ti/TiB_2 system, studies the properties of the obtained composite powders, and also shows a series of experiments on its microplasma spraying. The properties of the sprayed coatings were investigated. On its basis the optimal ratio of the matrix and reinforcing components was established in order to increase significantly the hardness of the sprayed coatings.

Keywords: powder composite materials, mechanosynthesis, composite powder, metal matrix powder, Ti/TiB_2 system, microplasma spraying method

DOI: 10.22349/1994-6716-2021-106-2-66-73

ACKNOWLEDGEMENTS

The work was carried out within the framework of the Cross-Border Cooperation Program "Russia – South-East Finland 2014–2020", the project "Energy Efficient Systems Based on Renewable Energy Sources for Arctic Conditions" (EFREA)

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UDC 621.793.7:669.24'26'28

PROTECTIVE COATINGS OF ALLOY OF THE Ni–Cr–Mo SYSTEM WITH A WIDE RANGE OF OPERATING TEMPERATURES

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Received March 16, 2021
Revised March 29, 2021
Accepted March 31, 2021

Abstract—This article presents the results of experimental studies of alloys of the Ni–Cr–Mo–Be–Re–Zr–Hf–Nb system for creating functional wear-resistant coatings on their basis by the method of microplasma spraying. The coating works efficiently in a wide range of positive (up to 1100°C) and negative (up to minus 196°C) temperatures.

Keywords: wear resistance, protective coating, construction materials, composite materials, operating temperatures

ACKNOWLEDGEMENTS

Experimental studies were performed on the equipment of the Center for Collective Use "Composition, Structure and Properties of Structural and Functional Materials" of the NRC "Kurchatov Institute" – CRISM "Prometey".

DOI: 10.22349/1994-6716-2021-106-2-74-79

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UDC 621.762.222:621.763: 621.793.7

ON THE STRUCTURE AND PROPERTIES OF FUNCTIONAL COATINGS FROM COMPOSITE POWDERS OF THE ALUMINUM – SILICON NITRIDE SYSTEM REINFORCED WITH A SiALON TYPE PHASE

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Received March 5, 2021
Revised March 31, 2021
Accepted April 1, 2021

Abstract—The work studies development process of a composite powder of the aluminum – silicon nitride system and sprayed coatings using the mechanism of the formation of composite granules and the distribution of a hardening phase of the Sialon type in them. Various modes of powder composite mechanosynthesis are studied. The results of determining the hardness, chemical composition and distribution of elements in the resulting coating are given.

Keywords: composite materials, nanostructured powders, composite coatings, aluminum coatings

ACKNOWLEDGEMENTS

Experimental studies were performed on the equipment of the Center for Collective Use "Composition, Structure and Properties of Structural and Functional Materials" of the NRC "Kurchatov Institute" – CRISM "Prometey".

DOI: 10.22349/1994-6716-2021-106-2-80-89

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UDC 621.793.7:669.296'293'6

CORROSION RESISTANT PROTECTIVE COATING OF THE Zr–Nb–Sn SYSTEM OBTAINED BY HIGH SPEED COLD GAS DYNAMIC SPRAYING

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Received March 16, 2021
Revised March 29, 2021
Accepted March 31, 2021

Abstract—The article presents the results of experimental studies on the creation of an optimal alloy composition of the Zr–Nb–Sn system for obtaining corrosion-resistant coatings using the technology of supersonic cold gas-dynamic spraying. Practical recommendations are given on the use of the developed coating in precision engineering products.

Keywords: corrosion resistance, alloy melting, supersonic cold gas-dynamic spraying, microhardness, precision engineering

ACKNOWLEDGEMENTS

Experimental studies were performed on the equipment of the Center for Collective Use "Composition, Structure and Properties of Structural and Functional Materials" of the NRC "Kurchatov Institute" – CRISM "Prometey".

DOI: 10.22349/1994-6716-2021-106-2-90-96

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UDC 621.793.7:66.097.3

DEVELOPMENT OF THE TECHNOLOGY OF MICROPLASMA SPRAYING OF FUNCTIONAL COATINGS OF THE NICKEL – ALUMINUM SYSTEM FOR THE CREATION OF CATALYTICALLY ACTIVE COMPOSITIONS

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Received April 19, 2021
Revised May 17, 2021
Accepted May 25, 2021

Abstract—The results of comprehensive studies on the development of an innovative technology for microplasma spraying of catalytically active systems based on nickel –aluminum intermetallic compositions are presented. A batch of high-capacity chemical current sources based on these compositions with a mass energy level of up to 250 Wt h / kg has been manufactured and tested.

Keywords: microplasma spraying, catalyst, synthesis gas, hydrogen, tape carrier, chemical current source

DOI: 10.22349/1994-6716-2021-106-2-97-104

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UDC 621.762.222:621.763:621.793.7

INVESTIGATION OF NICKEL COATINGS OBTAINED BY LASER PROCESSING ON THE SURFACE OF BRONZE

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Received May 24, 2021
Revised June 8, 2021
Accepted June 11, 2021

Abstract— The article presents the results of a comprehensive study of the modes of laser processing during the formation of a coating on nickel-aluminum bronze using nickel powders. The coating was obtained in two stages. At the first stage, a precursor coating of the powder material was applied by cold spraying, at the second stage, its surface treatment with a laser was performed. The change in the composition and properties of the coating is shown depending on the processing modes and the thickness of the precursor coating, as well as the modes of laser processing.

Keywords: nickel-aluminum bronze, precursor coating, laser processing, powder material

ACKNOWLEDGEMENTS

Experimental studies were performed on the equipment of the Center for Collective Use "Composition, Structure and Properties of Structural and Functional Materials" of the NRC "Kurchatov Institute" – CRISM "Prometey".

DOI: 10.22349/1994-6716-2021-106-2-105-112

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UDC 621.793.1:539.23

ON THE MECHANISM OF FORMATION OF ELECTROCHROMIC WO_3 FILMS ON THE SURFACE OF Sn, Ti & ITO-ELECTRODES IN THE PROCESS OF CATHODIC ELECTRODEPOSITION

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Received March 21, 2021
Revised June 10, 2021
Accepted June 17, 2021

Abstract—At the article of mechanism the electrochemical formation of WO_3 films on the surface of titanium, tin and ITO-electrodes is investigated under various regime, including the deposition time τ = 2000–8000 s, the electrochemical potential of deposition on the cathode in the range from –0,4 to –1 V. A technique for the synthesis of peroxytungstic acid and a method of cathodic electrodeposition are presented. The studies carried out with tin and titanium extend the field of application of WO_3 films to technologies of chemical current sources and fuel cells.

Keywords: peroxytungstic acid, electrochemical deposition, chronoamperometry, cyclic voltammetry

DOI: 10.22349/1994-6716-2021-106-2-113-126

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UDC 666.3–187:661.862'022

CONTRIBUTION OF THE HYBRID COMPONENT TO THE STRUCTURE AND PROPERTIES OF CERAMICS BASED ON METASTABLE PHASES Al_2O_3

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Received April 26, 2020
Revised May 3, 2020
Accepted May 20, 2021

Abstract—The paper presents results of the study of the effect of doping with yttrium oxide on ceramics of the composition (γ + θ) Al_2O_3 + nY_2O_3 (n = 0, 1, 2, 3 wt%), sintered at 1550°C for 2 h, from powders of the specified composition annealed at temperatures of 500 , 800, 1000°C. X-ray diffraction analysis established the formation in ceramics of yttrium aluminum garnet $Y_3Al_5O_{12}$ (YAG) and a metastable phase of the same composition with a tetragonal lattice type in powders at temperatures above 1200°C. The effect of YAG on the physical and mechanical properties was established: high properties were demonstrated by ceramics of the composition θ-Al_2O_3 + 2wt% Y_2O_3, obtained from a powder annealed at 1000°C. In addition, high physical and mechanical properties were observed in ceramics of the composition θ-Al_2O_3 + 0wt% Y_2O_3, obtained from a powder annealed at 800°C. The effect of the so-called "mutual protection against crystallization" was discovered, which consists in the mutual inhibition of crystallization processes in powders of the Al_2O_3–Y_2O_3 system.

Keywords: aluminum oxide, yttrium oxide, phase composition, structure, yttrium aluminum garnet, physical and mechanical properties

DOI: 10.22349/1994-6716-2021-106-2-127-136

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UDC 621.833:621.793.6:669.268

THERMAL DIFFUSION CHROMIUM PLATING OF STRUCTURAL CARBON STEEL 20 BY HIGH FREQUENCY CURRENTS

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Received April 28, 2020
Revised May 14, 2021
Accepted May 19, 2021

Abstract—To increase the service life of the gear teeth made of steel 20, operating under high shock loads, their main surfaces were subjected to high-temperature diffusion metallization, namely, chromium plating with high-frequency currents. As a result of diffusion metallization, the surface hardness increased 5.1–5.4 times – from 156–159 HV to 800–866 HV, and the strength level 3.3 times – from 250 to 820 mAh. Optimal parameters for the diffusion metallization: current I = 0.25–0.3 kA, power P_e = 8–10 kW, hardening τ = 8–10 min. By the method of scanning electron microscopy, it was found that after diffusion saturation of the surface of the gear teeth with chromium, the steel has a homogeneous structure with clearly pronounced transition layers, the average thickness of the diffusion layer was 0.06 mm. Energy dispersive analysis showed that after diffusion metallization with chromium powder, the basic composition of the steel remained constant, only the qualitative ratio of the components changed. X-ray phase analysis revealed the presence of an αFe-phase with the incorporation of Cr on the surface of the sample.

Keywords: steel, hardening, diffusion layer, gear, saturation, tooth, chrome plating, surface
DOI: 10.22349/1994-6716-2021-106-2-137-145

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UDC 678.742.2:539.389.3

PRINCIPLES OF EXPOSURE OF POLYMER MATERIALS TO HEAT, MOISTURE AND UV-RADIATION AND STUDY OF THEIR PROPERTIES BY FULL FACTORIAL EXPERIMENT: A review

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Received January 19, 2021
Revised March 7, 2021
Accepted March 12, 2021

Abstract—The work is dedicated to the effects of climatic factors on polyethylene terephthalate (PET) in terms of changes in the structure and interaction of polymer molecules. The kinetic concept of the

strength of PET has been developed, and the factors influencing the strength have been considered. Effects of moisture, thermal oxidative destruction, and UV-radiation on the structure of PET have been investigated. Polymers' properties predicting, durability and their computer modeling have been analyzed. A model of changes in PET properties under the influence of temperature, moisture and UV-radiation was constructed using the methods of a full factorial experiment. It has been shown that in the initial period of exposure, adsorption and diffusion of moisture, hydrolysis and surface oxidation occur; prolonged and constant exposure to UV-radiation break the bonds formed by moisture, then the C–C and C–O bonds in the PET molecule brake and new intermolecular bonds are formed. In the amorphous state of PET, the breaking of bonds in the polymer chain and the formation of bonds between two adjacent polymer chains, the formation of more densely packed nodes, the destruction of the polymer and its aging, are equally probable. Temperature has a secondary effect, facilitating both hydrolysis and oxidation and polymer degradation.

Keywords: polyethylene terephthalate, climatic factors, temperature, UV-radiation, humidity, polymer aging, full factorial experiment

DOI: 10.22349/1994-6716-2021-106-2-146-160

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UDC 621.791.461

SOCKET WELDING OF POLYPROPYLENE PIPES WITH A HEATED TOOL AT NEGATIVE AMBIENT TEMPERATURES

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Received April 26, 2021
Revised May 13, 2021
Accepted May 20, 2021

Abstract—The paper presents the results of study, which considered relationship between supramolecular structure and strength of polypropylene pipes joints obtained by socket welding with heated tool at various ambient temperatures, including negative ones.

Keywords: polypropylene, welding, negative temperatures, microscopic studies, supramolecular structure, tensile tests

DOI: 10.22349/1994-6716-2021-106-2-161-169

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UDC 620.193.4:669.15–194.2:669.788

STUDY OF HYDROGENATION AND CORROSION OF STEEL EQUIPMENT AND PIPELINES AT THE PRODUCTION FACILITIES OF H_2S-CONTAINING HYDROCARBON RAW MATERIALS

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Received April 9, 2021
Revised April 29, 2021
Accepted April 30, 2021

Abstract—The impact of hydrogen sulfide raw materials on steel equipment and pipelines is associated not only with corrosion processes, but also with the hydrogenation of used carbon and low-alloy steels. This can lead to the loss of their strength properties and the subsequent destruction of equipment operated under conditions of increased operating pressures. Such corrosive-mechanical effects associated with the penetration of hydrogen into steel are the most dangerous from the point of view of the safety and reliability of the operation of facilities for the production of hydrocarbon fluids. The effect of H_2S on the main types of structural steels was investigated according to the results of autoclave tests. The formation of blistering (blistering) and cracks on the surface of steels due to the effect of hydrogen on the steel was recorded. A study of the phase composition of corrosion products and their possible effect on the processes of corrosion and hydrogenation of steel has been carried out.

Keywords: corrosive destruction of equipment, carbon dioxide and hydrogen sulfide corrosion, hydrogenation of steel, liquid condensation

DOI: 10.22349/1994-6716-2021-106-2-170-181

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UDC 620.179.152:[669.715 + 669.721]

DIGITAL REFERENCE IMAGES WHEN EVALUATING THE QUALITY OF CASTINGS FROM ALUMINUM AND MAGNESIUM ALLOYS

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Received March 30, 2021
Revised April 23, 2021
Accepted May 20, 2021

Abstract—Reference X-ray images of defects in castings and welded joints have been used for many years in X-ray radiation inspection. With the transition to digital technologies, and the use of flat-panel detectors instead of radiographic film, the problem arose of creating reference digital images. Comparison of the digital image of the reference sample with the digital image of the test object can be carried out using software, which completely or partially excludes the subjective assessment of the operator, makes it possible to view doubtful areas of the image with magnification and without loss of contrast, automatically show the size of the defect, its intensity distribution by volume of the casting. All this makes the control more objective and productive. The reference images in the detector's memory do not undergo the aging and degradation typical of X-ray images, and there is no need to replicate them.

Keywords: X-ray non-destructive testing, digital radiography, porosity, microlooseness

DOI: 10.22349/1994-6716-2021-106-2-182-194

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