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CONTENTS

ABSTRACTS OF PUBLISHED ARTICLES

UDC 678.067:621.822

Antifriction carbon plastics for sliding friction units. Bakhareva V. E., Nikolaev G. I., Oryschenko A. S. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 15–33.

High strength antifriction polymeric carbon plastics (UGET, FUT) and their modified types (UGET-TN, FUT-B, UGET-MF, FUT-MF) as well as new heat resistant antifriction carbon plastic (UPFS-type) are developed for ship- and energy machine building, making possible work of friction units with water lubrication including over-heated water. These materials exceed the traditional polymeric antifriction materials in strength and wear resistance.

Keywords: antifriction polymeric carbon plastics, friction units, water lubricant, strength, wear resistance.

UDC 519.85:621.891:539.3

Mathematical modeling of the frictional interaction of deformable bodies. Goriacheva I. G. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 34–45.

The paper presents some mathematical models for studying quantitative dependences of friction characteristics on the mechanical properties of the interacting bodies, their structure, macro- and microgeometry, load and speed relative sliding, surface properties and staging environment.

Keywords: friction pair, frictional interaction, structure, mechanical properties, macro- and micro-geometry, mathematical model.

UDC 678.067:621.891:621.822:621.671

Antifriction phenolic carbon plastics for sliding bearings of centrifugal pumps. Bakhareva V. E., Anisimov A. V., Lishevich I. V. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 46–53.

Antifriction carbon plastics of FUT and FUT-B types based on phenol-formaldehyde binder and carbon fabric of URAL (УРАЛ) type are developed for sliding bearings of centrifugal pumps in fuel-energy complex and energy power stations. The whole complex of tests was held that showed that the developed materials maintain reliable work of built-in bearings with the pumped water temperature 4–125°C in serial pump systems for reservoir pressure maintenance and for pumping of oil and oil-products main pipe-lines. Technological process is developed and industrial production of the centrifugal pump bearings is organized. 5–10 years' experience of tests and centrifugal pump work and energy power stations with FUT and FUT-B type carbon plastic bearings was summarized.

Keywords: centrifugal pump, fuel-energy complex, energy power station, oil pipe-line, sliding bearing, babbit, wear intensity, service life, over-heated water, built-in bearing, remote bearing.

UDC 678.067:621.671

Experience and prospects of polymeric composite materials application in pumps of reservoir pressure maintenance. Velizhanin V. S., Peregudov D. G., Yurchenko S. A. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 54–57.

The paper describes composite materials FUT, UGET, STET application in plain bearings, groove seals, and other parts of centrifugal pumps. It concerns also operating experience of not abrasive ultrasonic finish machining (NAUFM) of metal with geomodifying (GEO) coating and its influence on pumps performance. The authors present the results of observation and exploitation of the upgraded pumps. Joint application of NAUFM + GEO of the steel sleeve in contact to the FUT sleeve reduces the vibration rate in the plain bearing 3 to 9 times. The FUT application for groove seals manufacturing also improves pumps' operational characteristics. A further course of action of MRP pumps modernizing is traced.

Keywords: plain bearing, groove seal, modernizing, centrifugal pump, geomodifying agent, not abrasive ultrasonic finish machining, FUT.

UDC 678.067:621.891:620.178.16

Investigation of tribological properties of modified carbon fibers in the flowing water. Morozov A. V., Sachek B. Ya., Mezrin A. M. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 58–65.

The paper presents results of experimental study of tribological characteristics of carbon fibers UGET-B and UGET-URAL-T15P-EHO, tested on the apparatus T-05 using scheme “block on ring” at constant sliding velocity 1.5 m/s in the range of pressures from 15 to 80 MPa. The tests were performed in the flowing water with constant flow consumption 1500 ml/min. The used counterbody was from hardened steel HRC 60–62. They obtained the analytical dependences of the friction coefficient and wear rate on contact pressure. Due to the anisotropy of the carbon fiber structure, the wear rate of the material varies up to 100 times subject to different contact pressure.

Keywords: carbon fibers, wear resistance, friction coefficient, tribological tests, flowing water.

UDC 678.067:539.538:621.891

Modification of thermoset antifriction carbon plastics. Bakhareva V. E., Anisimov A. V., Blyshko I. V., Savelov A. S. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 66–80.

The paper summarizes results of long time studies of antifriction carbon plastics modification at different scale levels (molecular, nano-, micro- and macro). The friction surface of modified plastics was tested by the scanning electron and atomic force microscopes. Modifying agents were chosen optimal for each scale level. The analysis of the performance for nano- and micromodifying agents was carried out.

Keywords: modification, antifriction carbon plastic, molecular, nano-, micro- and macroscale levels, wear resistance, tribo-pair.

UDC 678.067:539.538:621.891

Macro modification of antifriction carbon plastics by fluorine polymer: the effective way of friction coefficient decreasing. Bakhareva V. E., Anisimov A. V., Lobyntseva I. V., Savelov A. S. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 81–88.

It was found that macro modification of carbon plastic with fluorine polymer is an example of the composite surface engineering, namely the example of technology where nano modification is achieved through macro modification. Friction coefficient decreases 2–3 times, and wear resistance and bearings working life increase in this case. Binary structures and production technology of high speed bearings for propeller shafts and highly loaded low speed bearings of guiding devices for hydraulic turbines were proposed. Industrial production of sliding bearings from new modified antifriction carbon plastics for ship building and hydraulic turbine construction was organized.

Keywords: antifriction carbon plastic, fluorine polymer, macromodification, binary supports, high speed bearings, highly loaded low speed bearings, friction coefficient.

UDC 678.067:621.891:620.178.16

Morphology investigation of friction surface and mechanism of carbon plastics macro modification by fluorine polymer. Anisimov A. V., Bakhareva V. E., Savelov A. S. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 89–92.

The results of complex tests of epoxy carbon plastic macro modified by fluorine polymer are presented including tribo-technical tests, chemical content and friction surface structure analysis. Method of dry friction test at contact pressure 2 MPa and sliding velocity 0.1 m/s at tribometer UMT-2 of Center for Tribology Inc., USA is discussed in detail. For investigation of friction surface structure and content optical raster electron microscopy and X-ray micro analysis were used. It was confirmed that during lasting work secondary structures films are formed on the conjugated surfaces of friction pair (macro modified carbon plastic – metal) because of the frictional mass transition; these films contain fluorine polymer (tribo-modifying agent).

Keywords: macro modified carbon plastic, friction pair, counter body, fluorine plastic inserts, tribometer, friction transition.

UDC 678.067:621.891:621.822:620.178.16

The tribological stand tests of antifriction carbon plastic UGET-MF macro modified by fluorine polymer for hydraulic turbine friction units. Bakhareva V. E., Anisimov A. V., Ilyin S. Ya., Morkin O. V., Pekler K. V. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 93–97.

The test results of bearing models made of UGET and UGET-MF type carbon plastics at the stands imitating working conditions of hydraulic turbine guiding device are discussed. Testing equipment design and methods used at OJSC Power Machines, branch of Leningradsky Metallichesky Zavod (LMZ), and JSC Polzunov Central Boiler and Turbine Institute are presented.

Keywords: bearing, hydraulic turbine guiding device, contact pressure, sliding velocity, friction coefficient, wear intensity.

UDC 678.067:621.822

Quality control of sliding bearings made of antifriction carbon plastics. Bakhareva V. E., Tsukanov D. V. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 98–105.

The article is devoted to the manufacturing process of antifriction carbon plastic bearings, quality control of initial components, impregnating lacquer, impregnated carbon fabric, carbon plastic bearings. Defects of carbon plastic bearings are described. Special attention is paid to dependence of strength and tribo-technical properties of carbon plastics on technological features. For quality control of sliding bearings made of antifriction carbon plastic it is recommended to use ultrasonic methods. Capacity and thermo-electromotive force methods are promising as additional controlling methods.

Keywords: sliding bearings, carbon plastics, quality control, defects, ultrasonic control, visual control, capacity methods.

UDC 678.067:621.822

Production of sliding bearings based on new generation antifriction carbon plastics. Savelov A. S., Malaniuk A. I., Nikolaev G. I., Bakhareva V. E., Sadikov O. L., Alykhov A. S. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 106–114.

The technological process is discussed for production of sliding bearings from nano-modified antifriction carbon plastics of UGET, FUT, UPFS types based on thermosetting and thermoplastic binders. The data is given about laboratory and technological equipment available in scientific-industrial complex FSUE CRISM “Prometey”. Sections of modified thermosetting binder preparing, impregnation of reinforcing fabrics with thermosetting and thermoplastic binders (prepreg production), prepreg cutting and winding, pressing and mechanical treatment of friction articles are described.

Keywords: sliding bearings, antifriction carbon plastics, prepreg, impregnation, winding, mechanical treatment.

UDC 678.067:621.822

Epoxy-rubber glues application for production of sliding bearings made of antifriction carbon plastics. Sytov V. A., Verstakov A. E., Voronin A. E., Bakhareva V. E., Churikova A. A., Tsukanov D. V., Sytov V. V. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 115–119.

The questions of obtaining workable adhesive joints are discussed. Properties of epoxy-rubber glues, construction data for friction units, surface treatment and technology of glue application are presented. The dependence of EKAN-3 (ЭКАН-3) glue destruction shear stress and elasticity on aging time was found for different temperatures. The design of complex sliding bearings for hydraulic turbines made from carbon plastic and rubber is described along with production technology of glue connection by epoxy-rubber glues with different deformation ability.

Keywords: epoxy-rubber glue, surface pretreatment, complex bearing, rubber “hydrolocks”, connection of rubber and carbon plastic, glue aging.

UDC 678.067:621.892:621.822

Self-lubricating composite polymer materials for damping seismic insulators. Drozdov Yu. N., Nadein V. A., Puchkov V. N., Krasnov A. P. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 120–132.

For the first time in the world science and practice there are created scientific bases for designing of sliding bearings, self-lubricating, self-aligning, reversible, used as seismic insulators for bridges, industrial and civil constructions, and also for the oil-and-gas sea platforms surpassing the previously known as refers to bearing and damping characteristics. The authors have experimentally calculated the service life of the frictional pendulum bearing using dependences (presented as generalized variables), for wear rate determination and developed the method of friction factor estimation of frictional pendulum bearings.

They consider modern views and prospects for national manufacturing of antifriction self-lubricating coating with designed tribological properties, and the most perspective heat-resistant polymers, fillers, and combined mixed antifrictional fabrics.

Ключевые слова: frictional pendulum bearings, tribological characteristics, seismic loads damping, friction factor, wear, service life, calculations, composite self-lubricating materials.

UDC 7:621.891

Tribology of fluoropolymer materials: status and prospects. Buznik V. M., Yurkov G. Yu. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 133–149.

The review presents evidence showing that fluorocarbon polymers are effective materials for tribological application and already used in many industries, mostly high-tech. These materials have the prospect of new applications in tribology, which is associated with the development of new and more complex materials and structures based on fluorocarbon polymer. Development in this area is not possible without the enlarged research in the field of materials science and close cooperation with the manufacturers.

Keywords: fluoropolymers, synthesis of fluorocarbon polymer, application of fluorocarbon polymers.

UDC 678.5:621.891:621.78

Influence of the degree of intramolecular ordering in thermally stable structural thermoplastics on its mechanical and tribological properties in the temperature range 20–250°C. Gofman I. V., Yudin V. Ye., Orell O., Vuorinen J., Grigoriev A. Ya., Kovaleva I. N., Svetlichny V. M. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 150–159.

The paper describes mechanical characteristics of thermally stable thermoplastic block samples in a wide range of temperature 20–250°C. Together with industrial materials (polyetheretherketone, polyphenylene sulfide and polyetherimide) the polyimide thermoplastic on the basis of dianhydride of 1.3-bis (3.3′, 4.4′-dicarboxyphenoxy)benzene and 4.4′-bis-(4-aminophenoxy)diphenyl developed at the Institute of Macromolecular Compounds (RAS) was under examination. The authors studied tribological behavior of these thermoplastics against steel (contact pressure and temperature varying from the room temperature to 250°C) and analyzed possibilities of securing the working efficiency of thermoplastic polymeric material in a maximally broad temperature range by controlled regulation of the degree of its structural ordering.

Keywords: thermoplastics, thermal stability, mechanical characteristics, tribology, friction factor, wear resistance, crystallinity.

UDC 678.067:621.891:621.822

New heat-resistant antifriction carbon plastics based on polyphenylene sulfide for friction units, operating without lubrication or greased by superheated water. Bakhareva V. E., Lishevich I. V., Sargsyan A. S. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 160–170.

The paper describes properties, production and application of a new heat-resistant anti-friction carbon plastic UPFS-type based on partially crystalline polyphenylene sulfide. The new carbon plastic designed for friction units of ship pumps, power plants, nuclear power plants operating with lubrication by superheated water (up to 200°C), as well as friction units, working without lubrication.

Keywords: polyphenylene sulfide, carbon plastic UPFS-type, superheated water, polyheteroarylenes, thermoplastic, glass transition temperature, melting temperature, pump, power plant.

UDC 678.067:621.891:621.822

Application of heat-resistant antifriction carbon plastics for bearings of vapor turbines. Bakhareva V. E., Kovalev I. A., Lishevich I. V., Monogarov Yu. I., Sargsyan A. S., Esperov D. G., Enrold S. S. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 171–180.

The application prospects of heat-resistant antifriction carbon plastics of FUT-B and UPFS-types based on thermosetting phenol-formaldehyde binder and thermoplastic – polyphenylene sulfide for support surfaces of vapor turbine bearings are discussed. The unique test rig of JSC Polzunov Central Boiler-Turbine Institute for vapor turbine bearing tests and testing methods are described. The results of testing for the bearings of diameter 300 mm with inserts from carbon plastics FUT-B and UPFS and

babbit are presented. The experiment corresponded to natural field conditions. The tests showed high carrying capacity of carbon plastic UPFS-type at minimal temperature level of the bearing surface (up to 60°C). It will be useful to test the support bearing with diameter of 600 mm (the rotor neck diameter of modern turbine devices). Though it's necessary to check the working ability of hydro-moving chambers, testing under different loads and rotation frequencies.

Keywords: heat-resistant carbon plastics, polyphenylene sulfide, test rig, vapor turbine, support bearing, carrying capacity of the bearing, lubricant consumption.

UDC 678.067:621.891

Heat-resistant antifriction composites based on polycyanurates. Sargsyan A. S., Lishevich I. V., Blyshko I. V. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 181–184.

The paper reviews new heat resistant polymer composite materials (PCM) intended for antifriction purposes and based on polycyanurate binders. Lonza company monomers of LeCy (ethylene-bis-(4-phenylcyanate) and MethylCy (methylene-bis-(2.6-dimethylphenyl-4-cyanate)) types were used as binders. The results of tribo-technical and physical-mechanical tests of polymer composite materials are given.

Keywords: cyan esters, composite materials, polycyanurates, antifriction materials, heat-resistant materials.

UDC 678.067:678.028:543.42

Study of curing kinetics of bis-cyanate esters by differential scanning calorimetry and IR-spectroscopy. Tsegelskaya A. Yu., Samkov V. S., Semenova G. K., Krasovsky V. G., Kechekian A. S., Kuznetsov A. A. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 185–190.

Curing kinetics of two cyano ester type termosets was investigated by means of differential scanning calorimetry and IR-spectroscopy methods: ethylidene-bis-(4-phenyl cyanate) (LeCy) and methylene-bis-(2,6-dimethylphenyl-4-cyanate) (METHYLCy, Lonza) under 120–250°C. Curing rate depends on mode of preparation of samples (for ex., vacuum pumping), sample thickness and presence of fillers. Curing rate increases markedly in the presence of carbon fabric. Softening temperature of cured LeCy sample after post curing at 300°C equals to T_m = 270°C. Samples of 20-layer polymer composite materials were fabricated by hot pressing of prepregs at 120°C followed by post-curing at 250°C. Some mechanical properties of composite were estimated.

Keywords: cyanate esters, curing, kinetics, composites, polycyanurates, differential scanning calorimetry, IR-spectroscopy.

UDC 678.743.41:621.039.531:621.891

New class of wear-resistant materials obtained by irradiation of polytetrafluoroethylene in the melt. Khatipov S. A., Serov S. A., Sadovskaya N. V. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 191–202.

The paper studies mechanical and tribological properties of new materials obtained by irradiation of polytetrafluoroethylene (PTFE) in the melt. Irradiation in the melt by a dose above 200 kGy decreases the wear rate by more than four orders of magnitude (down to 10^{-8} mm^3/N m). Electron microscopy of wear debris and transfer film on the countersurface reveals that irradiation changes the mechanism of wear from delamination to fibrillar mechanism. Testing of new materials in the friction pairs with metals shows a significant increase in the endurance of corresponding assembly.

Keywords: polytetrafluoroethylene, modification by irradiation, tribological properties, wear debris, transfer film, wear mechanism.

UDC 621.315.61:678.7:621.891

Development of antifriction dielectric composites and study of their tribological features. Sargsyan A. S., Lishevich I. V., Blyshko I. V., Savelov A. S. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 203–209.

The article is devoted to the study of electric insulating materials with antifriction coatings for use in turbine generators that allow the relative movement of winding and insulation. The coating materials used were fluorine plastic F-4 and polyphenylene sulfide applied on the glass fabric T-11. Tribotechnical

features of these materials were studied at temperature range 20–150°C in friction process over counter body made of electro-technical copper. Temperature dependences of friction coefficient and wear intensity of these materials are presented. Friction coefficient of the moving beginning was studied. The prospects of using such materials in turbine generator design are shown.

Keywords: polyphenylene sulfide, antifriction material, electric insulating material, fluorine plastic, electro-technical materials, polymer composite material, heat resistant materials.

UDC 678.067:621.891

"Superfluvis" composite and its use in friction joints. Shelestova V. A., Grakovich P. N., Danchenko S. G. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 210–216.

The purpose of the work was to determine characteristics and problems arising at manufacturing and use of the fluoroplastic composites. The presented method of plasma processing of the polytetrafluoroethylene (PTFE) filler secures the improvement of its wetting by the polymer matrix and thereupon gives better results in refining structure and a combination of composite properties. Physico-chemical and tribological properties of the materials based on the modified carbon fibers were compared to those of the initial ones. The properties of the Fluvis group composites are analyzed along with their effects under different operating conditions. The examples of Superfluvis commercial application are given and further goals in raising their efficiency are stated.

Keywords: fluoroplast-4, polytetrafluoroethylene (PTFE), plasma, composite, Fluvis, Superfluvis, elasticity modulus, yield point, coefficient of thermal linear expansion (CTLE), friction joint, compressor.

UDC 678.743.41:621.891

Empirical wear law's application to wear forecasting of composites made on a basis of polytetrafluoroethulene. Sedakova Ye. B., Kozyrev Yu. P. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 217–222.

The work presents various aspects of empirical wear law application, as for an estimation of composite materials wear resistance (by examination of linear wear intensity of its components), as for an estimation of tribotechnical efficiency of filling (by calculation of relative linear wear intensity of a matrix compared to a composite). The expression is received, allowing to carry out the comparative analysis of linear wear intensity for new composites with earlier developed compositions.

Keywords: composite, polymer, filler, linear wear intensity, tribotechnical tests.

UDC 678.7:539.55:621.891

Effect of polymer chain flexibility on the tribological properties of DV and FV polyarylates. Sorokin A. E., Krasnov A. P., Ziuzina G. F., Bazhenova V. B., Klabukova L. F., Scheglov P. A. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 223–230.

Frictional properties of two polymers, which have similar chemical structure and different chain flexibility of the macromolecules, and flexibility and compatibility effects on properties of pressed mixtures have been investigated. It has been shown that a complete theoretical compatibility of DV and PV polyarylates leads to the formation of a new structure, on the surface of samples, probably of a copolymer. The copolymer combines the properties of two polyarylates and has the tribological parameters better than every initial component. This work provides new opportunities to create polymer mixtures with controlled anti-friction properties.

Keywords: polyarylate, surface, polyarylates copolymer, flexibility of polymer chain.

UDC 678.067-419.8:621.892

Disperse fillers in tribological fiber-reinforced polymer materials. Exploratory research. Yudin A. S., Buyaev D. I., Krasnov A. P., Sachek B. Ya., Afonicheva O. V., Bazhenova V. B. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 231–239.

The effects of disperse fillers on friction of phenol formaldehyde composite reinforced by heat-proof polyoxadiazole fibers were studied. The reasons, which affect on friction character of both carbon fiber reinforced composite and organic fiber reinforced composite were identified. Three groups of disperse fillers have been studied: ones forming a supporting surface, modifying physical and mechanical parameters of polymer marix and solid lubricants.

Keywords: fiber reinforced polymeric composites, disperse fillers, self-lubricating, polyoxadiazole fibers.

UDC 678.067:539.4:621.891

The application of new composite materials in oil equipment friction units (globe stop-valves and cables-pushers). Chulkin S. G., Asheichik A. A., Selin S. N. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 240–244.

The paper considers the application of the basic types of new composite materials, possessing high constructional durability, wear resistance and shock stability, manufacturability, dimensional stability at metal alloys level, but capable of operating on water greasing in contrast to metals. The basic areas of its use in Russia and abroad have been considered. The authors describe the experience of Department of Engineering Science and Machines Components of St Petersburg Polytechnic University on properties research of materials applied for bearings in shipbuilding, hydro turbine construction and pump manufacture.

Keywords: composite material, industry, transport.

UDC 678.7:621.822:621.891:620.178

Research of physical-mechanical properties of modified composite materials based on phenylon and polyesteresterketone designed for sliding bearings. Chulkin S. G., Zhukov V. A., Selin S. N. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 245–250.

The work studies physical-mechanical properties of four modified composite materials designed for manufacturing of sliding bearings. Techniques of samples preparation and materials tests of static bending, compression, stretching and impact bending are described. Models of the test equipment are presented. Influence of additives to basic materials on their durability is established. Basing on the analysis of comparative tests authors discuss perspectives of new materials creation.

Keywords: physical-mechanical properties, composite material, sliding bearing.

UDC 678.067–419.8:621.891:539.421

Studying the micro cracks formation in fiber composite at impact and friction. Vettegren V. I., Bashkarev A. Ya., Vasiliev K. D., Liashkov A. I., Mamalimov R. I., Savitsky A. V., Scherbakov I. P. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 251–257.

The dynamics of micro cracks in matrix and fiber composite was studied by mechanoluminescence (ML) with a resolution in time – 10 ns. The samples were prepared from polyphenylene sulfide (PPS), PPS modified by fullerene and composite (PPS, reinforced by carbon fibers). ML was induced by impact on the sample surface and the friction of the steel shaft. Analysis of the spectra showed that the ML appeared at relaxation of electronic excitation of free radicals formed by breaking chemical bonds in molecules of carbon fibers and PPS. It is established that the ML has the form of bursts, each corresponding to the creation of micro crack.

Keywords: antifriction polymeric composites, micro cracks dynamics at wear process.

UDC 621.891:620.179.17

Investigation of noise and vibration of metal-polymer friction units by methods of laser doppler vibrometry. Myshkin N. K., Sergienko V. P., Bukharov S. N. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 258–264.

The paper gives the analysis of modern investigation methods for vibroacoustic phenomena on the metal-polymer frictional contact. The authors developed methods for the study of vibration and noise of friction pairs allowing the identification in the spectra of vibration and noise components that characterize the vibroacoustic phenomena caused by the friction.

Keywords: friction, friction induced vibration, noise, vibration, frictional materials, measurement techniques.

UDC 678.7:621.891:543.42

Mass-spectrometric studies of polymer friction. Pozdniakov A. O., Ginzburg B. M., Lishevich I. V., Popov E. O., Pozdniakov O. F. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 265–274.

The paper compares the mass-spectra of the volatile products of thermal and tribo-decomposition of several polymers (polymethylmethacrylate, polystyrene, polytetrafluoroethylene, polyoxymethylene, polyesteresterketone, polyphenylene sulfide) and discusses the kinetics of their formation in order to get better insight in the relative inputs of thermal and mechanical decomposition in the overall process of polymer friction.

Keywords: mass-spectrometry, thermal decomposition, mechanical decomposition, wear resistance, volatile products, monomer, polymer.

UDC 678.067:621.891

The influence of modifying agent nature on the wear mechanism of antifriction carbon plastic under the end-face friction. Sosnov Ye. A., Anisimov A. V., Bakhareva V. E., Barakhtin B. K., Malyguin A. A., Lishevich I. V., Sargsyan A. S. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 275–281.

The paper studies the influence of highly dispersed modifier nature (babbit B-83, MoS_2) on tribological features, tribo-contact surface morphology and wear mechanism of epoxy carbon plastics by atomic-force microscopy. It was shown that modifying agent decreases the carbon plastic wear intensity 2–10 times as carbon plastic wear mechanism depends on modifying agent nature.

Keywords: epoxy carbon plastic, dispersed modifying agent, surface microstructure, atomic-force microscopy, wear mechanism.

UDC 678.686

Composite materials based on epoxy resin modified with ultradispersive diamond soot. Tikunova E. P., Yablokova M. Yu., Kurkin T. S., Ozerin A. N. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 282–289.

Nanocomposite materials based on epoxy resin modified with nanodiamond soot have been obtained. The paper presents the comparative study of mechanical properties of composite materials. It is shown that 0.05% of diamond soot (by mass) is enough to boost tensile strength by 127% (compared to unmodified cured epoxy resin), with flexural strength increasing by 24% and G_{1c} parameter increasing by 67%. The shear adhesion strength of cured nanomodified epoxy resin to a carbon monofiber increases by 80% compared to unmodified epoxy matrix. The effect of diamond soot content on glass transition temperature has been studied by differential-scanning calorimetry.

Keywords: epoxy resin, curing, diamond soot, nanomodified epoxy resin, nanocomposite materials, physical-mechanical characteristics, adhesive strength.

UDC 678.675:621.891

The tribological performance of polymer nanocomposites modified by fulleroid materials. Pikhurov D. V., Zuev V. V. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 290–295.

The paper shows effects of fulleroid (fullerene C_{60} and fulleroid soot used for fullerenes production) and carbon fibers on tribological properties of polymer nanocomposites based on polyamide 6. The composites were synthesized by polymerization *in situ* and direct mixing in extruder. It was found that at polymerization *in situ* additives of these fillers improve mechanical and tribological properties of composites more efficiently. Nanoparticles as fillers decrease the friction coefficient of polymer composites because they have the same size as the segments of the surrounding polymer chains.

Keywords: fullerene C_{60}, polyamide 6, nanocomposites, tribological properties.

UDC 678.675:621.891

Composite materials on the basis of polymers and complex metals compounds. Danyushina G. A., Mogilnitsky V. M., Chebanov R. A., Danyushin L. M., Berezhnoy Yu. M. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 296–299.

The paper analyzes the influence of contents of (merkupral and dithizone) mixture as poliamide-12 filler on physical and mechanical characteristics of items manufactured from the developed composite materials. The materials have the frictional coefficient 0.08–0.16, at sliding speed from 0.07 to 1.0 m/s and load 10.0 MPa.

Keywords: polyamide, merkupral, dithizone, frictional coefficient, structure, constancy.

UDC 678.675:621.891

Tribological properties of composite coatings based on aliphatic polyamide and nanostructured carbon particles. Shapovalov V. A., Valenkov A. M. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 300–302.

Composite coatings based on polyamide 6 and particles of nanostructured carbon have been obtained. The tribological and structural and morphological properties of the coatings have been studied. The optimum contents of the composition and technological parameters of coating formation have been established.

Keywords: nanostructured carbon particles, polyamide 6, composite coatings, tribological properties, surface, filler concentration.

UDC 661.66:621.891:620.179

Methods and inventories for operative nondestructive control of materials and tribocontacts modifying by fulleroid carbon nanoparticles. Letenko D. G. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 303–309.

This work gives the examples of fulleroid carbon nanoparticles (FCN) used for the development and production of new tribotechnical materials. The methods and inventories for operative nondestructive control of materials and tribocontacts modifying by FCN have been developed. Experimental data on abnormal growth of electrolyte conductivity in presence of fulleroid nanomaterials dispersions is presented. It is supplied with the description of these nanostructures made by electronic microscopy, the rentgenostructure and dispersive analysis. The author propose the mechanism of charge transfer, explaining additional conductivity by emergence (at certain concentration of dispersions) of a percolation fractal grid of nanoparticles in an environment of solvate covers.

Keywords: fulleroid nanoparticles, nanomodifying, suspensions, conductivity, fullerenol.

UDC 621.892:621.822:539.538

Tribological investigation of supramolecular self-organization mechanism with the introduction into the water of non-ionic surface-active substances and ionogenic combinations and nanotubes in water-lubricated friction units. Shylov M. A. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 310–315.

The article presents the results of the investigation of non-ionic additive surface-active substances (SAS) and their combinations with ionic ones. The results prove positive influence of the combination SAS_4 + SAS_5 + nanotubes, which is self-organized under the condition of 1 mas. % introduction into water, on the value of the friction coefficient and linear wear of water-lubricated bearing couples. Tribological experiments are proved by physical and chemical investigations of supramolecular state of SAS. It is shown that water solutions of SAS form supramolecular ensembles in the lubricating layer that serve to increase the efficiency of lubrication of contacting surfaces. There is a qualitative correlation between tribological characteristics of the lubricating layer and its physical and chemical properties.

Keywords: tribology, mesomorfism, wear, friction, liquid crystal, mesogen, adsorption, destruction, sorption, self-organization, supramolecular package.

UDC 678.067:661.66:621.892:620.178.16

Effect of fulleroide dispersions on the abrasive wear resistance of carbon plastics in oil environments. Ivanov A. S., Letenko D. G., Nikitin V. A., Petrov V. M., Fedosov A. V., Yuryev V. G. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 316–321.

The work gives the experimental data of the carbon armed materials UGET and FUT abrasive wear and shows the dependence of wear from the fulleroide nanoparticles concentration in the greasing environment (water and oil). The operation of the nanomodifier in tribocontact model is described. Comparative results of the gravitational analysis and linear wear of the samples tested on an equal footing with different options of lubricants are presented. The received results testify that the minimum linear wear and weight losses correspond to the nanostructured composition. It is shown that strengthening of antifrictional effect occurs at the expense of total action of a volume fractal grid from Hybrid Fulleroide Nano-Carbon Material (HFNCM) – capable to restrain a desorption of polymer and dissipate thermal energy from a local zone of the tribocontact. Formation of such grid probably under certain conditions and concentration of HFNCM (in our case close to 10^{-3} mas. %).

Keywords: fulleroide nano-structures, composite materials, abrasive wear, grinding, power, nano-modifying, carbon plastic, fullerenol.

UDC 678.067:621.892:620.178.16

Effect of aqueous and oil solutions of fullerenes on the abrasive wear resistance of carbon plastics. Letenko D. G., Yuryev V. G., Nikitin V. A., Petrov V. M., Fedosov A. V., Ivanov A. S. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 322–326.

This work gives the experimental data of the carbon armed materials UGET and FUT abrasive wear in aquatic and oil environments. Dependence of wear on fullerene or fullerenol concentration in the greasing environment is shown. The special technique of the abrasive wear research is developed and realized. During experiments size of material snagged part and effective power of grinding were measured. It is established that the updating in all cases promotes decrease of the wear, however wear of samples of UGET type essentially differs from FUT type due to the distinction between polymeric matrixes used in different types of the carbon plastic. It is shown that fullerenes and its water-soluble derivatives – fullerenols are capable to have active effect on a friction surface carbon plastics reducing their wear and friction factor in a zone of the tribocontact, achieving maximum effect in a certain concentration interval.

Keywords: fulleroid nano-structures, composite materials, abrasive wear, grinding, power, nano-modifying, carbon plastic, fullerenol.

UDC 678.7:621.892

Substantiation study for manufacturing of compositional self lubricating *Maslyanit*-materials by chemical nanodesign method. Derlugyan P. D., Loginov V. T. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 327–335.

The paper presents basic principles and concepts of the self-lubricating compositional materials development based on the process of polymers high-level plasticization as well as on the introduction of multifunctional solid lubricant additives and fillers in order to give the desired technical characteristics to the composite. The antifriction self-lubricating materials developed by the method of chemical structuring are to be used for friction bearings, sliding guides and seals in friction units operating in different environments and climatic conditions.

Keywords: self-lubricating material, plasticization, solid laminated lubrication materials, fillers, friction, friction bearings.

UDC 678.7-415:621.891

Compositional polymeric thin-sheet material for tribocoupling. Derlugayn F. P., Ivanova I. V. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 336–341.

The proposed compositional polymeric thin sheet material process (CPTSHM) based on an enforced introduction of a composite into fabric pores permitted to develop an antifriction self-lubricating material with upgraded properties as compared with the original polymer. Application of a chemical nanodesign method for composition material, together with technological succession scheme and conditions of integrants combination as well as fillers, additives and plasticizers addition made the friction coefficient reduction possible, and ensured the high level of wear resistance within a wide range of velocities and loads. The developed CPTSHM might be recommended to use in friction units operating in extreme conditions at sliding velocities running up to 5.0 m/s and pressure up to 100 MPa. Admissible values of PV are 3–5 MPa·m/s. The friction coefficient values within the limits of 0.06–0.12.

Keywords: friction coefficient, polymeric material, tribocoupling.

UDC 678:621.822:620.178

Nonmetallic roller bearings with water greasing. The frequency influence of loading on deformation rate of rubber and caprolon rollers. Grigoriev A. K., Yermolaev V. A. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 342–351.

The paper describes the way of development and use of nonmetallic roller bearings with water greasing in vessels stern gears. Results of bench static tests of the roller bearing with two-layer rubber rollers show that the frequency influence of loading on deformation rate of rubber and caprolon rollers, and also distribution of pressure on their section is shown.

Keywords: bearing, roller, shaft, rubber, caprolon, loading, deformation.

UDC 678.7:621.78:621.891

Thermal processing effects on the structure and properties of materials based on phenylone. Lobodenko A. V., Sytar V. I. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 352–356.

The paper is devoted to the influence of thermal processing on physicomechanical and tribotechnical properties of materials based on phenilon. The object of research is the polymeric composition based on phenilon comprising fine-dispersed graphite and low-molecular organosilicic rubber. Thermal processing of samples in polydimetilsiloxane environment consists in its heating to temperature close to temperature of polymer softening with subsequent slow cooling.

Consequently, they have established that heat treatment of phenilon and composites on its basis in polydimetilsiloxane environment improves tribotechnical properties of materials based on phenilon. It is shown, that thermal processing of graphite-filled phenilon composites modified with low-molecular organosilicic rubber is more effective, than the heat treatment of not modified composite.

Keywords: phenilon, thermal processing, tribotechnical properties.

UDC 621.891:620.178.16

Tribo research testing system for support-running parts of locks and hydraulic works. Derlugyan P. D., Moguilnitsky V. M., Chebanov R. A. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 357–362.

Re-equipment of the multipurpose friction testing system USUT-2 with up-to-date equipment and supporting of applied researches by tribotechnical scientific methods provided operational capacity enhancement of the system USUT-2. Testing data of the advanced compositional antifrictional material allows to recommend it for support-running parts of locks and hydraulic works.

Keywords: friction testing system, compositional antifrictional material, friction units of mechanisms.

UDC [678.742.2+678.675]:539.25:539.4

Influence of emulsifier and compatibilizer as additives on morphology and mechanical properties of low density polyethylene/polyamide-6 blend. Podshivalov A. V., Zuev V. V., Bronnikov S. V. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 363–369.

The paper studies morphology of a blend of low density polyethylene (LDPE) and polyamide-6 (PA-6) in ratio 75%/25% with an emulsifier, organoclay (20A), and a compatibilizer, polystyrene-b-poly(ethylene-co-butene-1)-b-polystyrene copolymer (SEBS-g-MA). It is shown that in the course of polymer blending, PA-6 particles disperse, and then coalesce in the LDPE phase. The introduction of an emulsifier (not less than 5 ‰) improves a dispersion of the PA-6 particles and suppresses their coalescence promoting improvement of the mechanical properties of the blend at stretching. At the same time, introduction of both emulsifier and compatibilizer also improves dispersion of the PA-6 particles but does not interfere their coalescence, promoting improvement of the impact mechanical properties of the blend.

Keywords: morphology, polymer blend, compatibilizer, emulsifier, thermodynamics of irreversible processes.

UDC 666.3/.7:621.891

Kinetics of ceramic wear. Kuznetsova O. S., Danilovich D. P., Ordanyan S. S., Fadin Yu. A. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 370–375.

The paper describes a new method for wear measuring, based on the phenomenon of acoustic emission, without stopping the process of friction, and wear dependences for a pair of silicon carbide – silicon carbide without lubricant and under the water. It is shown that ceramic wear occurs by means of successive formation and destruction of surface layers. Wear mechanisms during the running-in and catastrophic wear have the same physical nature due to the process of combining subsurface cracks.

Keywords: friction, wear, acoustic emission, silicon carbide, running-in, stages of wear, friction without lubrication, friction in the water.

UDC 666.193.2:621.891

Synthetic basalts, new antifrictional and structural materials. Borovko V. N. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 376–380.

The paper treats the possibility of synthetic basalt manufacturing – new advanced structural materials obtained on the basis of achievements of contemporary materials science. Unlike bazaltoplasts synthetic basalts do not require polymer resins binders. They receive thin films by directional solidification and stacking orientation of the amorphous phase. Synthetic basalt multilayer products would surpass many of the expensive metal superalloys possessing high tribotechnical characteristics.

Keywords: bazaltoplasts, synthetic basalts, crystallization in thin films, multilayer forming products.

UDC 621.822:621.891:620.193.2

Studies of corrosion resistance and wear resistance for pilot samples of bearing materials in high-parameter water fluid. Anokhin A. I., Afrikantov G. G., Bugreev A. V., Korobov I. B., Kuritsyn V. S., Lukanov A. V., Shishkin V. A. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 381–387.

The most important requirements for friction couple materials to be operated in aquatic environment are stated. The program of corrosion and wear resistance tests for pilot samples of candidate materials for bearings, performed at the JSC Afrikantov OKBM testing base, is given.

Keywords: wear resistance, kinetic coefficient of friction, wear rate, friction couple material, temperature, axial load, sliding velocity, friction unit.

UDC 621.891:621.822:620.178.16

Study of wear resistance of material couples of slide bearings and determination of its tribological characteristics under dry friction conditions in the helium. Borovkov M. N., Bugreev A. V., Iliakhinsky I. A., Kuritsyn V. S., Shishkin V. A. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 388–393.

Studies of tribotechnical characteristics were performed for friction pair materials of the catcher bearings of the turbomachine of the Gas-Turbine Modular Helium Reactor (GT-MHR) under dry friction conditions in the helium. Materials and coatings were tested on the TR20 M 40 tribometer. The best combinations for friction pairs were selected. These combinations were recommended for full-scale tests in catcher bearing mock-ups under standard specific loads and sliding velocities.

Keywords: wear resistance, friction kinetic coefficient, wear rate, helium, friction pair material, temperature, axial load, sliding velocity, “pin-disk” friction unit.

UDC 621.892:620.178.16

The research of lubricating compositions on the basis of plastic lubricants. Fomichev D. S., Berezina E. V., Godlevsky V. A. – Voprosy Materialovedeniya, 2012, N 4 (72), p. 394–401.

The paper describes plastic lubricants with high-dispersed solid tribo-active additives of organic nature, the derivatives of heterocyclic compounds. Presence of supramolecular ordered structures in lubricant environment causes the raised propensity to self-organizing of boundary lubricant layer in lubricant’s volume and on sliding solid surfaces. Physical and chemical properties of the lubricating compositions were researched by various methods. The phase condition and temperatures of phase transitions of lubricant mesomorphic structures were investigated by the polarizing microscopy. Temperature influence on rheological characteristics of samples was studied by means of basic graphic method of non-Newtonian flow analysis that is the drawing “viscosity vs. shear velocity”. The tribological properties of lubricating compositions were studied on tribometer СМЦ-2 (SMTs-2) by standard techniques. The correlation between parameters was revealed during definition of interrelation between the results obtained by the tribometer and rheological tests.

Keywords: phthalocyanines, mesomorphic structures, tribological research, rheology.