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ENGINEERING METHODS DEVELOPMENT OF CONTACT SURFACES TRIBOLOGICAL SYSTEMS

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The developments of engineering methods contact surfaces of tribological systems have been analyzed. Problems and prospects of development of discrete surfaces oriented structure technologies have been shown.

The general formulation of the problem and its relation to scientific and practical problems. Modern development of the science of friction and wear is becoming increasingly important role in modern engineering. The question increase of durability and reduce losses in tribological systems remains largely unresolved for reasons complexity of processes and phenomena taking place in thin surface layers. The study of these phenomena for many years history of the science of friction and wear is considerable interest in tribological society. The economic feasibility of a comprehensive quality assurance of surface layers in tribological systems marked the beginning of scientific direction - surface engineering, which is to develop a sound choice of geometric parameters and physic-chemical properties of the working surfaces which ensure reliability and durability required.

The innovative nature of surface engineering covers a range of different scientific fields of science and knowledge, combines techniques targeted changes in physic-chemical properties of the surface layers of materials by deformation, modification, application tapes, coatings, protective layers of different methods and their combinations. The unique combination of modern scientific and technical tools and advances, real needs and incentives initiated creative atmosphere, large-scale international cooperation and attracted a large number of surface engineering scientific and technical intelligentsia [1].

The choice of methods for specific engineering parts and components of friction is a complex technical and business problems. The methods of surface modification have known for today more than one hundred. In the next decades is expected to more rapid development of surface engineering, which will stimulate the development of new technologies. One such technology is now methods for creating surfaces of discrete-oriented structure (foreign literature they are also called textured surface, spotty coverage) that originated many years ago, but widespread over the past decade as the most promising, viable way of engineering the surface. The essence of this technology is to replace the traditional continuous layer on the surface of the mosaic-discrete discontinuous structure that ensures the necessary reliability and durability trybo-conjugation in extreme conditions where continuous protective coatings lose their efficiency.

Review articles and analysis. Research-oriented discrete surface structure devoted a lot of works of famous domestic and foreign scientists such as L. Barshteyna, H. Wang, S. Wenzel, M. Gayger, B. Lyashenko, H. Kato, W. Petersen, N. Saka, N. Saha, E. Falz, D. Hamylton, Y. Schneider, J. Etsiona and many others.

Textured surface actually formed by friction of contacting surfaces in place of the actual contact surface strain due to the simultaneous action of normal and tangential stresses on the surface of the exit slip lines and dislocation of other entities. Textured layer (surface roughness) is characterized by a very low altitude, depending on the direction of the contacting surfaces and friction plays a significant role in shaping the forces of friction and has a significant impact on the plasticity of metals, the value of elastic modulus.

The effect of texturing appears stable in the absence of invalid setting processes. The growth oxide coating on the surface of contact and the pathological damage of a textured surface leads to the gradual disappearance of the effect of texturing [2].

Improving the micro geometry of the contacting surfaces possible way thin plastic deformation of the surface layers of the processed material - vibrato roll forming. The method of vibrato roll forming was developed by J.Schneider in the 80's of last century, which is to create mesh micro channels (small troughs) by plastic deformation of metal surfaces using a rigid indenter. After vibrato roll forming contact surface hardness and wear resistance of parts is increased 1.5-3 times, reduced time of pick-up of one of the parts in contact 1,5-1,7 times fumes that promotes smooth working connection. When dry friction grooves are as traps that detain a wear products, dust and abrasive constituents, so localized their destructive action [3].

Today actively used mechanical method of forming textured surfaces, the essence of which is to influence dynamic indenter surface details and create depressions (holes) by PPD. Concavity improves lubricity in the surface increases the resistance setting and corrosion, reducing time bedding. Choosing the best location allows the construction of surface depressions with desired performance properties, improve tribotechnical performance, and reduce stress state of the surface [4, 5].

D. Hamilton is proposed to texturing of surface in the form of micro roughness that serves as micro hydrodynamic supports [6]. This idea has largely moved parallel sliding, as is the case with mechanical texturing.

In the U.S. in 1984, was proposed the method of forming a textured surface to remove wear products of electrical contacts using ion etching technology [7]. Subsequently, this method was replaced by abrasive finish, resulting in a wave-like shape of the surface low.

In Japan, was developed and actively used reactive ion etching (RIE) as a method of forming a discrete surface in the form of micro holes. The satisfactory results of this surface in an aqueous medium in the presence of abrasive SiC have been obtained [8].

S. Wenzel proposed to formation of discrete surface-oriented structures by electrochemical treatment. As a result of improved conditions bedding trybo-conjugation and reduced wear 3 times [9].

Actively the method of forming textured surfaces using laser facilities (LST) is developing. A large amount of research work in this area is conducted by many research groups in Germany, Japan, USA and Switzerland. This method is perspective due to its high speed surface treatment provides control of the shape and size of discrete areas. These technologies have been used in mechanical seals in bearings operating at medium or lubricating oil-starvation [10, 11].

But working with laser texturing worn mostly experimental in nature. Whenever tries to optimize the parameters of a discrete surface using the method of trial and error. Perhaps this is the reason for the large differences in determining the optimal parameters obtained by different research groups. Trial and error can take place only in the case of sliding without lubricant or in poor lubrication, which theoretical base models do not exist. In these cases, micro hollow LST usually function as micro traps for products or wear micro storage tanks for oil. However, in other cases, in which the micro depressions act as micro-hydrodynamic resistance, it is necessary to carry out a careful theoretical study to optimize the parameters of LST to obtain high durability tribo-combinations. This idea was the impetus for conducting thorough research and software development in the Technion-Israel Institute of Technology, which resulted in several models of optimization of LST in different devices [12].

J. Etsion and L. Barshteyn [13] presented a model of laser texturing surfaces with constant surface micro structure, which showed significant benefits hemispherical micro depressions. The modeling was carried out based on the solution of the Reynolds equation for hydrodynamic pressure distribution on the surface and determines the optimal parameters for surface texture of different operational modes.

Discrete surface structure tribo-combinations provided by application of protective coatings. The Institute for Problems of Strength of the NAS of Ukraine. G. Pisarenko led by B. Lyashenko actively pursuing research in this area [14]. Despite the lack of knowledge of the phenomena occurring on the surface of discrete structures, and the lack of computational methods to design a practical advantage in many cases it is obvious. Discrete coating to achieve high adhesive and cohesive stability of each discrete area by limiting the normal stresses in the coating and tangential to the plane of adhesive contact with the base cover.

The most successful discrete coating deposited by EIL, operated by strengthening stamps, increasing longevity die equipments at 2.6 times the cutting tool in 2,0 times. Discrete cover only one shelf top ring groove of the piston internal combustion engine is reduced by 4 times the total wear of cylinder-piston group of VAZ-2121 with mileage of 50 km. [15-17].

Widely used combined methods create discrete protective structures. Discrete laser surface treatment and subsequent nitriding significantly increases the strength steels in 7-9 times. In addition, laser treatment eliminates high fragility coatings increased adhesion coating to the substrate [18].

Thus, basic research in the field of surface engineering offer new opportunities to expand the range of the friction pairs, improving of its reliability and durability under extreme conditions, where continuous coverage can not work. Despite the large number of publications, the mechanism of the phenomena occurring at regular micro-relief is now studied enough. There is no data design of surfaces with maximum gain for performance properties. Also in use of textured surfaces there is a need of clear standards, technology transfer of technology from laboratory to industry. It should also improve existing and develop new methods of accurately predicting long-term behavior surfaces during operation based on the results of short-term laboratory tests.

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Анотація

РОЗВИТОК МЕТОДІВ ІНЖЕНЕРІЇ КОНТАКТНИХ ПОВЕРХОНЬ ТРИБОЛОГІЧНИХ СИСТЕМ

Марчук В.Є.

Проаналізовано розвиток методів інженерії контактних поверхонь трибологічних систем. Показано проблеми та перспективи розвитку технологій створення поверхонь дискретно-орієнтованої структури.

Аннотация

РАЗВИТИЕ МЕТОДОВ ИНЖЕНЕРИИ КОНТАКТНЫХ ПОВЕРХНОСТЕЙ ТРИБОЛОГИЧЕСКИХ СИСТЕМ

Марчук В.Е.

Проанализировано развитие методов инженерии контактных поверхностей трибологических систем. Показано проблемы и перспективы развития технологий создания поверхностей дискретно-ориентированной структуры.