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THE WORK OF DEFORMING WEAR-PROOF IRON-NICKEL PLATING IN MICROSQUEEGING

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Rezultatele experimentale au demonstrat că cu ajutorul proprietăților fizico-mecanice în microvolum (A- lucru total pentru deformarea acoperirilor galvanice şi lucru pentru deformarea plastica An), corespund cu recomandările de mai înainte referitor la regimurile optimale pentru care acoperirile galvanice au durata de funcționare maximală.

Introduction

The actual problems of studying physical and mechanical characteristics of materials in near – surface layers are caused by the fact that all the modern methods of processing, ruggedizing and coupling metals are connected with contact deformations.

Kinetic micro hardness and hardness tests open up new possibilities for determining physical and mechanical properties and destructions viscosity of wear-proof coverings [1]. The potentialities of defining elastically plastic characteristics, deformation work (Ay, An, Ap, A), the relationship among micro hardnesses (H/Hh, H/Hd) of wear-proof iron-nickel coverings have been expended in [2, 3].

Information

Kinetic micro hardness and hardness tests open up new possibilities for determining physical and mechanical properties and destructions viscosity of wear-proof coverings.

The study on the deformation of deep and superficial layers of material under indentor by putting the grid in the plane of the meridian section of the model showed that the deformation of the deep layers of material when pressing in the pyramid for the metals is qualitatively identical. Deformations are maximal along the axis of pressing in at the point of maximum shearing stresses. On the surface of the imprint deformations grow from the centre to the outline, they decrease near the outline and the direction changes beyond its limits.

The inversion of the direction of deformation occurs in the consequence of the fact that in the imprint and at a certain depth under it the material experiences axial compression and broadening in the radial direction. Beyond the outline of imprint extension of material to the surface occurs, which is accompanied by axial broadening and contraction in the radial direction. In the intermediate directions the components of axial deformation smoothly change from the compression along the axis of pressing in to broadening on the outline of imprint.

The potentialities of defining elastically plastic characteristics, deformation work (A_y, A_n, A_p, A), the relationship among micro hardnesses (H/H_h, H/H_d) of wear-proof iron-nickel coverings have been expended in [2, 4].

Iron-nickel plating form electrolytes (tab. 6) were under investigation by the procedure described in the work [2]. As specimens, were studied rollers of 30mm in diameter, with plating 0.5 mm thick and 100 mm in length, which were treated in optimal polishing modes.

The depth of elastic restoration (h_y), of plastic and general squeezing (h_h, h) were defined by the diagram of pressing indentor of springy (V_y), plastic (V_n), and total (V) deformed for elastic (A_y), plastic (A_n) and total elastic (A) deformed volumes (kgf·mm) were determined for one depth of pressing in (h = 2 µm) by the well-known methods [2,3]. The dynamic hardness elastic ($H_d = A/V$) was specified as the ratio of complete work of deforming (A) to the expelled material volume elastic (V), i.e. as an average specific work of deformation.

The experimental studies

The experimental studies carried out by us have shown that the dependence of dynamic micro hardness elastic (H_d) upon the current density of iron-nickel coverings is of extreme character (fig.1). With the increase of current density from 5 A/dm^2 to 50 A/dm^2, the dynamic micro hardness rose from 6540 (H/mm^2) to 9460 (H/mm^2). Of the current density is increased further from 50 A/dm^2 to 80 A/dm^2, the dynamic micro hardness (H_d) will decrease from 9460 H/mm^2 to 6120 (H/mm^2).

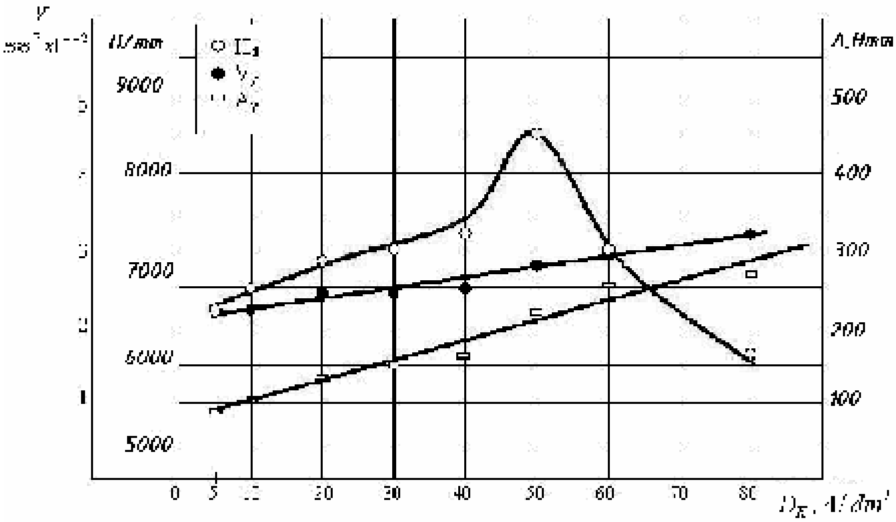

Fig. 1. The influence of current density on elastic characteristics of iron – nickel coverings

On the entire range of increasing current densities (from 5 A/dm^2 to 80 A/dm^2) the volume of elastic deformation of iron-nickel coverings (V_y) rose from 2.08x10^{-2} mm^3 up to 3.02 x 10^{-2}mm^3 and the work expended on plastic deforming of these volumes (A_y) increased from 73.7 H·mm to 261,3 H·mm. The above data are in good agreement with the previous studies [2] and show that with rise of current density from 5 A/dm^2 to 80 A/dm^2, has increased the depth of the restored imprint from 0.24 μm to 0.374 μm in the process of micro identification of iron-nickel coverings.

The dependence of dynamic micro hardness (H_d) and work expended on plastic deforming of iron-nickel coverings with the increase of current densities from 5 A/dm^2 to 80 A/dm^2 is of extreme character (fig.2).

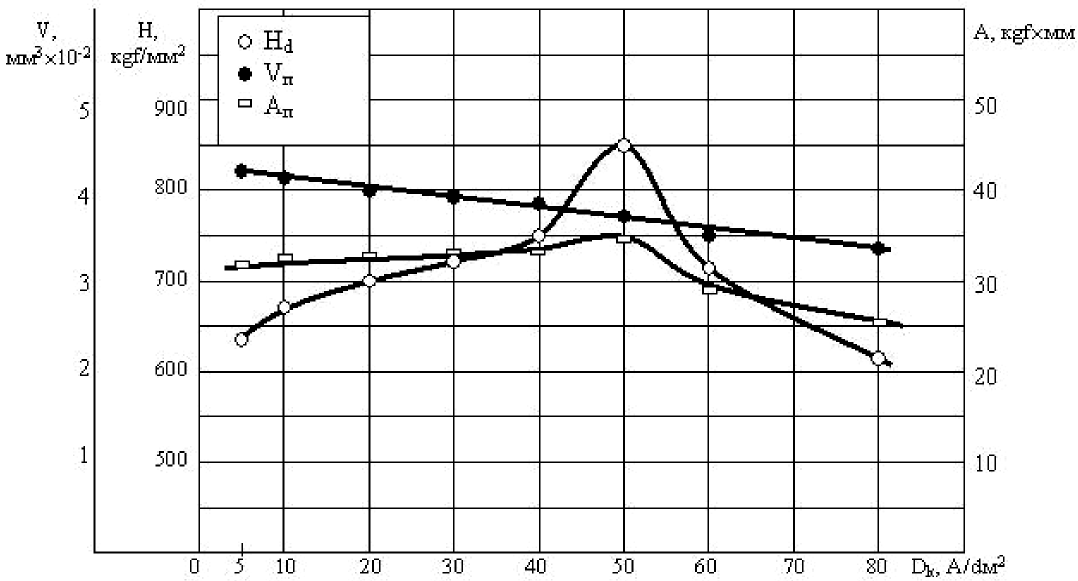

Fig. 2. The influence of current density on plastic properties of iron – nickel coverings

Of the current densities are increased from 5 A/dm^2 to 50 A/dm^2, the work of plastic deformation (A_n) will increase from 310 H·mm to 331 H·mm. With further increase of current densities from 50 A/dm^2 to 80 A/dm^2 the work expended for plastic deformation would decrease from 331 H·mm to 210 H·mm. With the rise of current densities from 5 A/dm^2 to 80 A/dm^2 the deformed plastic volume (V_n) was reduced from 4.45x10^{-2} mm^3·10^{-2} to 3.51x10 $^{-2}$ mm^3·10^{-2}. These data have shown that with the increase of current densities from 5 A/dm^2 to 80 A/dm^2 the depth of plastic imprint (h_n) was decreased from 1.760 μm to 1.626 μm in micro identifying iron-nickel coverings.

Total work consumed

The dynamic micro hardness dependence (H_d) and total work consumed on iron-nickel plating deformation with the increase of current density from 5A/dm^2 to 80A/dm^2 are of extreme character and the total volume of plastic deformation (V) impressing at the same value (h = 2 μm) was a constant quantity (V = 6.53x10^{-2} mm^3) (fig.3).

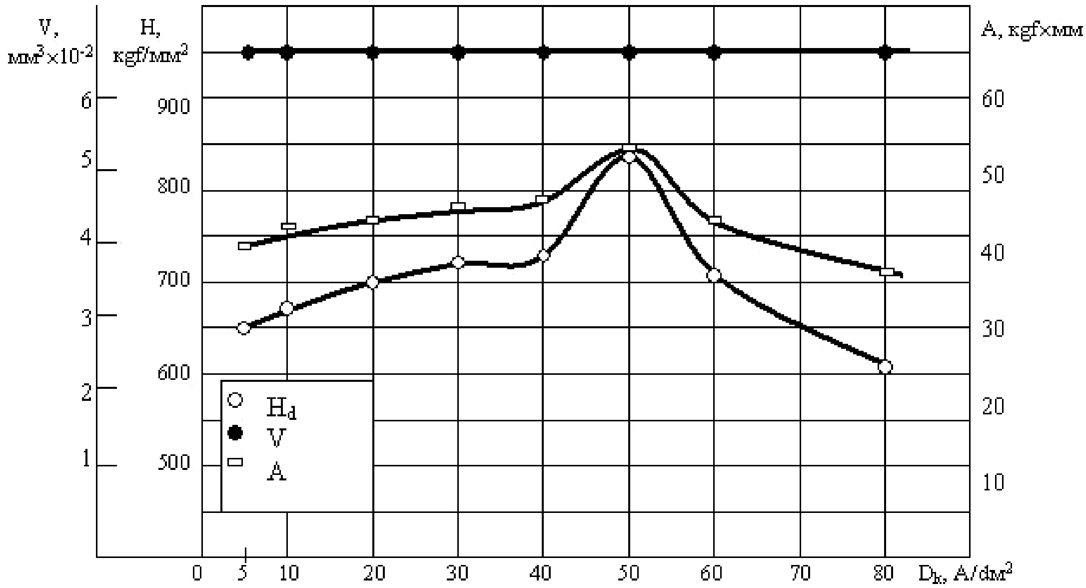

Fig. 3. The influence of current density on dynamic micro hardness (Hd) and the work expended on deforming Fe-Ni plating in micro squeezing.

When raised current density from 5 to 50 A/dm^2, the sum total deformation work increased from 427,2 H·mm to 552,6 H·mm. With the further increase of current density from 50 A/dm^2 to 80 A/dm^2, the sum total deformation work decreased from 552,6 H·mm to 399,8 H·mm.

With the temperature of electrolyte from 20^{o}C to 40^{o}C, the dynamic micro hardness (H_d) grew up from 5780 H/mm^2 to 8460 H/mm^2 and the work expended for plastic deformation rose from 199,9 H·mm to 330,9 H·mm. The sum total work (A) consumed on deforming the total volume increased from 377,2 H·mm to 552,6 H·mm. The work for fragile destruction (A_p) grew up from 151,5 H·mm to 200,1 H·mm.

In spite of an increase in the dynamic microhardness, the work, spent on general, plastic and brittle failure of iron-nickel coatings with an increase in the temperature of electrolyte from 20 ^{o}C to 40 ^{o}C works spent on the elastic deformation of iron-nickel sediments decreases from 25,82 to 21,57 H·mm.

Of the temperature is further increased from 40 ^oC to 60 ^oC, the dynamic micro hardness (H_d) will drop from 8460 H/mm^2 to 6540 H/mm^2. The sun total work (A) expended for deforming the general volume was decreased from 552,6 H·mm to 427,2 H·mm. The work for fragile destruction did not practically change. The work for plastic deformation reduced from 330,9 H·mm to 263,3 H·mm and work spent on elastic deformation decreased from 21,57 H·mm to 14,15 H·mm.

It should be pointed put that with the increase of electrolyte temperature from 20 ^oC to 60 ^oC, the depth of plastic pressing decreased (h_y) from 0.390 μm to 0.298 μm; the work expended for plastic deformation (A_y) reduced from 25,82 H·mm to 14,15 H·mm and the depth of plastic pressing (h_n) rose from 1.620 μm to 1.702 μm.

The studies undertaken have shown that the dynamic micro hardness (H_d), the work for plastic and general deformation (A_n, A) and the work for fragile destruction (A_p) are of extreme character with the change of current density from 5 A/dm^2 to 80 A/dm^2 and electrolyte temperature from 20 ^oC to 60 ^oC.

Extreme quantities of the above values (H_d, A_n, A_p, A) coincide with the recommendations obtained earlier for iron-nickel plating from the viewpoint of their optimal wear resistance. The greatest dynamic micro hardness (H_d), the most value of the work expended for springy, plastic and general deformations of iron-nickel coverings of iron density of 50 A/dm^2 and temperature (T) of 40 ^oC.

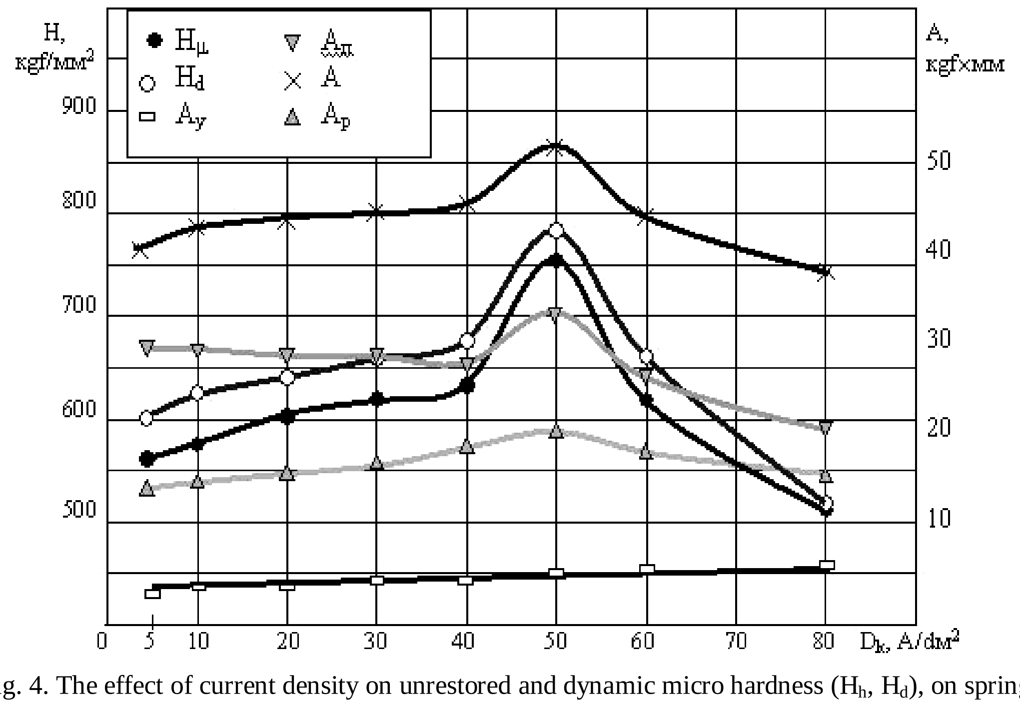

Fig. 4. The effect of current density on unrestored and dynamic micro hardness (H_h, H_d), on springy plastic destruction fragility and on sum total work (A_s, A_p, A_d, A) in micro squeezing of Fe-Ni.

The possibility of evaluating fragility of coverings

The possibility of evaluating fragility of coverings by pressing indentor is of great importance as in defining by means of other methods some difficulties arise connected with plating peeling off the base and their testing because of low hardness [2].

The increase of current density assists in fragile destruction of coverings at smaller critical loads regardless of the solution where plating occurred which agrees with the available published data on determining fragility of coverings by means of flexible cathode.

This regularity can be explained by the fact that increasing current density leads to increasing the number of micro cracks and decreasing the plating density. The plating destruction may arise only after some preliminary deformation. The intensity of this accumulation depends on the type of interatomic bonds, material structure and deformation conditions.

With the change of conditions of electroplating the deposit structure and deformation condition will change either [2]. Pores and cracks concentrate tensions and reduce plastic properties of plating raising their tendency to fragile destruction. The sum total material porosity is defined by means of elasticity module E and H/H_d ratio [4]. The work is consumed on the plastic deformation connected with the preparation of destruction [1].

Final recommendations

1. On relation with the statements mentioned above, it should be noted that the work connected with energy expenses on springy and plastic deformation of the volume (V) will always be more than the sun total of works connected with springy (A_s) and plastic (A_p) deformations in pressing iron-nickel coverings.

2. This gives grounds to assume that the difference of this work [$A_d = A - (A_s + A_p)$] is the work (A_d) expended on the fragile destruction of plating in squeezing.

3. Thus, the obtained results have given possibility for the first time to determine deformed volumes of iron-nickel plating (V_s, V_p, V), the work expended for the plastic deforming of these volumes (A_s, A_p, A) and the work consumed has frail destruction. These supplementary and very important data allow explaining the mechanism and nature of springy and plastic deformations as well as frail destruction of iron-nickel plating.

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DETERMINAREA LUCRULUI EFECTUAT LA DEFORMAREA ACOPERIRILOR FIER-NIKEL ÎN MICROVOLUM

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Rezultatele experimentale au demonstrat că cu ajutorul proprietăților fizico-mecanice în microvolum (A- lucru total pentru deformarea acoperirilor galvanice şi lucru pentru deformarea plastica An), corespund cu recomandările de mai înainte referitor la regimurile optimale pentru care acoperirile galvanice au durata de funcționare maximală.

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