WEB OF SCIENTIST: INTERNATIONAL SCIENTIFIC RESEARCH JOURNAL
ISSN: 2776-0979, Volume 3, Issue 5, May., 2022

FEATURES OF FLUOROCOMPOSITES OBTAINING FOR WEARING PARTS OF MACHINE-BUILDING PURPOSE

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Abstract

This article presents the structural and technological aspects of the jbtaining technology of composite materials based on polytetrafluoroethylene. It is shown that due to the existence of inert components in the process of interfacial interaction with the degree of filling in the traditional technological paradigm implemented structural paradox manifests itself in proportion to the reduction of the parameter of tensile strength with increasing degree of filling. Technological principles are proposed to eliminate the negative impact of the structural paradox fluorine composites by controlling the structure of the organization at various levels -molecular, supramolecular, and interfacial phase. Efficient methods of manufacture of products from highly filled fluorine composites containing 25-35% by weight, carbon fiber and having parameters of strength characteristics 1.5-2 times superior analog parameters "Flubon", "Fluvis".

Keywords: highly filled fluorcomposite, polytetrafluoroethylene, structural paradox, technological paradigm, strength, thermal characteristics, tribological characteristics.

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1. Introduction

Polytetrafluoroethylene (PTFE) and composite materials based on it are widely used for the manufacture of sealing products, tribological, as well as for protection against corrosive process fluids and high temperatures[1-8]. The characteristic features of the structure of macromolecules PTFE cause supra molecular structure parameters defining the mechanisms of friction, wear, deformation under the influence of statistical and dynamic loads, as well as the inertia in the process of interaction with the components of the most technological and operational environments. An analysis of the literature devoted to the research of physico-chemical and technological aspects of the production and processing of functional fluorine composites, as well as the use of their products in various fields of technology, evidence of mature traditional methodological approaches based on the classical concepts of polymer materials science, physics, chemistry and technology of plastics and composite materials[1-3]. The essence of this approach is the application of methods of regulation of the supra molecular structure of the PTFE matrix by introducing a dispersed phase modifiers and structure through the use of composite fiber fragments of organic and inorganic fibers - glass, oksalonovyh, basalt, carbon [1-3].

For the filling materials based on PTFE - fluorine composites - use effective methods of management of structural parameters on different levels [2, 6, 8], which allowed us to develop and industrially master brand variety, including a few dozen names with different parameters of strength, tribological and thermal characteristics [1-4, 6-8]. With all the variety of stamps fluorine composites (Papers Series "Flubon", "Fluvis" F4K20, F4G10 et al.), In their preparation implemented common technological principle of forming and processing into products, involving a combination of the operations of mixing the components in a predetermined ratio, cold extrusion billets and their hot sintering (mono politicization) in air at a given temperature-time mode. This technological principle is similar in nature to those used in powder metallurgy, currently dominates the literature, patent and commercial sources, becoming the basis for the technological paradigm fluorine composites function [1-9].

The purpose of this research was to' develop the principles of improving the technology of machine fluorine composites based on the concept of multi-level modification.

2. Methods

The base of the binder used in the preparation of fluorine composites commercially available polytetrafluoroethylene (PTFE) marks F-4PN, F-4PN90, F-4TM differing average size of the powder fraction (JSC "HaloPolymer", Russia). For PTFE reinforcement matrix Used fragments of carbon fiber (CF), obtained by mechanical dispersion of the carbon ribbon brand LO-1-12N (JSC "SyetlogorskHimvolokno", Belarus) with the size of fractions of less than 200 microns. Structural modification of PTFE was carried out by introducing a part of carbon (TC) grades P234 and P803 with a mean size of individual particle's 20 and 80 nm, respectively, also ultrafine polytetrafluoroethylene (UPTFE) is a polymer-oligomer products termogazodynamic synthesis of polytetrafluoroethylene, obtained according to [6, 7] . UPTFE used in the experiments, commercially available under the trade name "Forum" (Institute of Chemistry FEB RAS, Russia). In addition, as structure modifiers used PTFE dispersion particles semifinished organic and inorganic -clay, tripoli, metal oxides, carbon nanotubes, ultrafine products of detonation synthesis and UDD UDAG et al. The samples for the research of strength and tribological characteristics of the developed fluorine composites prepared in accordance with the requirements of normative documents on materials like "Flubon" (analogous to "fluvis") [8]. Defines the parameters of strength and tribological properties (wear intensity I, the coefficient of friction f) according to standard procedures or methods recommended in the standard documentation, using settings MP-200, ComTen 94c, P 0.5, HP-250, friction machines SMC-2, HTI-72. Analysis of the .physicochemical and structural aspects of the modification of the PTFE technology for production and processing fluorine composites and features of operation of products are carried out on the basis of IR spectroscopy (Tensor-27), nuclear power (NANOTOP-III), optical (Micro 200T-01), scanning electron (LEO 1455VP) microscopy and X-ray diffraction (DRON-3.0). Samples were prepared for research on technological regimes recommended in[3, 9] and on the original technology, the possibility of multi-level modification. For the modification of hydrocarbon used short-impulse laser radiation with a wavelength λ = 1.06mkm at the energy storage device (800-900) and in the number of pulses from 1 to 10.

III. Results and Discussion

An analysis of the literature devoted to materials science and technology of functional fluorine composites [1-9] suggests that the main provisions of the traditional technology, part of the paradigm is the use of classical methods of control of the supra molecular structure of the polymer matrix by means of dispersed fillers of organic and inorganic nature and the injection of PTFE dispersed fragments reinforcing fibers using mechanical operations of mixing, cold pressing and mono politicization preforms at temperatures above the melting point of the crystalline phase of the binder. Using this technology, a variety,of types, consisting in the introduction of fine fillers (carbonaceous, siliceous - UDD UDAG, zeolites, etc.), including nanoscale and mechanical activated h[1, 4, 5], and the reinforcing fibers (carbon, glass, basalt, aramid), or mixtures thereof[2, 3, 6, 7], while Keeping the traditional process flow for obtaining blanks (of products), not achieve a fundamentally new effects enhance the parameters of strength, thermal and tribological characteristics. Use of complex modifier comprising finely divided fraction of the carbonaceous substance (cryptocrystalline graphite) in combination with disperse fragments carbon reinforcing fibers (CF)[6] the conventional technique for forming preforms, also not significantly increase the values of tensile strength, toughness and wear resistance, which is determined the potential for their use in the construction of machines and process equipment with high requirements for reliability and warranty service life.

The experimentally observed adverse effect of the values of a number of important parameters fluorine composites with the introduction of the high-strength fillers can not be explained using the classical concepts of the role of structure on the interfacial and supra molecular levels in the implementation of mechanisms of deformation and fracture of these products under the influence of operational factors.

However, for any type fluorine composites containing as finely including nanoscale1, [2, 5] as well as fibrous reinforcing fillers (original and modified)[2, 3, 6, 8], and mixtures thereof[2] realized the effect of multiple parameter is increased wear resistance ini friction products for metal counter body without applying external lubrication. Obviously, this effect is a consequence of the mechanism of manifestation of creating filler particles of any composition, structure and dispersion of mechanical obstacles to deformation and displacement of local areas of the matrix of the binder under the action of the tangential stresses and their own resistance to tribological factors thermal, mechanical, destructive.

Method SEM revealed that, regardless of the individual parameters of composition, structure and technology particulate characteristic of them clustering in the preparation and storage (Figure 1) and the presence of the particles of micro-range (particles of mechanical' dispersion of silicate glass, copper formate, tripoli, clays, oxides metal, PTFE, polytetrafluoroethylene ultrafine) nanoscale components, which define the characteristic morphology of the surface layer. Processes clustering technology due to a particle, the conditions of their storage and preparation for use as modifiers of polymer matrices.

Analysis of the literature and the research results indicate the prospects of using laser technology in the formation of functional materials and systems. Laser radiation has a complex effect on the polymer intermediates, changing its structure, deformation-strength and electrical characteristics. Probably a synergistic effect of laser radiation

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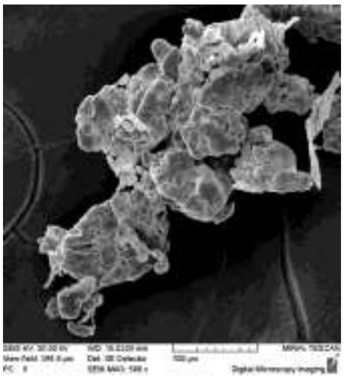
due to the change of the energy parameters of polymeric macromolecules, which causes secondary processes of structural transformations that modify the settings of service characteristics.



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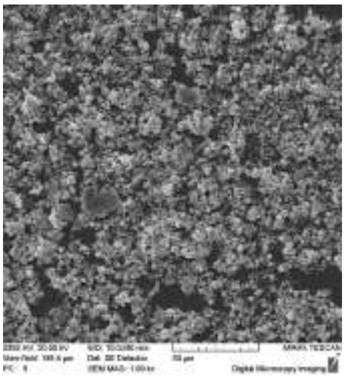

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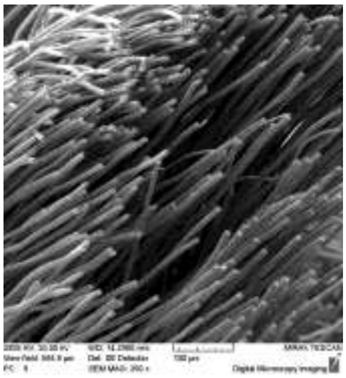

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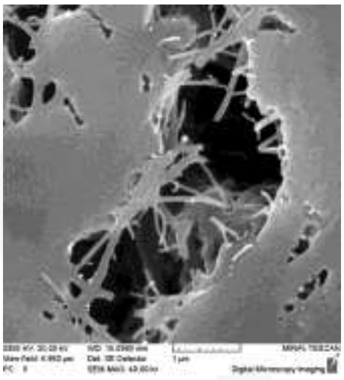

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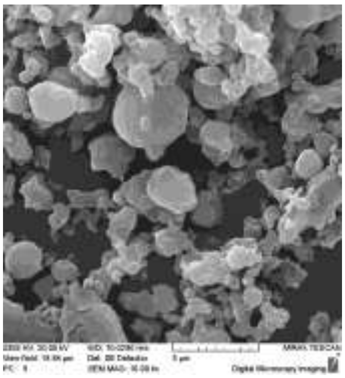

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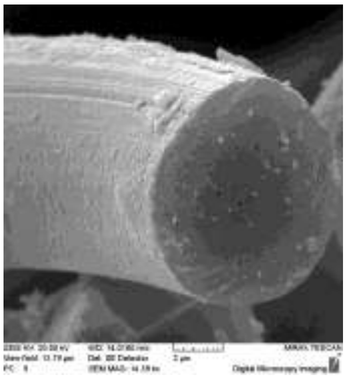

f

Figure 1 - A typical cluster structure (a, b, c) and particle morphology polytetrafluoroethylene PTFE (d) ultrafine UPTFE polytetrafluoroethylene (e) and carbon fibers (f). The increase indicated in the pictures. These SEM

The manifestation of the clustering process and the morphology of the surface layer of the individual particles of different composition, structure 'and technology of necessitate the use of individual techniques in the preparation of composite materials' specified functionality that will provide the optimum modifying effect at a certain level of structural organization.

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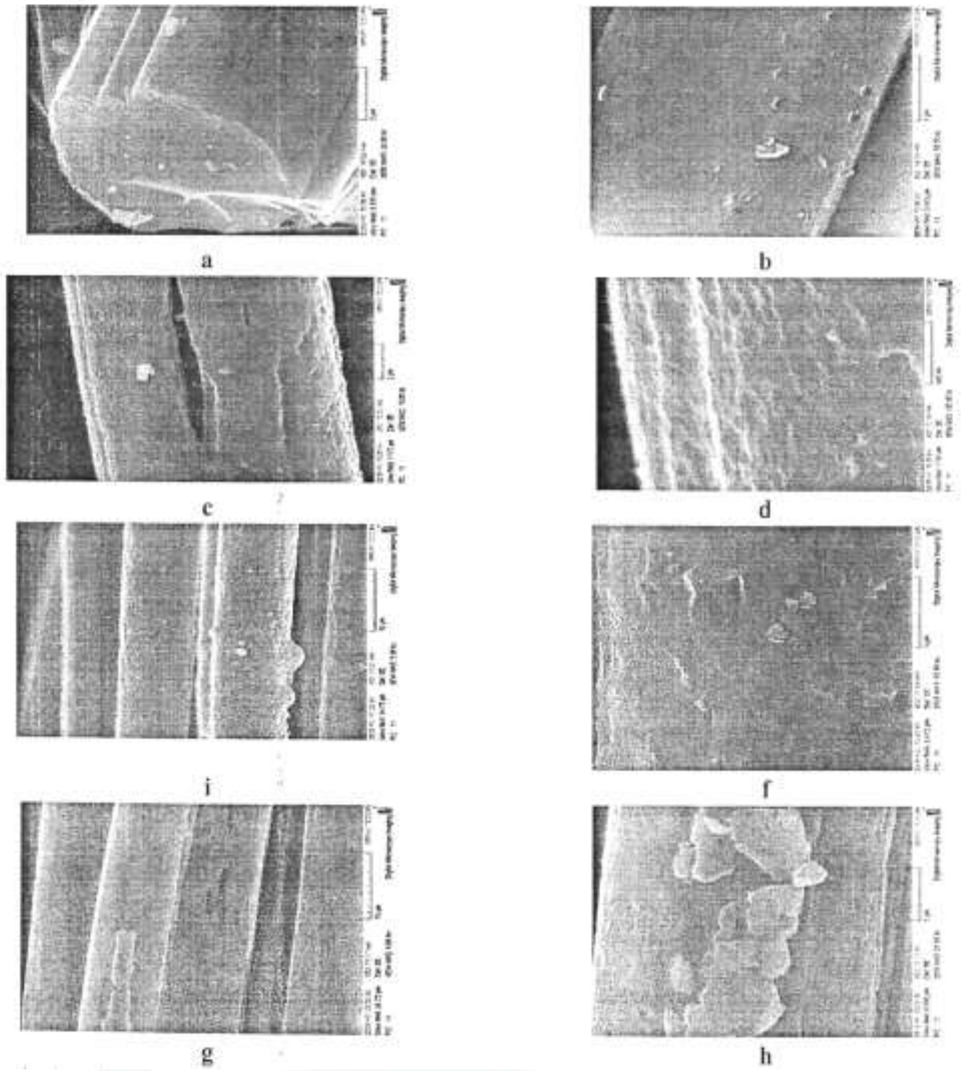

Figure 2 - A typical morphology of the surface layer of the carbon fiber source (a, b) and the processed short-pulse laser beam (c-h) when the number of pulses 1 (c, d), 5 (i, h) and the energy storage device 800 (c-f) and 900 (g, h). The increases shown in the pictures. These SEM

Obvious role of individual characteristics of the energy state of the dispersed particles of different composition, crystal-chemical structure and technology of on the mechanisms of the processes of clustering in composite matrices when used together the necessary operations that make up the process - storage, dosing, mixing, loading into the working volume of the installation, and others. It is therefore advisable the establishment of the common symptoms that cause effective modifying effect of dispersed particles, kinetics and mechanisms of cluster formation at various stages of the process. The features of the energy state of the dispersed particles of modifiers in view of modern concepts of condensed matter physics and materials science of polymer composites with nanoscale components (nanocomposites)[10-12]. Analysis of the morphology of the surface layer of particles of different modifiers (Figure 1) indicates a characteristic of nanoscale components, mechanisms of formation which, as a rule, individual substances with different composition, structure, technological prehistory receiving and dispersing.

Given the pronounced inertia of the carbon fiber to the processes of physical and chemical adsorption, which would promote the formation of the boundary layer of the required adhesive strength, and expressed inertia macromolecules PTFE to the process of adsorption interaction with virtually any high-molecular matrix and the absence of the characteristic viscous fluid state even at temperatures above melting point of the crystalline phase, the mechanism becomes understandable manifestations of adverse fall PTFE strength parameters when modifying the HC over the entire range of concentrations (5-20) wt%. To reduce the probability of manifestation of this adverse effect, we proposed technology of modifying the surface layer of a short-pulse laser light hydrocarbon (s) with the wavelength λ = 1.06 microns and the voltage on storage devices U = 800-900 V in an air atmosphere. Research by REM indicate the possibility of significant changes in the morphology of the surface layer of hydrocarbon treated LEE (Figure 1).

So even with a single pulse exposure, not only the surface layer of carbon fiber .fragments nanotopography gets developed to the size of the components (10-100) nm {Figure 2, c, d), but the image of three-dimensional structure of \. the defects caused by the destruction (perforation) of fiber under the influence of processes ablation and thermal shock. By increasing the intensity of the energy effect by increasing the number of pulses and five (Figure 2, i, f) or simultaneously increasing the voltage drive to U = 900 V (Figure 2, g, h) is observed development of the relief of the surface layer to form the marked portions of fusion (Figure 2 , y), ablation (Figure 2, f), the deposition of ablation products with the formation of cluster structures (Figure 2, h) and perforating the fiber (Figure 2, c). Without considering the mechanisms of morphological changes in the carbon fiber fragments that make up the object individual studies, we note that the method of modifying the surface layers of fibrous fillers has a special perspective in connection with the development of instrumental base designs laser sources, which are widely spread in modern materials. Note that modification with the laser radiation can be subjected to both the pulp and dispersed tissue fragments and intermediates, are widely used in the art of composites.

Model experiments to assess the effectiveness of the modified laser light carbon fiber (CF LR) to fill PTFE indicate the prospects of development of this technological approach.

This method of activation of CF fragments seems more promising than the stated plasma chemical processing method in an environment of fluorine-containing components in the vacuum chamber [8] as implemented in an environment of air, and allows different types of modification of the surface layer of functional components, including fluorinated (oligomers and polymer-oligomer mixtures Epilam, Foleoks, Forum), metal containing (formates, oxalates), carbon-containing (mineral and synthetic oil), silicon (silane compounds) compounds which fragments formed by the action of high flow, are capable of reacting with active centers nano topography carbon fiber. By controlling the aspect ratio, energy and structural parameters" of the active layer nano topography and sizing may obtain the optimal structure and energy state of the boundary layer in the composites based on PTFE and increase the parameters of their service
characteristics.

IV. Conclusion

When choosing a methodological approach to defining the technology of composite materials based on high molecular weight matrix (polymer, oligomer, combined) suitable mechanisms for the implementation of the energy state of manifestation in the process of modifying component of structure at the interface level. Optimal control parameters of the energy state of the dispersed filler particles causes the realization of the cumulative effect of the structuring of the boundary layer in a force field modifier and optimize adsorption processes various mechanisms in active nano-relief of the surface layer. In order to control the parameters of the energy state of the dispersed particles should be used fillers technological impact, taking into account the features of the composition, the structure of the crystal-chemical, technological history. Prospective application of technologies of thermal, laser and mechanical activation of the components used to create functional materials based on macromolecular matrices of various kinds

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