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Physical Foundations Structural - Formation, Surface Layer Of Parts

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ABSTRACT

In this article, traditional and innovative methods for treating the surface layer of a part by plastic deformation form roughness and dislocation of structures are presented.

KEYWORDS

Surface layer, macro and micro relief, macro and micro-hardness, shape deviation, dislocation structural -formation, crystal lattice, atom.

INTRODUCTION

During the manufacture of machine parts by mechanical processing (cutting, under pressure, stamping in a coarse state of materials), irregularities and micro-irregularities are formed on their surfaces, crystal grates of structural phase formation and chemical changes, at which the residual stress is concentrated under the surface layer, directed perpendicular to the plane of the surface layer.

A surface is a state of surface structure that differs from the base metal structure in a phase and chemical state. The surface of the part during the performance of its service position is influenced by external factors: mechanical wear, temperatures, electrical magnetic forces, solar heat molasses, chemical interaction of elements, etc.

In many cases, under the influence of these factors, the surface of the part worsens its working condition: for example wear, erosion and cavitation, external and surface corrosion, fatigue destruction, etc.

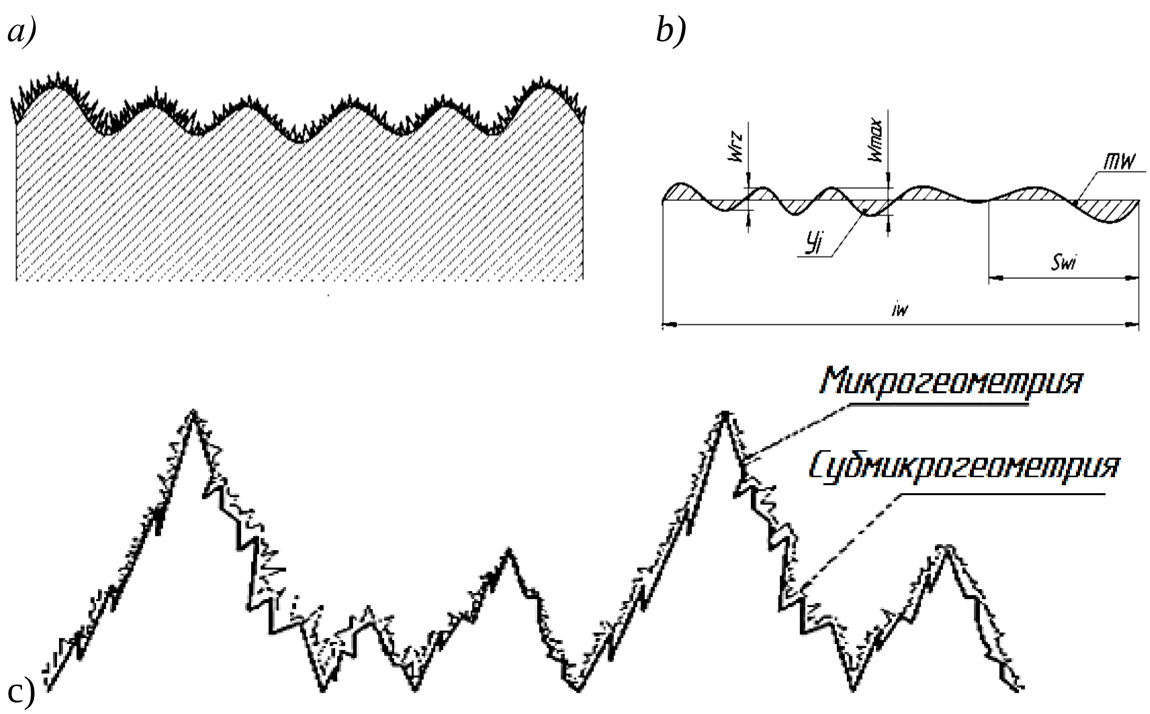
In this regard, the requirement for the surface layer of the working parts is high.

The surface layer of the raw material obtained after treatment is not always improved. They are characterized by the step geometric structure of the surface layer, roughness, shape deviation (taper, avalanche, convexity, concavity, etc.).

Surface defect - these incisions, balls, accordions, shells, chips, dyeing, cracks, burrs, etc.

MATERIALS AND METHODS

Surface roughness parameters are regulated by GOST 2789-73, this covers the height of unevenness (Rz, Ra, Rmax), microroughness in the base length, i.e. the length of the microroughness step Sm, the average roughness step along the vertices S and relative to the reference length tp. In addition, in its turn, roughness has in its existence also submicro-roughness, which is not desirable. The geometric parameters of the surface layer after machining are shown in Fig. 1.



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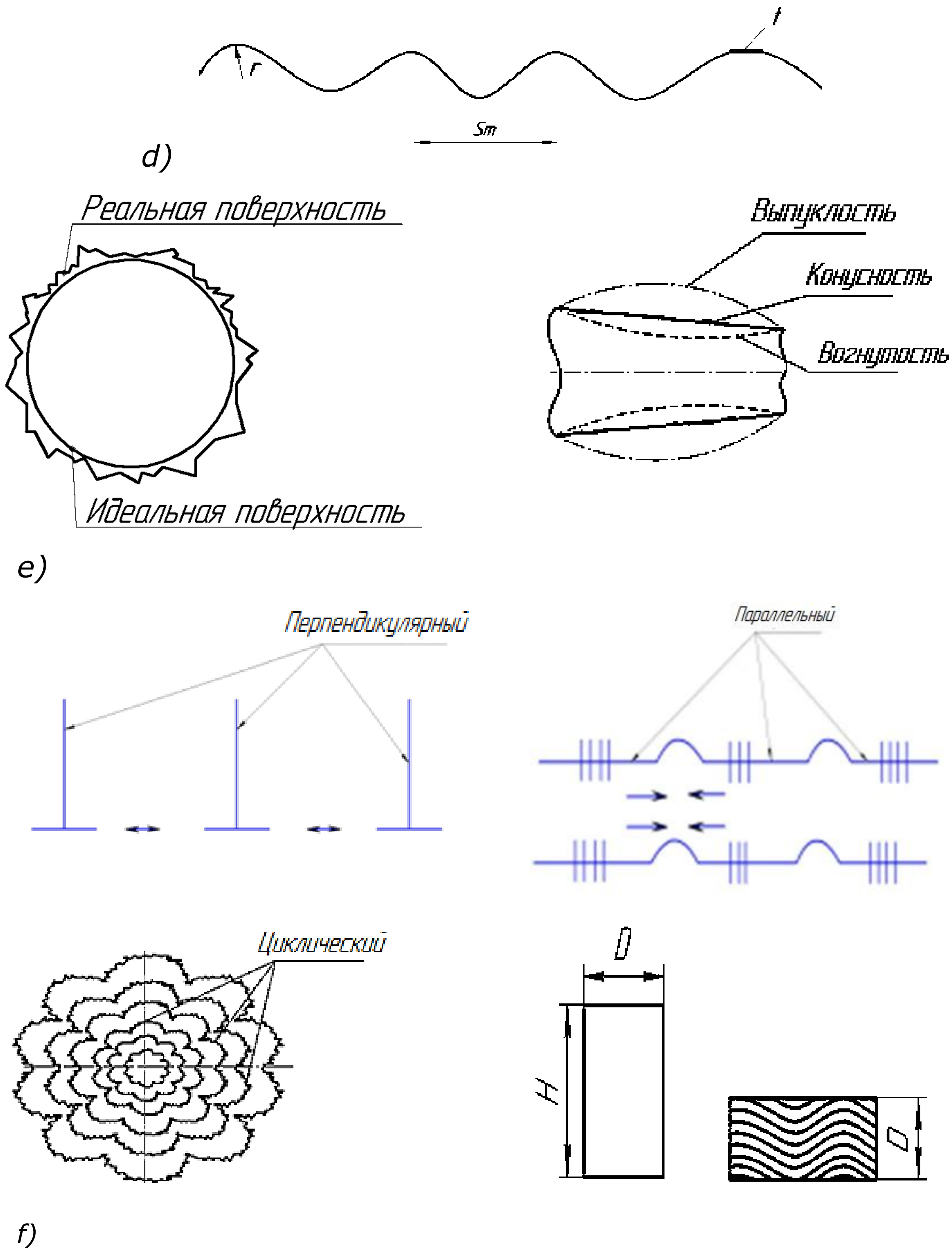

Fig. 1. An image of the geometric characteristics of the surface achieved by machining.

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a) The actual nature of the surface;
b) Microgeomerism;
c) Undulation;
d) Macrogeometry;
e) Microgeometry directions
f) Submicrogeometry.

When processing by plastic deformation (ball, trowel, roller, etc.), waviness appears, it cannot be rejected. On the appearance of waviness, this is the pressure force, the degree of elasticity of the damping element, the size of the area of the contacting surfaces of the deforming tool and the processed surface of the part, etc. [1-3].

Waviness is divided into longitudinal, transverse, concentric and helical.

Longitudinal - coincide with the directions of movement of the working tool, transverse - perpendicular to the direction of movement of the working tool, concentric - this type is formed when processing the ends with the transverse movement of the working tool, screw - in the form of a screw movement of the working tool. In under-ice, the wave will be applied in the form of a screw Fig. 1, d.

Waviness is characterized by height Wt, maximum height Wmax and average wave step Sm. The screw is also characterized by the height Wt, the maximum height Wmax and the average pitch of the screw Sm, as well as the number of similarity z and the value of the relative bearing contact area foп. For the logical implementation of the parameters of the surface layer of the part during the processing of surface plastic deformations, in particular, with ball tools, a relief in the form of a screw is applied.

The accumulated atoms at one point of the crystal lattice (Fig. 2) under the influence of the deformation force is uniformly decomposed into its area. According to the helical movements of the instrument, the atoms located in the crystal lattice are intertwined with each other in a structural - formation. As a result, it forms screw dislocation structures. In the case of a screw dislocation, a crystal lattice defect is expressed by a shift of only some part of the lattice by one order of magnitude in the direction of motion of the dislocation. Helical surface micro relief is formed around the crystal dislocation axis. The movement of atoms along a horizontal plane radially or against it is called a right or left dislocation.

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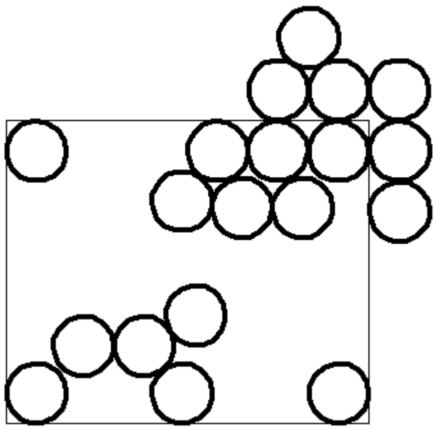

Fig. 2. Accumulation of atoms on points in the crystal lattice.

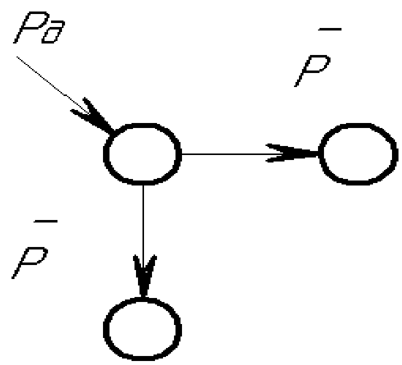

Fig. 2. Accumulation of atoms on points in the crystal lattice.

In structural - the formation of crystalline lattices occurs accumulated atoms, under the influence of deformation force Rd there is a movement of atoms (Fig. 3).

The scheme of transfer of atoms structural formation according to the 3rd law of I. Newton shifts and occupies free revenge in the crystal lattice and fills with atoms. Atoms will decompose evenly. The strength of the metal will increase. And increases the resistance of the load acting in the radial and tangential plane (Figure 4).

Dislocation in the sliding plane under the action of shear stress, due to this, the screw micro relief becomes stationary. This is due to the fact that in this case the dislocation movement by an entire interatomic distance is made, a slight permutation of atoms in the shear direction, and most of the crystal atoms remain in their places. In the case of screw dislocation, the crystal lattice defect is expressed by shifting only some part of the lattice by one period in the direction of dislocation movement. Figure 4 shows that the dislocation axis and the shear voltage vector are parallel, that is, the movement of atoms in the case of screw dislocation occurs in the direction of action of the shear voltage perpendicular to the dislocation movement. Moving along the horizontal plane around the dislocation axis along the arrow, the atoms after each revolution are shifted by one period of the lattice. Eventually, the shift will spread over the entire sliding plane. One part of the crystal will be shifted by one inter-atomic distance with respect to the other, which is a single shift, i.e. plastic deformation of the crystal for the period of the lattice.

A comparison of the energy of the edge and screw dislocations showed that the energy of the edge dislocation $(1 - \mu)$ is more than the screw (where μ Poisson coefficient for metal and alloys μ = 0.22 – 0.44).

For this reason, the development of screw dislocations in crystals can be expected to be advantageous. But, most likely, the largest number of dislocations will be of mixed-orientation, that is, partially screw and edge [4-7].

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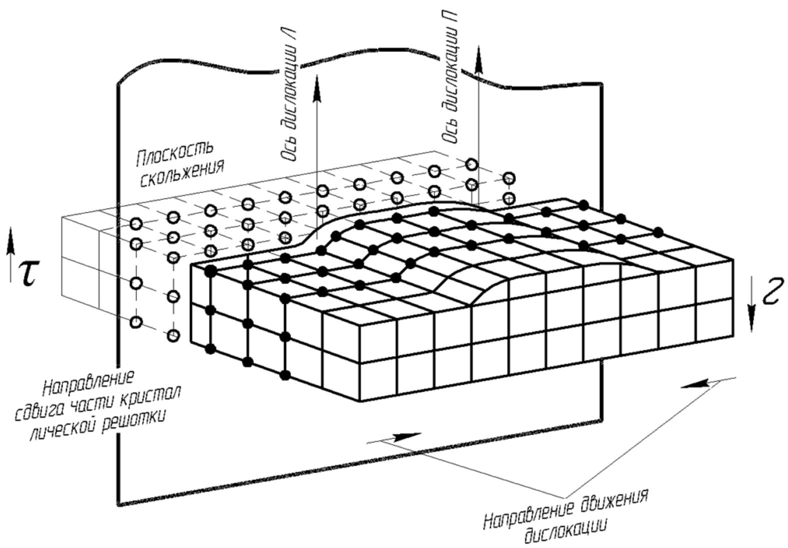

Figure: 4. Layout of the screw dislocation.

CONCLUSION

From the analysis of the mechanism of plastic deformation, it follows that in each crystal, under the influence of shear stress, dislocations move and can sequentially be removed outside the crystal. At the same time, it can be assumed that as deformation develops, the internal structure of the crystal, freeing itself from dislocations, becomes more and more perfect, and the sliding resistance approaches the theoretical value. However, it has been experimentally established that in the process of screw plastic deformation, not only dislocations come to the surface, but also their origin, and accumulation, that is, an increase in dislocation density in the volume of woven crystals. Thus, by applying screw dislocation to parts of machines and current conductive materials, increased performance in products can be achieved.

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