ABSTRACT AND REFERENCES

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MODELING THE ELECTROSTATIC CONTROL OVER DEPTH OF THE INTRODUCTION OF INTELLIGENT SENSORS INTO A POLYMER COMPOSITE MATERIAL (p. 4-9)

Igor Ivitskiy
National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", Kyiv, Ukraine
ORCID: http://orcid.org/0000-0002-9749-6414

Vladimir Sivetskiy
National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", Kyiv, Ukraine
ORCID: http://orcid.org/0000-0001-8402-0874

Victor Bazhenov
National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", Kyiv, Ukraine
ORCID: http://orcid.org/0000-0002-8858-4412

D. Ivitska
National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", Kyiv, Ukraine
ORCID: http://orcid.org/0000-0002-3491-4893

Intelligent polymeric composites are materials that can remotely transmit data on the properties of material, including the stress-strained state. It is necessary for the implementation of online monitoring of critically important parts and nodes. Obtaining data is achieved by the introduction of intelligent sensors into a polymer composite. Intelligent sensor is a miniature measuring device consisting of one or more transducers of measured magnitudes. They form an output signal, which is used for the remote transmission, storage and use in the control systems.

A problem of obtaining data about the depth of the introduction of intelligent sensors into polymer composites is a multifaceted one. On one hand, the question is about technology and equipment for the introduction of sensors into polymer composites, the interpretation of data on deformations and other properties received from the sensors, and is connected to polymer engineering. On the other hand, the question of receiving signals about the depth of placement of intelligent sensors and their further processing is associated with nondestructive control.

The present article investigated the possibility of receiving a signal about the depth of placement of intelligent sensors that are introduced at a certain depth into a polymer composite material, using the electrostatic method of nondestructive testing. We performed a simulation of the distribution of electric potential in the material. Through modeling, we determined maximum possible depth of the introduction of intelligent sensor into polymer material, which can be measured with a given accuracy, which is 40H, where H is the relative magnitude of the size of electrodes.

The technique applied might be used to any dielectric material after adjusting the properties of material. The obtained results allow the determination by numerical simulation of maximum depth of the introduction of intelligent sensors into a polymer material.

Keywords: intelligent polymeric composites, intelligent sensors, electrostatic method of nondestructive control.

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STUDY OF THE FEATURES OF THE MAGNETIC AND CRYSTAL STRUCTURES OF THE $BaFe_{12-X}$ AL_XO_{19} AND $BaFe_{12-X}$ Ga_XO_{19} SUBSTITUTED HEXAGONAL FERRITES (p. 10-15)

Vladimir Kostishyn
National University of Science and Technology "MISiS", Moscow, Russia
ORCID: http://orcid.org/0000-0001-5384-6331

Vladimir Korovushkin
National University of Science and Technology "MISiS", Moscow, Russia
ORCID: http://orcid.org/0000-0002-6991-704X

Igor Isaev
National University of Science and Technology "MISiS", Moscow, Russia

Alex Trukhanov
National University of Science and Technology "MISiS", Moscow, Russia
ORCID: http://orcid.org/0000-0003-3430-9578

The mechanism of formation of polycrystalline hexagonal barium ferrite with diamagnetic substitution with Al and Ga ions is considered. The localization of the dopants (Al and Ga) in hexagonal and spinel blocks is shown. It is found that the main Al–Fe and Ga–Fe substitutions occur in the 12k sublattice. The substitutions break the Fe–O–Fe exchange couples of the 12k sublattice with other sublattices, which leads to the emergence of non-equivalent positions of Fe^{3+} ions, on the basis of which in the Mössbauer spectra with isomorphic aluminum, 7 sextets are identified and with isomorphic gallium – 6. This leads to a decrease in the magnetic parameters of ferrites, such as specific and residual magnetization, Curie temperature. It is shown that aluminum (x=2.1) entry increases the coercive force, magnetic hardness of the hexagonal ferrite, and gallium (x=0.6) entry lowers the coercive force and magnetic hardness. The angles θ between the magnetic moment and the γ-radiation direction in isotropic substituted hexagonal ferrite polycrystals and foil are determined.

Keywords: substituted barium hexaferrites, Mössbauer spectroscopy, magnetization, coercive force, Curie temperature.

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DEVELOPMENT OF RADIOISOTOPIC-PLASMA TECHNOLOGY FOR THE PROTECTION OF RADIO ELECTRONIC MEANS FROM POWERFUL ELECTROMAGNETIC RADIATION
(p. 16-22)

Oleh Vorobiov
National University of Defense of Ukraine named after Ivan Chernyakhovsky, Kyiv, Ukraine
ORCID: http://orcid.org/0000-0001-5362-1976

Vitalii Savchenko
National University of Defense of Ukraine named after Ivan Chernyakhovsky, Kyiv, Ukraine
ORCID: http://orcid.org/0000-0002-3014-131X

Alexander Sotnikov
Ivan Kozhedub Kharkiv University of Air Force, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0003-2985-3704

Volodymyr Tarshin
Ivan Kozhedub Kharkiv University of Air Force, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0001-7059-6354

Tymur Kurtseitov
National University of Defense of Ukraine named after Ivan Chernyakhovsky, Kyiv, Ukraine
ORCID: http://orcid.org/0000-0001-6478-6469

In order to protect REM from the impact of powerful pulse EMR, we proposed a radioisotopic-plasma technology for creating absorbing screens. For this purpose, it is proposed to use semiconducting materials with radioisotopic elements. This will provide for a significant absorption of EMR over a wide frequency range due to the creation of non-equilibrium state of electronic subsystems of different layers of material. We designed a generalized structure of absorbing material and carried out an analysis of the physical mechanisms that occur through the use of radioisotopic elements. It is demonstrated that the physical mechanisms that occur in the material define its dielectric permittivity and its comprehensive nature. We obtained an analytical expression for the reflection coefficient of the proposed absorbing material. A peculiarity of the analytical expression consists in the consideration of the impact of both its structure and changes in dielectric permittivity components that occur under the influence, first of all, of radioisotopic elements on the reflective characteristics of material. A procedure for determining the dielectric permittivity of the material was devised. The procedure consists in determining the kinetic equation to describe the state of electronic subsystem of layers in the material depending on the intensity of radioisotopic elements and the type of environment, finding a non-equilibrium distribution function, determining the components of dielectric permittivity, which makes it possible to assess the contribution of non-equilibrium state of electronic subsystem of separate layers in the material into the provision of required reflective and absorbing properties.

We conducted assessment of absorbing and scattering properties of material. The estimates obtained demonstrate the feasibility of applying radioisotopic-plasma technology to create materials in order to protect REM from powerful EMR, especially under conditions of constraints on weight and size characteristics of absorbing screens.

Keywords: powerful electromagnetic radiation, radioisotopic-plasma technology, reflection coefficient, dielectric permittivity.

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DEVELOPMENT AND ANALYSIS OF MATHEMATICAL MODELS FOR THE PROCESS OF THERMAL CONDUCTIVITY FOR PIECEWISE UNIFORM ELEMENTS OF ELECTRONIC SYSTEMS
(p. 23-33)

Vasily Havrysh
National University "Lviv Polytechnic", Lviv, Ukraine
ORCID: http://orcid.org/0000-0003-3092-2279

Igor Ovchar
Ivano-Frankivsk National Technical University of Oil and Gas, Ivano-Frankivsk, Ukraine
ORCID: http://orcid.org/0000-0002-8490-5645

Yaroslav Baranetskij
National University "Lviv Polytechnic", Lviv, Ukraine
ORCID: http://orcid.org/0000-0002-5571-5391

Yaroslav Pelekh
National University "Lviv Polytechnic", Lviv, Ukraine
ORCID: http://orcid.org/0000-0002-4339-8093

Paul Serduik
National University "Lviv Polytechnic", Lviv, Ukraine
ORCID: http://orcid.org/0000-0002-2677-3170

Halyna Ivasyk
National University "Lviv Polytechnic", Lviv, Ukraine

We examined linear and non-linear mathematical models for the thermal conductivity process in the elements of electronic systems, which are described by a layer and a piecewise uniform layer with a through foreign cylindrical inclusion, with a concentrated heat flow at one of their boundary surfaces. Classical methods cannot resolve boundary problems of mathematical physics, which correspond to these models, in a closed form. In this connection, thermophysical parameters for piecewise uniform media are described by using generalized functions as a single entity for the entire system. As a result of this approach, we obtain one equation of thermal conductivity with generalized derivatives for the entire system with boundary conditions at the boundary surfaces of inhomogeneous media. In the classic case, the process of thermal conductivity would be described by a system of equations on thermal conductivity for each of the elements of heterogeneous medium under conditions of perfect thermal contact at the conjugating surfaces of dissimilar elements and boundary conditions at the boundary surfaces of non-uniform media. For a case of nonlinear models, which are more accurate than the linear ones, one of the conditions of a perfect thermal contact, namely equality of temperatures at the conjugating surfaces of dissimilar elements of the structure, cannot be used in the process of linearization of nonlinear boundary problems that correspond to these models. In this regard, in the present study we propose approaches that make it possible to solve such type of boundary problems in mathematical physics.

Keywords: thermal conductivity, isotropic piecewise uniform layer, a through foreign inclusion, thermal sensitivity, heat flow.

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A STUDY OF AN EFFECT OF THE PARAMETERS OF NIOBIUM-BASED ION CLEANING OF A SURFACE ON ITS STRUCTURE AND PROPERTIES (p. 34-39)

Hanna Postelnyk
National Technical University
"Kharkiv Polytechnic Institute", Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0002-5290-7566

Sergey Knyazev
National Technical University
"Kharkiv Polytechnic Institute", Kharkiv, Ukraine

Andrei Meylekhov
National Technical University
"Kharkiv Polytechnic Institute", Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0002-8142-6024

Vyacheslav Stolbovoy
National Science Center "Kharkiv Institute of Physics and Technology", Kharkiv, Ukraine

Dmitriy Kovteba
National Science Center "Kharkiv Institute of Physics and Technology", Kharkiv, Ukraine

The paper describes using techniques of structural engineering in a comprehensive study of the effects of the negative displacement potential, nitrogen and argon pressures, as well as the distance from a sample to the cathode on the processes of sputtering and depositing. In practice, it is highly important to obtain steel surfaces with high mechanical properties

and low roughness. The highest microhardness is manifested at the highest degree of sputtering on the samples at Ub= =−1,300 V. It has been determined that the presence of nitrogen in the vacuum chamber shifts the equilibrium point of sputtering and depositing towards a higher Ub. It has been established that the presence of argon in the ion bombardment process increases the sputtering rate, whereas the presence of active nitrogen gas reduces the deposition rate due to nitride formations on the surface. The point "sputtering-depositing" shifts: in the case of Ar (from Ub=−350 V to Ub=−200...−300 V) when the RN increases from 0.002 Pa to 0.66 Pa, respectively. In the case of nitrogen, when PN increase from 0.02 Pa to 0.08 Pa, the point shifts from Ub=−400 V to Ub=−600 V (at a distance of 300 mm from the cathode to the sample).

Keywords: plasma, vacuum arc evaporation, displacement potential, microhardness, deposition, mixing, sputtering, substrate.

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EXAMINING THE EFFECT OF TRIBOELECTRIC PHENOMENA ON WEAR-FRICTION PROPERTIES OF METAL-POLYMERIC FRICTIONAL COUPLES (p. 40-45)

Sviatoslav Kryshtopa
Ivano-Frankivsk National Technical University of Oil and Gas, Ivano-Frankivsk, Ukraine
ORCID: http://orcid.org/0000-0001-7899-8817

Liudmyla Kryshtopa
Ivano-Frankivsk National Technical University of Oil and Gas, Ivano-Frankivsk, Ukraine
ORCID: http://orcid.org/0000-0002-5274-0217

Ivan Bogatchuk
Ivano-Frankivsk National Technical University of Oil and Gas, Ivano-Frankivsk, Ukraine
ORCID: http://orcid.org/0000-0002-4465-2620

Igor Prunko
Ivano-Frankivsk National Technical University of Oil and Gas, Ivano-Frankivsk, Ukraine
ORCID: http://orcid.org/ 0000-0003-1880-9505

Vasyl Melnyk
Ivano-Frankivsk National Technical University of Oil and Gas, Ivano-Frankivsk, Ukraine
ORCID: http://orcid.org/0000-0002-5793-5486

The influence of triboelectric phenomena on the wear-friction properties of microasperities contacts of friction couples of drum – shoe brakes was explored. As a result of the conducted research into the wear-friction properties of metal-polymeric frictional couples of braking devices under laboratory and operational conditions at the nano-, micro- and millilevel during triboelectric interaction, the regularities of changes were established:

– of magnitudes of the contact difference of potentials of frictional couples "grey cast iron – polymers" of the drum-shoe brake on the surface temperature of linings and specific loads;

– of circulating thermal and tribocurrents on the time of friction interaction of frictional couples "cast iron – polymers" and "steel – polymers" at different sliding velocities;

– of generated tribocurrents in the contact of two-layered structures "steel – polymer" and circulating tribocurrents through the three-layered structure "steel – polymer – steel" on the surface temperatures.

Keywords: metal-polymeric frictional couples, drum-shoe brake, disc brake, tribosystem, triboelectric processes.

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ANALYSIS OF STRUCTURE AND TRIBOTECHNICAL PROPERTIES OF PLASMA CARBIDE-SILICON COATINGS UNDER CONDITIONS OF ELEVATED TEMPERATURES (p. 46-53)

Liudmyla Pryimak
National Aviation University, Kyiv, Ukraine
ORCID: http://orcid.org/0000-0003-4024-0941

Andriy Dovgal
National Aviation University, Kyiv, Ukraine
ORCID: http://orcid.org/0000-0003-1300-0192

Yevheniia Puhachevska
National Aviation University, Kyiv, Ukraine
ORCID: http://orcid.org/0000-0001-5302-0214

In a fundamentally new way we obtained a composite metal-ceramic coating of the $SiC–Al_2O_3$ system, which contains metallic component based on iron. The metallic component was not introduced into the original charge in the powder form but was obtained as a result of grinding the charge components in steel drums with steel grinding bodies. We studied

the possibility of obtaining plasma coatings applied from this composition to steel parts with the intermediate sublayer from intermetallic compound Ni_3Al for restoring and reinforcing their surfaces. The optimum modes of the application of coating from this material by the plasma method were established. Using the method of scanning electron microscopy and X-ray phase analysis, the structure of coating applied from this material on medium-carbon steel was investigated. Obtaining coatings from these inexpensive components with high performance properties presents economic and technological interest.

As a result, tribotechnical properties of coatings under friction conditions with heating of friction contact to 500 ºC with the steel counterbody were explored. The regularities of their wear were established. Using the methods of scanning electron microscopy and X-ray phase analysis, the friction surfaces of the obtained coatings were studied and special features and laws governing the mechanisms of their wear under conditions of elevated temperatures were determined. The possibility of applying these coatings for protecting and reinforcing parts of aviation ground-based equipment, working at elevated temperatures, was shown.

Keywords: composite coating, adhesion, plasma spraying, wear resistance at elevated temperatures, reinforcement, electron microscopy.

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SELECTIVE ANODIC TREATMENT OF W(WC)-BASED SUPERALLOY SCRAP (p. 53-58)

Vadym Kovalenko
Ukrainian State University of Chemical Technology, Dnipro, Ukraine
Federal State Educational Institution of Higher Education "Vyatka State University", Kirov, Russian Federation
ORCID: http://orcid.org/0000-0002-8012-6732

Valerii Kotok
Ukrainian State University of Chemical Technology, Dnipro, Ukraine
Federal State Educational Institution of Higher Education "Vyatka State University", Kirov, Russian Federation
ORCID: http://orcid.org/0000-0001-8879-7189

Superalloys based on W/WC are widely used as elements of drilling equipment, high-speed steel-cutting tools, penetrators of armor-piercing munitions. The spent or broken superalloy goods are a valuable waste for recycling with extracting of valuable components. The most economically and technologically attractive methods of superalloy scrap recycling is selective treatment with dissolution of metal binder and obtaining of non-oxidized tungsten/tungsten carbide powder. The aim of the present work was to develop a method of selective anodic reprocessing of superalloys. By using voltamperometry method the anodic behavior of VK20KS (20% Co, 80 WC), VN8 (8 % Ni, 92 % WC), VNG (5 % Ni, 5 % Fe, 90 % W) and VNDS (W, Ni, Cu.) superalloys in a proposed solution has been studied. The possibility of selective anodic dissolution of metal binder without oxidation of solid component (tungsten/tungsten carbide) has been demonstrated. The potential and current density values for this process have been determined. Low reactivity of tungsten-based superalloys in comparison to tungsten carbide-based alloy has been demonstrated. Galvanostatic selective anodic treatment of VK20KS superalloy scrap at 15 A/dm^2, which is a dissolution peak current density on the anodic curve, has been conducted. A phenomenon of gradual surface passivation due to dissolution of metal binder and increasing the content of passive tungsten carbide has been found. In order to prevent passivation, the use of rotating titanium basket has been proposed. The composition of tungsten-containing products has been determined to be: 23 % WO_3 or H_2WO_4, 73 % WC.

Keywords: superalloys, passivation, selective anodic treatment, tungsten, tungsten carbide.

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