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INFLUENCE OF THE TEXTURE DIRECTION ON THE PROCESS AND QUALITY OF FRICTIONAL APPLICATION OF A COPPER FILM ON STEEL

For the first time the question of the effect of shear deformation texture on the efficiency of deposition of a copper film on its surface by a friction method was stated and experimentally clarified. It has been established that the friction process performed against the rough machining texture leads to the better improvement of quality of the copper layer than in the orientation of the texture. It is recommended to use this relationship for practical purposes.

Keywords: friction, texture orientation, steel, copper, coating, quality

At present the development and use of energy-saving technologies for improving the wear resistance of parts and restoring their performance characteristics during the repair of ship technical equipment (STE) parts is of particular social importance.

The technologies used for restoration of STE are characterised by high labor-intensiveness, energy intensity and metal intensity, and special requirements for production facilities.

The development of a method of applying wear-resistant coatings on the complex surfaces of worn STE parts without the use of energy-intensive and metal-consuming operations is one of the ways to solve the problem of wear resistance of the working surfaces of STE parts and to restore their technical characteristics.

One of the effective methods of improving the technological properties of STE parts is the coating and strain hardening of the surface layer. In recent years combined surface treatment processes have been developed, when along with the mechanical impact on the product, the effect of current, ultrasound, laser, plasma, various processing medium, etc. is added. Friction deposition of metal coatings should be added to the combined methods.

The essence of the process is that the rod of the coating material (copper or copper-containing alloys) is pressed with a certain force to the surface of the workpiece, which must first be preliminary degreased and lubricated with glycerin or some other special liquid. As consequence, in the process of friction, the oxide film loosens on the surface of steel or cast iron and plasticizes the surface of the copper alloy, which facilitates its setting. As a result, the surface of the part is covered with a thin layer (1 ... 3 mm) of brass, copper or bronze. A specificity of this method is the coating ability to self-regenerate to certain limits. [1]

The aim of the study was to determine the properties of a substance applied to a film base (copper and copper alloys) and to obtain empirical dependencies of these properties on the elements of the technological process of frictional filming.

The task of the study was to determine the optimal process of applying a copper film, depending on the orientation of the texture of the base.

It should be immediately pointed out that the process of frictional deposition of a film of copper on steel has long been known and has been successfully used, mainly for lathe machining of workpieces [2, 3].

The novelty of the material described below lies in the fact that it reflects the influence of the orientation of the texture of the subsurface metal layer on the process of copper coating formation.

For example, when fixing shafts on lathes for various operations, they can be installed in chucks without constant or clear orientation of the workpieces and without taking into account the shear strains already existing in the direction. As a result, shear strain reorientation occurs. With the frictional deposition of a copper film, the process of their formation against the already existing processing structure is possible.

The research was conducted on the basis of the methodology of Professor Evdokimov, at the premises of the Military Academy of Odessa. As a part of the study

the frictional application of solid films on the bodies of rotation was studied.

A separate, new area of research is the use of reversible friction for coating.

It is necessary to clarify the notion of reverse movement. In engineering reverse means going in or turning toward the direction opposite to that previously stated. In this case, there is a reorientation to the other side of the surface layers.

However, the reversal of shear deformations can occur without changing to the reverse direction of motion. It often occurs while assembling machine components in a production environment, where attention is not paid to the direction of shear deformation resulting from machining. However, turning, as well as all types of cutting, grinding and rolling lead to the appearance of a directed texture.

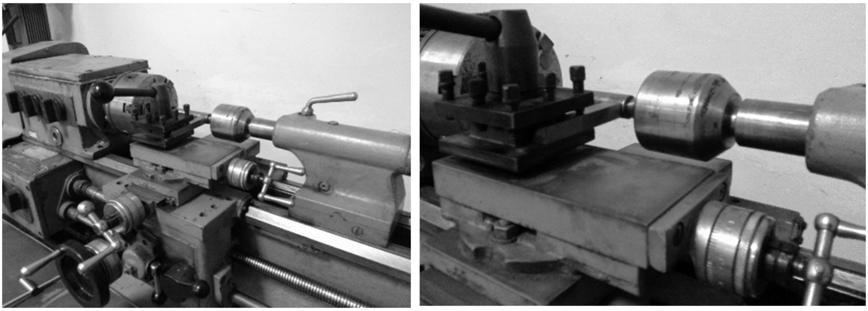
Friction of parts in the unit can occur both along the texture and against, i.e, reverse occurs. This reverse, which can be called " countersunking", leads to an increase in the wear of the connection. Usually, to cope with it we apply a smoothing method of shear deformations based on the principle of the absence of friction with the reverse orientation of the shear strains [4].

The study included the application of a copper or copper containing film under such a reverse - friction against the texture.

The experiments were carried out on a lathe (Fig. 1, a,b) with a copper film applied by the friction method in the direction of the structure and against the structure of the preliminary treatment. All other conditions were accepted. To eliminate the influence of the orientation of roughness or traces of processing, they were removed by applying transverse movements of the abrasive cloth or with a cutter.

While carrying out the experiments, various factors were studied. First of all, the influence of the orientation of the texture on the process of applying a film of copper was determined .

The texture in the surface layers was created by turning on a lathe in fig. 2, a. Then, by rubbing the sample made of bronze DIN standart CuSn12 (12% Stannum, the rest is copper) and the active medium, a copper film was applied according to the processing structure (Fig. 2.b) and against (Fig. 2, c) with fixing of time when copper began to form or transfer to steel.



a b

Fig. 1,Experimental setting on the base of lathe machin.

It turned out that friction against the texture (fig.2, c) contributes to a more rapid formation of a copper film than the friction in the orientation of the texture — by almost 40% with its increased continuity or relative thickness of about one micrometer, which is almost its limit.

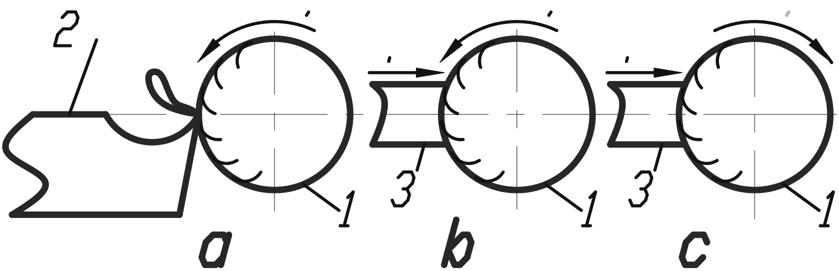


Fig. 2. Texture formation during turning and friction with regard to texture 1 - detail; 2 - cutter; 3 - the counterbody, and - the direction of the texture when turning; b- friction in the direction of the texture; in - friction against the texture or hidden reverse.

In addition, the friction force when applying the film against the texture was bigger than in the direction of the texture, and then became less (Fig. 3). It is due to a slightly increased film thickness formed by friction against the texture: curve 2 lies above curve 1 in fig. 4. and the continuity of the film is greater (Fig. 4).

It was possible to determine the abrasion of the film without re-occurrence by applying the method of exoelectron emission, in which the change in the area of steel coating with copper (Fig. 5).

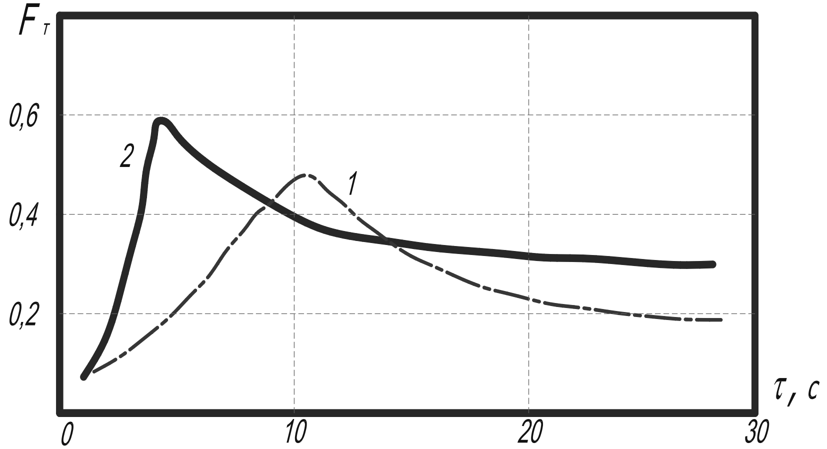


Fig.3. The effect of texture orientation on friction 1 - friction in the direction of the texture; 2 - friction against texture

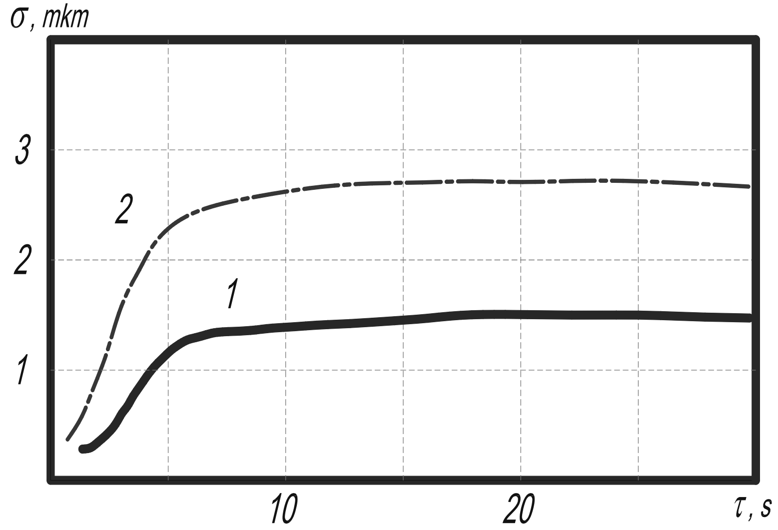


Fig. 4. The formation of the coating thickness δ from copper film with regard to texture 1 - in the direction of the texture; 2 - against the texture.

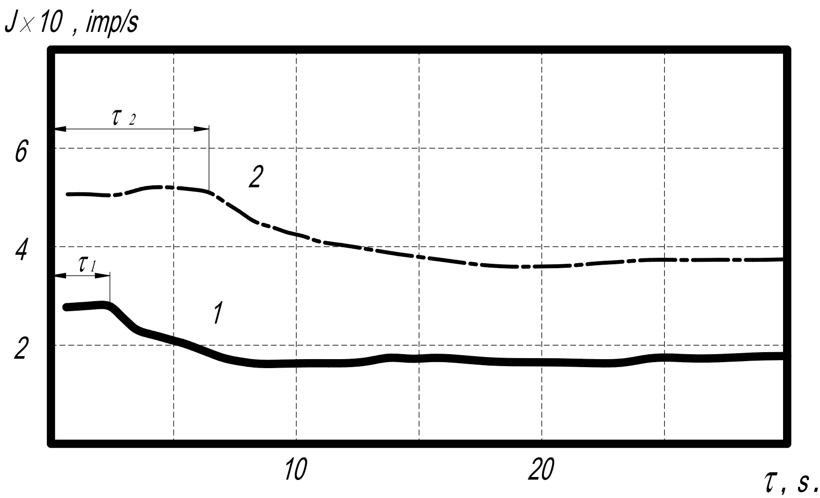


Fig. 5. The abrasion of the copper film on steel determined by exoemission 1 - in the direction of the texture; 2 - against the texture

It turned out that the time of coating of steel with copper with friction against the texture was about four seconds, whereas with friction over the texture it was several times longer (Fig. 6).

1. The efficiency of the process of forming a copper film on steel by friction depends on the direction of the steel texture;
2. It is shown that creation of a copper film against the texture of the steel underlayer is more preferable, for a number of reasons than in the direction of the texture, as it leads to increased coating thickness, formation rate, density, and so on.
3. The coordination of the texture of mechanical processing with the direction of movement of the spindle of the machine is not a difficult process and can be used for practical purposes without difficulty.

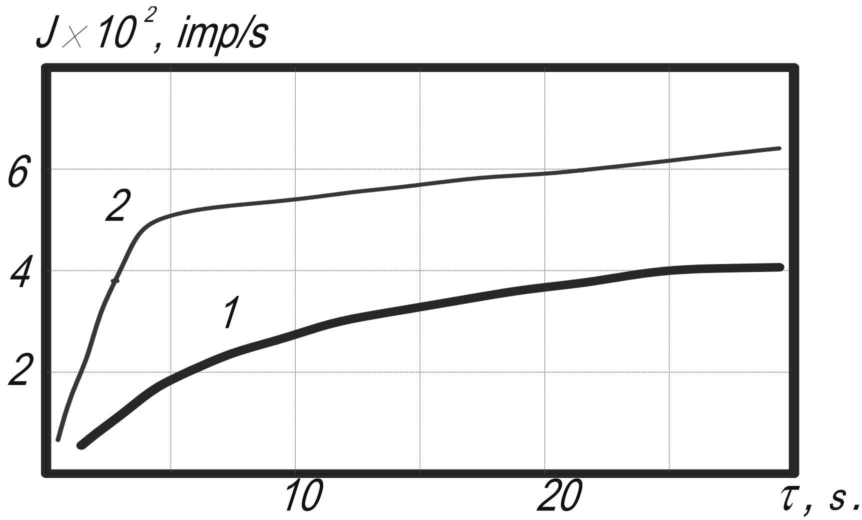


Fig. 6. The influence of the orientation of the texture of steel on the formation of copper coating 1 - in the direction of the texture; 2 - against texture

The obtained results allow us to draw the following conclusions.

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