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Anti-friction properties of thin layered nanosized protective films "Epilam": synergy effect

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Abstract. In the general concept of temperature-resistant antifriction coatings, greate attention is paid to the growing use of multifunctional films. Epilams are polymer compositions, studying organic chemistry, namely to compositions (liquids), which, when applied to a solid surface, form on it nanosize multifunctional molecular film of a certain way of oriented molecules of surface-active agents (surfactants, SAA), which significantly changes the surface energy of the base (substrate).

1. Introduction

In recent times new materials: alloys, composite metals, ceramics, textolite and other that require a thin protective coating. The use of modern film-forming lubricating composition for producing a thin layer (nanosize thickness up to 100 nm) of a protective coating that preserves the geometrical, and electrical parameters of the surface, while reducing energy surface, friction [1], adhesion (sticking of the particles) in the absence of corrosion activity, aging, wear can be characterized by the synergy effect of resource that is imperative for the preservation of technical characteristics, durability and reliability.

In addition to handling mechanisms and bevel pairs, where there is friction, for example the bed slideways of machine tools with CNC, conical pairs of gears, the compositions can also be used as an additive in internal combustion engines, transmission, transmission (including robotic). Methods of thermodispersion or added in the form of additives, which are caused by intermolecular forces (van der Waals) between the fluids, oils, greases, provide durability of the applied coating, but in chemical connections (chemisorption) the molecule triboactive and irreversible adsorbate form chemical connections.

After activation of the polymer composition (production process) the fluorine-containing macromolecule acquires properties entirely different from properties of those composite units from which they are built. Under the influence of certain rays of the fluorine molecules are activated and begin to "ordered" vertically-directed, i.e. the hydrophilic ends. Charged molecules can reduce surface energy of the material to be adsorbed, hemosorbents hydrophilic tail (polar layer), while the hydrophobic tail remains on the surface (non-polar layer). There are different activation methods, for example ultrasonic. In the works of V E Panin and group of authors the use of ultrasound accelerates diffusion and adhesion processes in the coating with different materials [2]. In this source indicates that the analysis of the influence of ultrasound on the structure is determined by the penetration of ultrasound (and charges) in a layer of liquid phase coating, thus changing the structure properties of the alloy (material). According to the authors [2, 3] the mechanism of activation structures of the composition under the influence of ultrasonic vibrations is a process that affects the structure of the

composition. Vibrations of the ULTRASONIC instrument are excited by the transformation of mechanical fluctuations of current or voltage. In practice, the role of the system of airless mixing with the use of Doctorow (ejectors), based on the Venturi effect, carry out internal combustion engines, gearboxes and other automatic stirring mechanisms.

2. Research of a nanosized monomolecular surface-active agents films

The process of obtaining a film characterized by monomolecular layer. Are determining parameters such as substrate temperature, deposition rate, indicators of charge of the molecules, the degree of activation of the surfactant, pressure and humidity of the working atmosphere, the porosity and surface finish.

The study profilograms (figure 1) can be carried out with the help of modern devices nanoscopy, study on the level of neopane (adhesion) – an instrument adhesimeter where to achieve maximum grip of the focusing device with the surface of the test specimens, they are left for 7 days (the standard methods). After 7 days it stops around the perimeter of its circumference is cut, and then the pull test. For example, the results of tests on the bond strength of the focusing parts adhesimet with plates covered in the nanotechnology center of the Institute Gosniti (Moscow) composition "Epilam SFC-05" received following data for adhesion: 0.55 MPa, which confirmed the very low adhesion of the fluoropolymer, which is 6 times less than on polyethylene, 11 times – than glass, in 13 than steel and 15 times than ceramics.

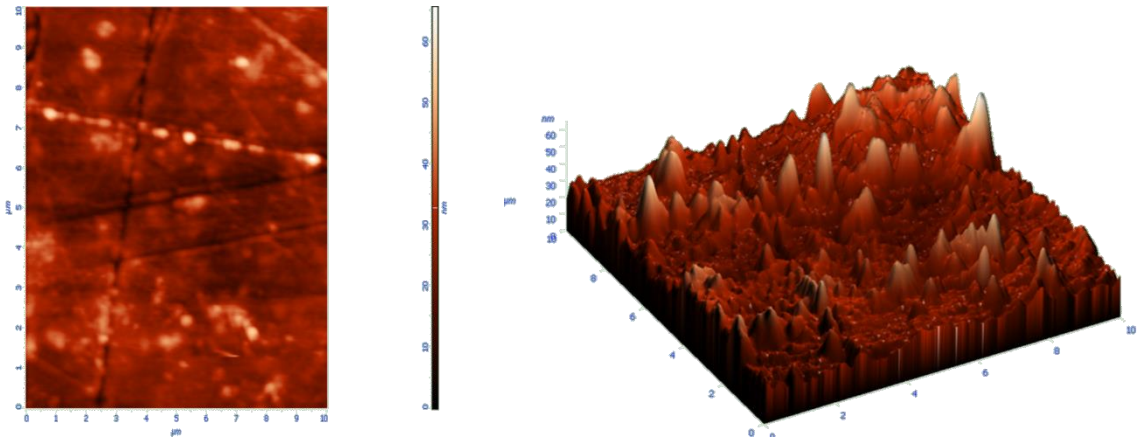

Figure 1. The profilogram the surface of a fiberglass dielectric material after covering by Epilam SFC-05 nanofilms.

The impact of the strong links between metal ions and surfactants the formed complexes increase the polarization of the hydrophilic and hydrophobic ends. The nature of the coverage on average is consistent with theoretical notions about surfaces Langmuir–Blogett. The height of the "pile" (palisade Langmuir) of 1–3 nm, the coating on the plot is uniform, without visible spikes. The surface roughness of the coating film: the RMS is 2 nm, the arithmetic mean is 1.6 nm (figure 2).

Study of parameters of the microrelief of the substrate surface can be a significant source of information on the modifying effects of a film-forming composition prior to application and after the application of a uniform nanosized layer coatings [4]. A plurality of functional impact (antifrictional, antiadhesives, bacteriostatic) in total creates a synergistic result.

Theoretical and practically synergy effect is achieved through colloidal processes, where the properties of colloidal systems depend not only on particle size but by the presence of interfaces with significant free surface energy. In the source, it was concluded that in addition to the kinetic stability depending on the size of the particles has a resistance of particles to mutual adhesion (aggregate stability). Stabilizing the coefficient of surface energy is achieved not only smoothing of the surface roughness in the range of 10.6 nm (exposure contributes to the conductivity of nanofilms), but also to improve the water resistance of semiconductors, etc., providing a clean surface. Moreover, the surface

layer can withstand temperatures ranging from –160 to +420 °C, providing thermal protection of the surface layer depending on the reduction or increase of temperature.

Ostwald maturation neutralized due to the acceleration of coalescence and reduction of surface energy, which directly affects the angle of wettability of the deposited and developing droplets of moisture and corrosive liquids on the surface. High adsorption ability at the interfaces liquid–solid and determined by the rate of adsorption of nano-films and can be described by the equation [5]:

$$\alpha = 0.856 \cdot 10^{-11} + 8.900 \cdot 10^{-7} \text{ °C}, \quad (1)$$

which corresponds to linear dependence in the region of Henry isotherms, i.e. the initial stage, in which is formed the first adsorption layer.

The diffusion coefficient in the aggressive air environment has higher value and can reach 10^{-6} m^2/s, which means that the movement of fine particles of different sizes when applied by aerosol (selective spraying) will be more intense according to the criterion of relativity.

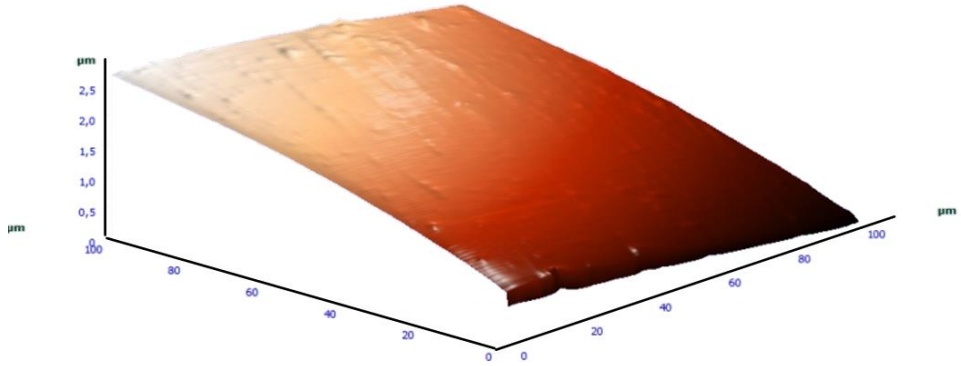

Figure 2. The profilogram the surface after covering by Epilam SFC-20 nanofilms and chemical thermoactivation.

3. Conclusions

The process of obtaining a uniform layer due to the fact that macromolecules of this type of surfactant, polar, ordered (the activation process) hydrophilic/ hydrophobic ends and have a magnetic dipole moment. The polar portion of the macromolecule, getting into the field of the part surface, oriented in the directions of the force fields details [6], its polar part of the adsorption bonds is fixed on details, and non-polar part remains outside over the item. Thanks to the strong links between metal ions and surfactants the formed complexes increase the polarization of the hydrophilic and hydrophobic ends, which leads to a duration of thin coatings that reduce friction coefficient and low adhesion surface.

Coverage (including epilam) insulate the surface of the material of the part, prevent the introduction of superficial layers of the working surfaces of agents of the aggressive environment and thus protect the material from wear, corrosion and fracture.

References

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