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SURFACE BASE EFFECTS ON ZINC COATING CHARACTERISTICS

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Abstract: *Galvanic zinc coating applied in addition to perform appropriate performances of the base material surface such as corrosion resistance, chemical stability, required aesthetic impression etc. Galvanic zinc coating examinations are focused mostly on Zn connection with the base material, while we have poor data about the influence of the surface on the characteristics of the coating. Previous final processing has a large impact on the physical and mechanical properties and coating structure. This paper presents the results of research on the properties of zinc coatings deposition on the surface obtained by various final processing with different hardness and topography.*

Keywords*: galvanic zinc coating, hardness, topography*

1. INTRODUCTION

We have very poor research of the influence of processing procedure type and previous processing operations such as surfaces preparation wear coating. The surfaces that were processed obtained by various methods of processing may have a various structure. That could be noticed when exploitation period starts. Therefore, we can say that the surface layer characteristics are formed as a result of different processing conditions in the technological series of final parts production.

The main parameters that are arising from technological process can be divided into two groups. First, these are parameters related to the material properties: composition, structure, stress state, etc.., While the other parameters related to the macro and micro geometric area (geometric parameters) [1, 2]. That points that the problem is very complex and it has to be researched.

Zinc coatings are mostly used to protect steel surfaces from corrosion. Electrochemical zinc coatings may have different morphology and texture. Majority of studies conducted relating to the impact of standard parameters during the subsidence of the coatings such as current density, temperature, bath composition [3-7]. On the other hand the importance of steel base surface preparation was less considered. Researching influence on base conditions for deposition of zinc coatings mechanically polished [8-9] or electrochemical [10-11]. It shows that the morphology and texture of the coating on the surfaces are significantly different.

Surface finishing has a large impact upon the physically - mechanical properties and structure of the surface base. This paper research the influence of the previous surface processing and coating thickness on the mechanical and chemical properties of the zinc coating.

2. EXPERIMENTAL INVESTIGATION

The basis for coating deposited steel Č5730 was selected (according to GOST 30HN2FA 1). Selected steel is used for making shooting arms barrels.(Table 1) shows the chemical composition of the base. Testing samples are tiles 15 x 10 x 6.3 mm dimension (ASTM G 77). The samples were produced by milling. Heat treatment performs improvement on different hardness. Final processing of samples was carried out in several ways, with multiple modes of grinding, polishing, and sanding. In this way different characteristics of the surface layer and different samples surface topography were obtained.

Micro-geometry of coating surface was recorded on a computerized measuring device Talysurf-6, which allows complex monitoring of the contact surfaces.

Using this measuring system we have got the information about the initial micro-geometry of the samples contact surfaces.

Table 1. Chemical composition of the basics Č5730 **(**GOST: 30HN2FA 1)

	element	chemical composition %
1.	C	0.27-0.34
2.	Mn	0.30-0.60
3.	Si	0.17-0.37
4.	Ni	2.0-2.4
5.	Cr	0.60-0.90
6.	Mo	0.20-0.30
7.	V	0.10-0.18
8.	S	max 0.025
9.	P	max 0.025
10	Cu	max 0.25

Application of metal coatings was carried out at the electroplating operational of the factory "Zastava Arms" in Kragujevac. Table 2 shows the characteristics of the base material where coating was applied.

Zinc coatings are deposited in the progra-mmed mode by direct current, according to requested experiment plan. During the deposition process, direct current parameters are strictly controlled and regulated within the specific limits. The anodes which are made of lead with 10% tin were used.

Zinc coating was performed as follows:

- alkaline without cyanides degreasing with industrial detergent,
- flush water wash-out,
- pickling in diluted hydrochloric acid in the ratio 1:1,
- wash-out,
- electro-chemical coating of zinc,
  - coating on room temperature,
  - electric power I = 3 A/dm^2
  - illumination in 2% HNO_3 dilution during 50 seconds,
- flush water wash-out,
- drying by hot air.

Table 2. Surface samples characteristics

Sample No	Processing type	Ra, µm	Base hardness, HRC
10	grinding	0.818	38
11		0.719	29
12		0.844	19
13		0.920	37
20	polishing	0.197	25
21		0.185	38
30	sandblasting	1.570	35

The zinc coating was carried out by placing the samples in a vertical position, in same direction. The sample was marked on the upper side with "A" (Figure 1). Measurement of local thickness of the zinc coating was carried out on 15 points with the pattern of the sample shown in Figure 1.

Characteristics of the (mean of thickness and roughness) deposited coatings are given in Table 3.

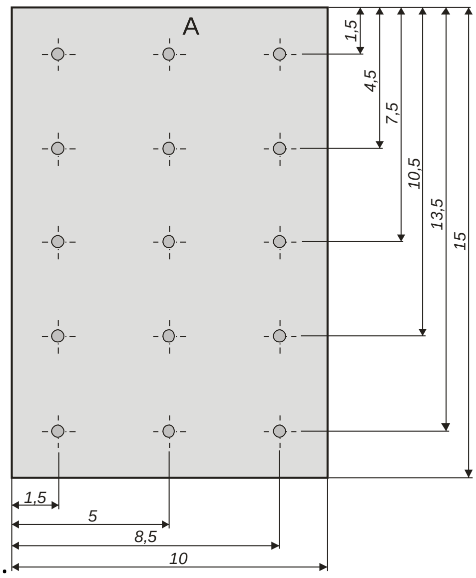
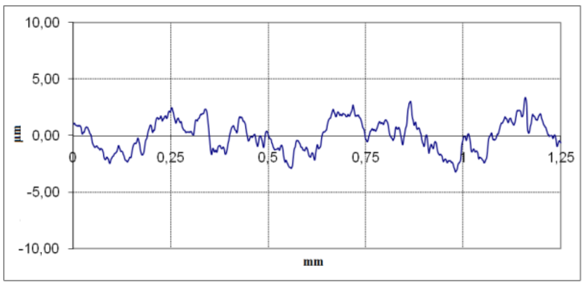


Figure 1. Scheme of coating thickness measuring points

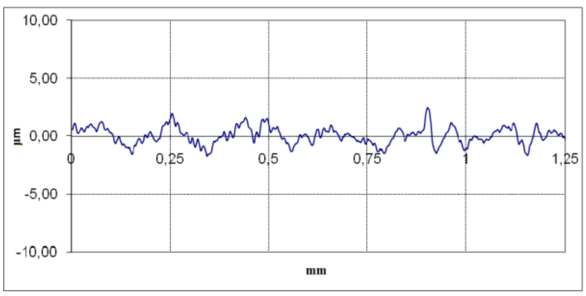
Table 3. Coating characteristics

	Sample No.	Ra, µm	Coating thickness, µm
1	10	1.070	9.85
2	11	1.120	18.90
3	12	1.130	23.87
4	13	1.540	20.16
5	20	0.667	16.57
6	21	0.610	21.62
7	30	2.010	11.26

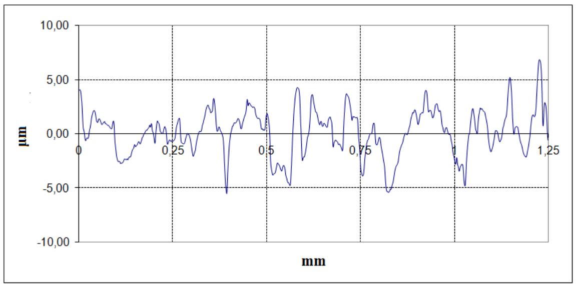
Figure 2, shows the topography of coatings for samples 13, 20 and 30.



Sample 13



Sample 20

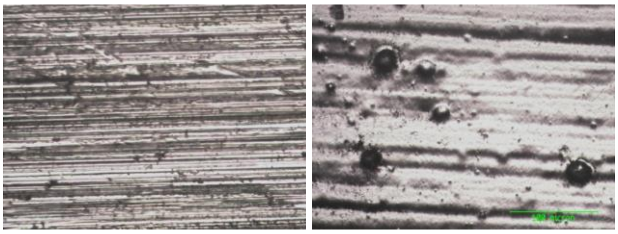


Sample 30

Figure 2. Topography after applying the coating

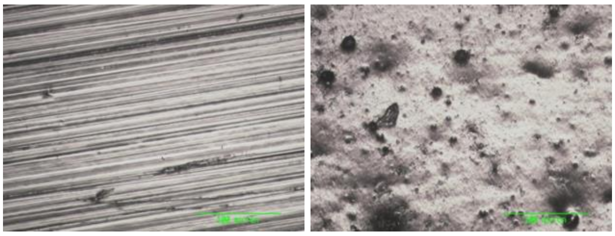
Figure 3 shows the appearance of the samples before and after coating.

Sample 13



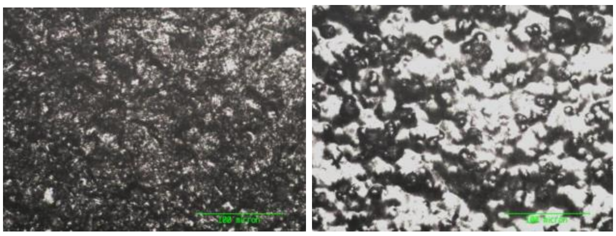
Before the coating After the coating

Sample 20



Before the coating After the coating

Sample 30



Before the coating After the coating

Figure 3. Look of the of samples before and after the coating

3. RESULTS ANALYSIS

Exterior checking was conducted for all samples first. The look of the coating was monitored visually in daylight, at an angle of 45 º. Coating surface for all samples is shiny and smooth. There are no dendrites, burnt and uncovered surfaces.

Zinc coating thickness was measured at 15 locations according to plan in Figure 1. The graph, Figure 4, shows the distribution of coating thickness on the sample surface, based on measurement results. According to those graphics we can concluded that the thickness along width and length of the sample is varied and uneven. The highest values of coating thickness were measured in the central part of the sample at the length of 13.5 mm from the edge. The edge of the sample is marked with "A". This is the point that marks the top of the sample during zinc coating.

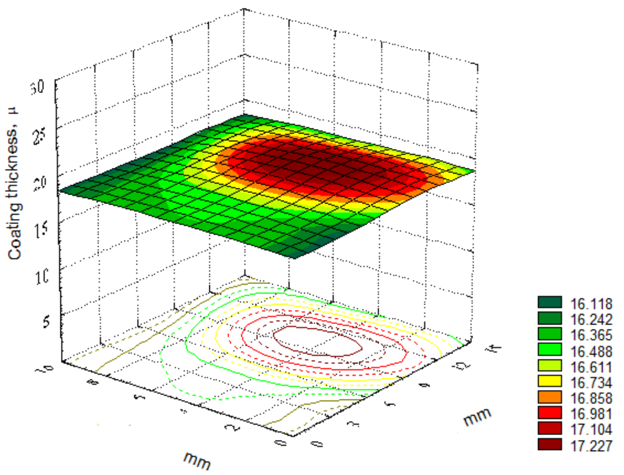


Figure 4. Schedule of coating thickness

Test of coatings adherence was carried out by warming, according to ISO 2819-1980. Terms of examination:

- Samples heating temperature T = 200^{0}C (according to T = 180^0-200^0 C),
- Warm-up time 1 hour.
- Wetting by cold water flash.

After heating according to required standard conditions samples are exposed to cold water flash. Coating must remain unchanged. The separation of the coating from the substrate must not be allowed.

The samples that were tested are in accordance to standard. Adhesion of the zinc coatings is good; there is no significant changing of zinc coating that could indicate the separation of the coating from the base metal surface (Figure 5).

Corrosion stability of zinc was determined by samples monitoring over time exposure to a solution of 3% Na Cl, in accordance with ASTM B117-64 method. The samples that were examined had different characteristics (roughness and hardness of the base, and the coating thickness), Table 2 The results of corrosion stability monitoring of zinc coating shows that there was no corrosion, so we cannot establish a connection between the parameters of the previous processing and corrosion resistance (Figure 6).

a)

b)

Figure 5. Appearance of samples after the original heating a) and cooling b)

Figure 6. The appearance of the coating after the corrosion resistance tests

The width of wear track on the block was measured by tribological tests on tribometre block-on-disk. On that way zinc coating wear resistance was determined (Figure 7).

Wear testing of coatings was performed on tribometre TR-95 with a contact block-on-disk at the Centre for metal cutting and the tribology of the Faculty of Engineering Sciences in Kragujevac. The tribometer TR-95 perform contact condition variations in terms of shape, dimension and material of the contact elements, the normal load contact and sliding speed. The tests may be conducted with using of lubrication or without them. The development of wearing process on the block appears by formatting and expansion as significant trace of wear. Normal load was 10 N and the sliding speed 0.25 m / s, 0.5 m / s and 1 m / s. Total slip route was 150 m. Tests have been realized with the boundary lubrication with mineral hydraulic oil Hidrovisk HD46. High coefficient of the friction which is usual measured with tribometer TR-95, avoided by using lubricants.

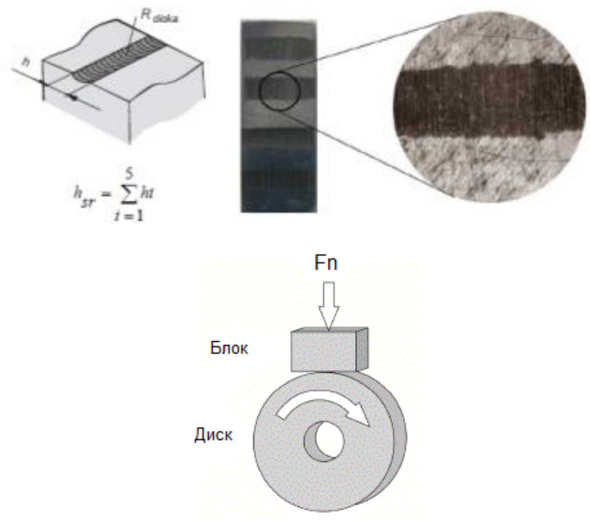


Figure 7. Trace of wear on the block

The initial nominal line contact between the disk and the block due to wear development process becomes a specific contact on the surface. This contact results as destruction of such materials, primarily in the surface layer of the block (Figure 8). Changing in wear track width has the same character for all tested samples; only difference was their wear level.

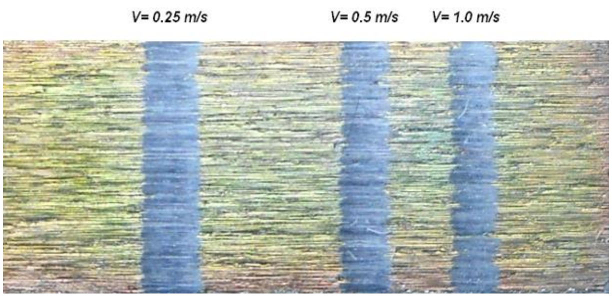


Figure 8. Wear track width on the block

The wearing process is characterized by achieving a certain level such as stabilization and slow growth wear track width during the test period. The contact (sliding velocity, normal force) individual and cumulative histogram of wear track width changes. Based on the measuring results of the wear track width on the block has been created, depending on the conditions (Fig. 9). Maximal wear track width of suit matches to minimal sliding speed.

The samples with different characteristics (roughness and hardness of the base, the coating thickness) were tested. Observing the histogram, Figure 7, it can be concluded that the surface roughness between samples before and after the application of the zinc coating and wear track width of the block cannot establish a connection. Also we cannot establish a connection between the technologies of processing of samples (grinding, sanding, etc...) with wear track width.

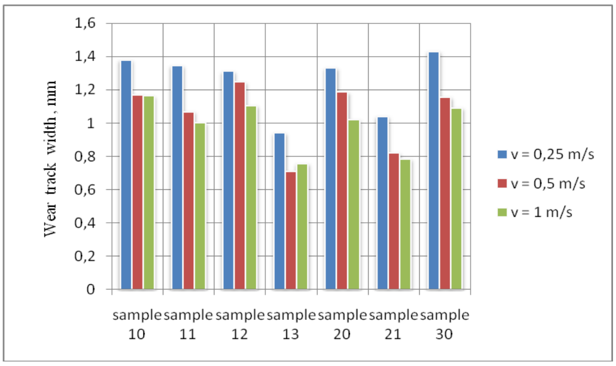


Figure 9. Wear track width of the block

Minimum wear was in samples 13 and 21, for samples with high surface hardness and high coating thickness. The greatest wear was in samples 30, 10 and 12. Sample 12 has the lowest hardness and samples 30 and 10 the least thickness of the zinc coating.

4. CONCLUSION

The investigated coatings of different thicknesses were applied on samples with varying topography and hardness. The results achieved by visual examination, results of corrosion resistance and adhesion of zinc coatings on base metal, showed that they are in accordance with standards. It means that we have optimal preparation and coatings technology.

The testing results shows that coating leads on significant surface topography changes (roughness increase) but it does not affect other characteristics of the zinc coating. The results show that there is dependence between the base hardness, coating thickness and wear track width during tribological tests. Establishment of correlative connections is possible by realization of numerous experiments.

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