THIN FILM COATINGS FOR LOW WEAR METAL-POLYMER SYSTEMS

ТОНКОПЛЁНОЧНЫЕ ПОКРЫТИЯ ДЛЯ МАЛОИЗНАШИВАЮЩИХСЯ МЕТАЛЛОПОЛИМЕРНЫХ СИТЕМ

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Abstract: *Investigated the features of the structure of the thin-film coatings based on polymeric and oligomeric matrix formed by dipping, spraying or rubbing. It was found a significant effect of energy substrate parameters and components of the coating on the mechanisms of interfacial interactions that determine the parameters of strength, tribological and protective coatings. The active layer morphology of the surface of the substrate formed by mechanical, laser or chemical influence, characterized by the presence of low-dimensional components of different habitus, which affect the energy and mechanical component adhesive strength. By managing service parameters of composite material components on the basis of polymeric and oligomeric matrix manages to change the mechanisms of formation of coatings on metal substrates of carbon steels and non-ferrous metals. Coatings based on the thermal ablation of PTFE products are effective in the process of running heavy-duty friction units and their operation at reversing the motion. Installed effect Nanophase formation regions in the volume of the coating, which help to increase their durability in friction without external supply of lubricant.*
***KEYWORDS**: THIN FILM, MORPHOLOGY, FLUORINE-CONTAINING OLIGOMERS, WEAR MECHANISM, NANOSCALE STRUCTURES AND MODIFIERS*

1. Introduction

One of the most important conditions for sustainable functioning tribosystems different structures is the presence of a frictional contact zone so called "the third body", which is formed as a result of physical and chemical processes of interaction of the surface layers of the details included in the friction unit design, elements of technological couples "tool–blank" and technological protection– of air, lubricating or cooling lubricants [1].

It is obvious that the main task of any constructive-technological, or material science solutions tribological device (assembly friction and the technological scheme) is to create a separation layer with the parameters in the optimal degree of ensuring its equilibrium.

Thin film inhibitors wear tribosystems formed from the active gas phase and the solutions rotaprinting and plasma chemical methods, commonly used in tribotechnology including precision [1–4]. Despite the difference in technology of forming the fluorine-containing coating (FCC), differing in composition, structure and geometric parameters, there are general patterns of manifestation of their anti-friction and anti-wear mechanism of action due to the specificity of the molecular and supramolecular structure.

Therefore, the aim of this study was to investigate the general laws of the formation of separation layers on the basis of fluorine-containing components of different composition and structure.

2. Research methods

For the conducting research were chosen of fluorine compounds of various compositions and molecular weight – fluoro chemical oligomers with a molecular weight of up to 1000 units, produced under the trademark "Foleoks" and polymer composites based on polytetrafluoroethylene (PTFE) with a different toppings and modifiers. Coatings on metal substrates formed of fluorine-containing components in the solution by dipping or rotaprinting method. The surface layer of the substrate was exposed to various energy flows - laser, ionizing or deposition of thin film layers in the active phase of the vacuum.

3. Results and discussion

An analysis of the literature and own studies of features structure of the fluorine-containing coating formed by different technologies [1-4] have allowed to carry out their classification according to the criterion by the molecular weight used of the matrix (Fig. 1).

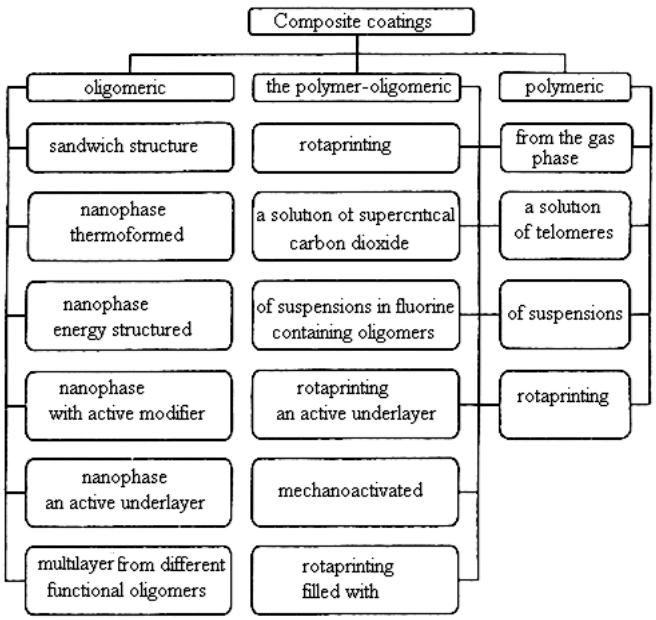

***Fig. 1** Classification of fluorine containing tribological coatings*

Without pretending to be exhaustive of the proposed classification, consider the typical structural features of composite coatings of various compositions and imaging technologies.

Preferential attention will coatings which are formed by the interaction of the friction modifier the fluoropolymer component on mainly the under layer, which is applied to the metal substrate. The most widely used coatings were prepared based on titanium compounds (nitrides, carbides, altins), which is formed using vacuum technology. Widely used methods chemical treatment (for example phosphating) to form a surface layer of desired morphology.

When applying nitride titanium sub layer of the steel substrate, depending on the technological conditions, is formed the film with a different morphology. Analyzed influence sub layer of TiN, wherein there was no so-called "drip phase" when varying thickness (denoted "nitride titanium -1" and "nitride titanium-3") and a sub layer with a dropping phase (the designation "nitride titanium -4").

There are two basic methodological approaches to the formation of separation layers in the friction pair. The first is based on the management of kinetics migration of fragments Tribo destruction polymer component in the mating surface and fixing them under the influence of physical and chemical processes in the

friction zone. Management of the parameters of this process can be accomplished by adjusting the roughness parameters of the opposing member surfaces.

Another more effective by forming the separation layer is tribosystem prior application of thin films, including polymeric and oligomeric components on the surface of the friction pair [3, 4]. This area is currently developing intensively in the production of high-precision systems, tools, parts tribosystems increased resource.

We believe that the combination of these two approaches would achieve a synergetic effect in the creation of low wear systems.

It is found that regardless of the technology of preparation of the surface layer of steel metallic counterface of steel 45 (underlayer of TiN without dropping phase and a droplet phase,treated witha jet ofsandunderlayer or phosphated for 5–30 min) and the type of oligomer used (F-1, F-14) observed intensification of the migration process and the formation of the separation layer (Fig. 2-4).

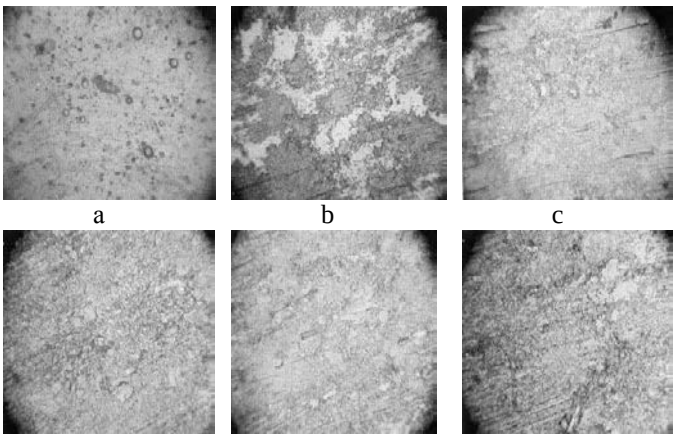

Fig. 2 *The morphology of the surface layer of a sample of steel 45 with a under layer of TiN without dropping phase, modified oligomer F-14, after frictional engagement with a graphite sample: a - the original; b - after 10 cycles; c - after 20 cycles; g - after 30 cycles; d - after 40 cycles; e - after 50 cycles. ×300*

Applying to the surface a under layer of TiN with a smooth morphology of a thin film of a fluorine-containing oligomer grades of F-1 contributes to the fact that after 10 cycles of contacting loops formed separating layers with a sufficiently homogeneous structure and a high resistance due to the lateral movement without exfoliation, aided oligomeric component (Fig. 3).

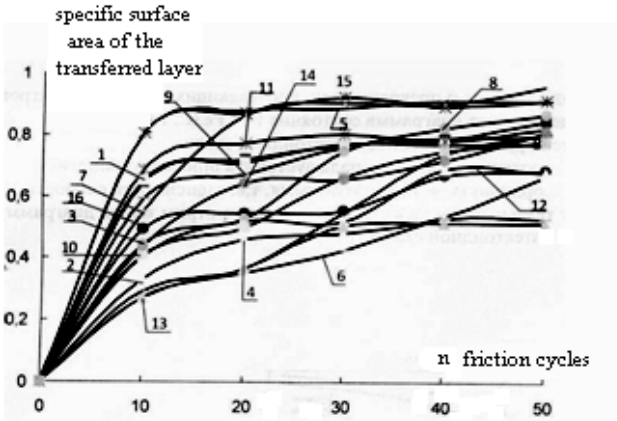

Fig. 3 *The kinetics of mass transfer during friction carbon sample for counter body with various pre-treatment: 1 – TiN + F-1; 2 - phosphate. layer 5 m + F-14; 3 - phosphate. layer 15 m + F-1; 4 - TiN + F-14; 5 - TiN ("drip." phase) + F-1; 6 - phosphate. layer 15 m + F-14; 7 - steel 45 sand jet + F-1. 8 - steel 45 sand jet + F-14;. 9 - TiN ("drip." Phase) + F-14; 10 - 30 m + fosfat. layer F-14; 11 - fosfat. layer 30 m + F-1; 12 - steel 45 + F-14; 13 - steel 45 + F-1; 14 – phosphate layer 5 m + F-1 + F-14 +; 15 - fosfat. layer 5m + F-1; 16 - TiN + F1 + F-14*

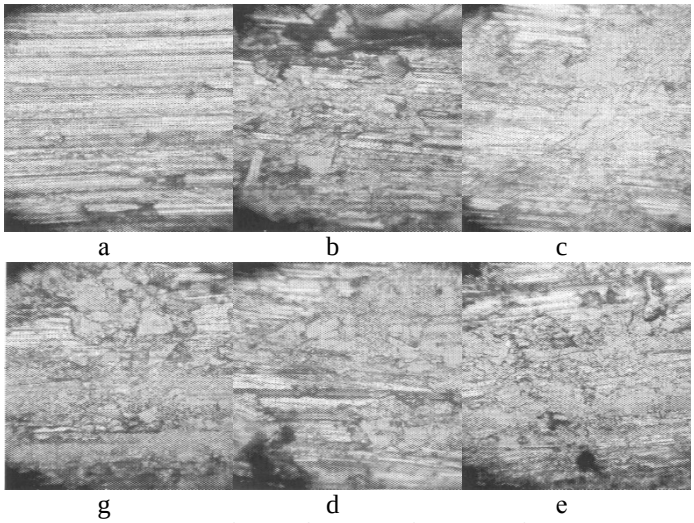

Fig. 4 *The morphology of the surface layer of a sample of 45 steel with a sub layer of TiN without dropping phase, modified by oligomer F-1, after the frictional interaction with composites based on PTFE: a – the original; b – after 10 cycles; c – after 20 cycles; g – after 30 cycles; d – after 40 cycles; e – after 50 cycles. ×300*

The choice of specific technology of preparation of the morphology of contact surface of the hydraulic elements, oligomeric composition thin film coatings and components forming the separating layers of a given structure, due to technical requirements, defining the resource, the quality of the product and implementation costs [5].

4. Conclusions

The effectiveness of the fluorine-containing wear inhibitors approbation was realized for the manufacture of production tools (molds) and tools for cold deformation of sheet semis. Tests are indicating increaseof wear resistance for the movable joints of molds and tools for the production of tubular billets by at least 1.5-2.0 times after a single application to an active sub-layer of fluorinated oligomers "Foleoks" or "Epilam".

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