METABK 57(3) 165-167 (2018)
UDC – UDK 621.793:546.57.002.4:673.4:338.987.7=111

DECORATIVE METALLIC COATINGS APPLIED WITH GALVANIC METHOD

Received – Primljeno: 2017-09-23
Accepted – Prihvaćeno: 2018-01-25
Preliminary Note – Prethodno priopćenje

In the presented paper the authors aimed at describing the effects of basic parameters of galvanizing process upon the quality of the obtained silver decorative coatings.

Key words: decorative coatings, silver coatings, galvanizing, roughness, profilometer.

INTRODUCTION

The most common method of applying metallic coatings is the electrolytic (galvanic) method. Galvanic coatings are used for corrosion protection of basic metal or sometimes for decorative purposes.

The main factors which modify the appearance of the coating are: current density, concentration and mixing intensity of electrolyte, temperature, presence of surfactants (surface-active-agents), type of electrolyte as well as properties of metal on which the coating is applied [1, 2].

Many factors affect the quality of coatings which include thickness, adhesion, tightness, abrasion, hardness, elasticity and corrosion resistance.

Decorative metallic coatings which include nickel, chromium and silver should meet additional requirements such as higher decorative norms, lower roughness and high gloss [3, 4].

In the paper presented the authors aimed at describing the effects of basic parameters of galvanizing process upon the quality of the obtained silver decorative coatings.

MATERIALS AND TEST APARATUS

The investigation of the process of galvanic coatings application required the use of QUASAR galvanizer. The galvanizer was composed of a tub, temperature controller and power supply. The tub 300 mm × 240 mm × 350 mm was made of polypropylene and equipped with 3 current supply rails, electric immersion heater with max. heating power 493 K and a pump which provides constant electrolyte circulation. Galvanic tub was connected with directly with the digital temperature controller. Power supply device helped control the process.

Sulfuric acid etching of copper plates (100 mm × 30 mm) was initiated to remove impurities and clean the surface. The plates were then used in galvanizing tests and subjected to silvering process with galvanizing method. The process was carried out in the bath with antimony fluoride, potassium cyanide, and potassium silver cyanide in temperature of 293 K.

Table 1 shows the basic parameters of the process of applying galvanic silver coatings.

Tabela 1 **Parameters of galvanizing process**

Simple No	Time / s	Current / A
1	10	0,6
2	10	0,6
3	15	0,6
4	15	0,6
5	20	0,6
6	20	0,6
7	10	0,9
8	10	0,9
9	15	0,9
10	15	0,9
11	20	0,9
12	20	0,9
13	10	1,2
14	10	1,2
15	15	1,2
16	15	1,2
17	20	1,2
18	20	1,2

In order to determine the quality of the obtained coatings the roughness test were performed on SURFTEST SJ - 500 and FRT MicroProf 3 000 profilometers.

The height of roughness can be described by:

$$R_z = \frac{1}{5}(R_{Z1} + R_{Z2} + R_{Z3} + R_{Z4} + R_{Z5}) \qquad (1)$$

where R_z is defined as the average roughness height (arithmetic height of the five highest peaks above the

B. Oleksiak: Beata.Oleksiak@polsl.pl, Silesian University of Technology, Katowice, Poland
G. Siwiec, J. Wieczorek, A. Tomaszewska, A. Wańkowicz- Lis – Energoinstal S.A., Katowice, Poland

mean line minus the average height of the five deepest valleys below the average line) [5].

However, the arithmetic mean of the ordinates of R_a profile is the arithmetic mean of absolute values of Z(x) ordinates along elementary line segment [5].

The height of roughness can be described by:

$$Ra = \frac{1}{l}\int |Z(x)|dx \qquad (2)$$

Microscopic examinations on the continuity of coating (absence of clearances) after galvanizing process were carried out both with Nikon SMZ 1 000 stereo microscope and HITACHI S 4 200 scanning microscope.

In order to determine adhesion of the coating to the substrate the authors conducted the examinations based on temperature changes between thermal expansion of the coating and substrate. The sample was heated to 573 K in laboratory furnace and immersed in cold water. No sign of bladders or peeling is found which indicates good adhesion of the substrate [6].

TEST RESULTS

Sample measurement results of roughness received from SURFTEST SJ - 500 are presented in Figures 1 - 4.

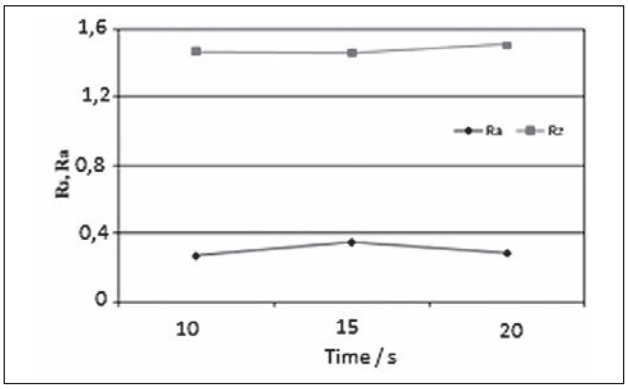

Figure 1 Relationship between roughness parameters of silver coatings R_a and R_z and application time (cathode current density 1 / A·dm^{-2})

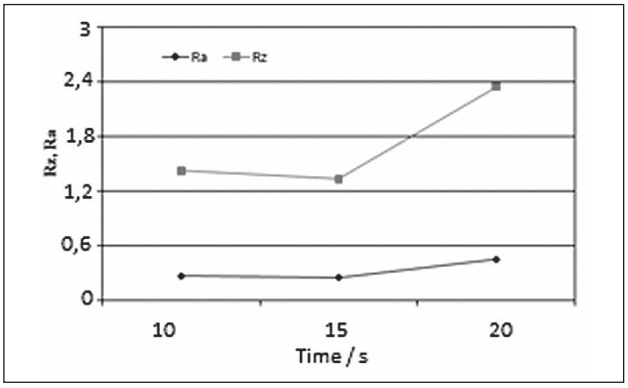

Figure 2 Relationship between roughness parameters of silver coatings R_a and R_z and application time (cathode current density 1,5 / A·dm^{-2}, temp. 293 K)

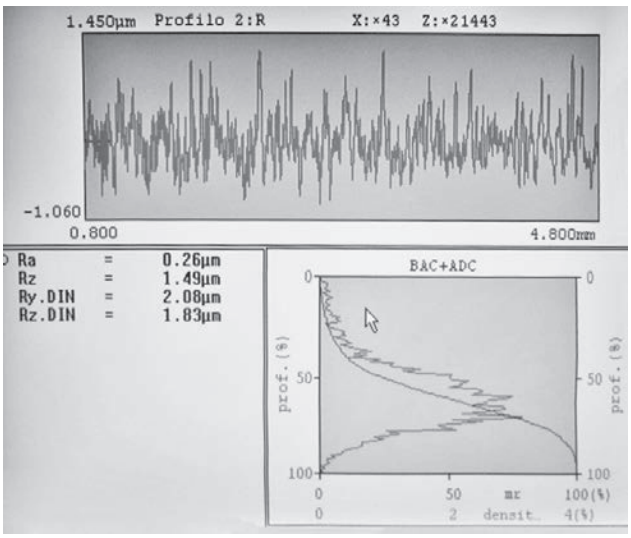

Figure 3 Roughness distribution upon silver coating revealed with SURFTEST SJ - 500 profilometer (sample 2)

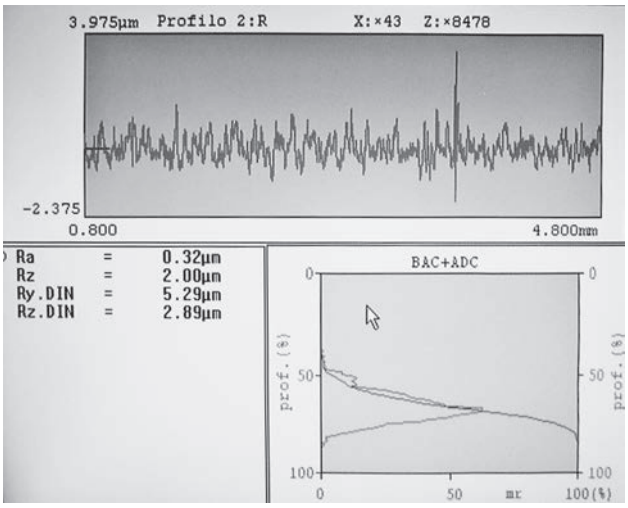

Figure 4 Roughness distribution upon silver coating revealed with SURFTEST SJ - 500 profilometer (sample 17)

Examinations of roughness parameters with FRT MicroProf 3 000 profilometer were carried out on 4 mm × 3 mm surface, with resolution 3 000 measurement points along 1 500 lines.

Figures 5 - 6 and Table 2 present sample examination report including:

- 2D isometric surface image in ,
- 3D sample surface image,
- roughness distribution upon selected surfaces and a list of roughness parameters.

The measurement results of roughness for the selected galvanic coatings are presented in Table 3.

Tabela 2 **Roughness parameters of silver surface (sample 1)**

ISO 4287	Roughness profile - Amplitude parameters
R_a	0,557 µm - mean arithmetic deviation of roughness profile
R_z	4,14 µm - maximum height of roughness profile.
ISO 25178	Height parameters
S_z	11,6 µm Maximum surface height
S_a	1,31 µm Mean arithmetic height of surface

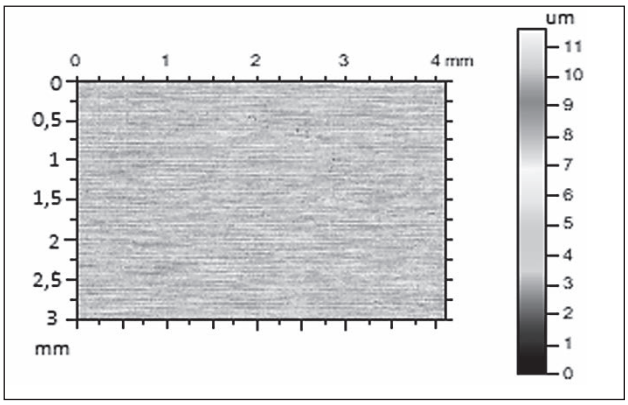

Figure 5 2D isometric image of silver surface

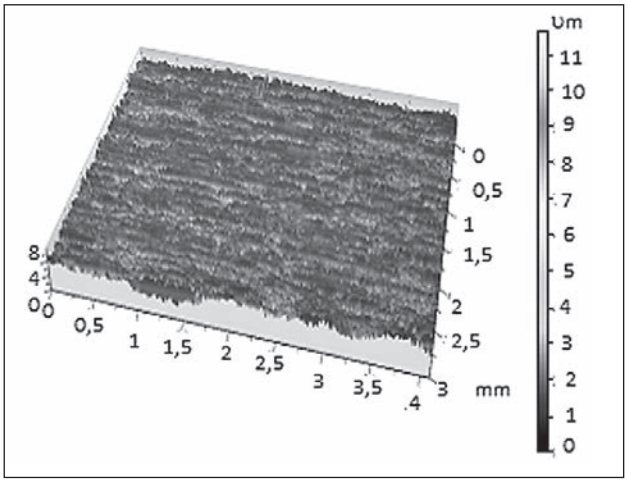

Figure 6 3D image of silver surface

Tabela 3 **Measurement results of roughness for silver samples obtained from FRT MicroProf 3000 profilometer**

Sample No	R_a / µm	R_z / µm	S_z / Mm	S_a / µm
1	0,557	4,140	11,600	1,310
3	0,880	5,610	11,100	0,995
5	0,556	3,870	8,030	0,863
8	0,684	4,520	7,800	0,992
9	0,528	3,320	8,930	1,050
12	0,917	6,010	8,270	1,110
13	0,654	5,452	8,140	1,112
16	0,761	4,850	8,130	1,100
18	1,433	8,830	53,300	2,060

Figure 7, on the other hand, shows sample images of silver coatings from stereo microscope.

As mentioned above the obtained samples were subjected to scanning microscope analysis in order to specify the continuity of galvanic coatings. Sample microanalysis results of chemical composition of the obtained samples, which were done upon the coated surface, are presented in Figure 8.

Thermal expansion method applied also proved, in all cases, good quality of the obtained silver coatings.

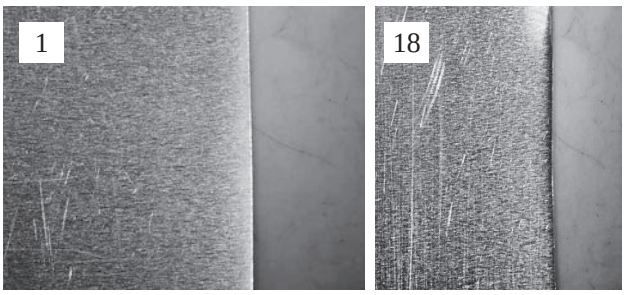

Figure 7 Images of silver coatings from stereo mocroscope (sample 1 and 18)

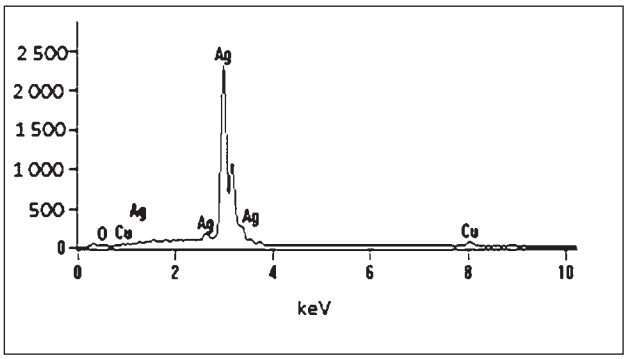

Figure 8 Microanalysis of chemical composition performed upon silver coating surface

SUMMARY

The conducted investigation on the process of application of silver coatings upon copper plates surfaces with galvanic method prove the following : when cathode current density ranges between 1 – 2 A, the surfaces of good quality can be obtained in less than 30 seconds. It is confirmed by the positive results of the roughness analysis performed with two types of profilometers as well adhesion tests which are based on the difference between thermal expansion of coating and substrate. Continuity of coating upon the entire surface of the sample confirmed the scan microscope tests.

REFERENCES

[1] Blicharski M, Surface engineering, Scientific and Technical Publishing, Warsaw (2012).

[2] Wieczorek J., Oleksiak B., Mizera J., Kulikowski K., Maj P., Evaluation of the quality of coatings deposited on AZ31 magnesium alloy using the anodising method, Archives of Metallurgy and Materials 60 (2015) 4, 2843-2849.

[3] Peng S.; Xie S. K; Lu J-T., Surface characteristics and corrosion resistance of spangle on hot-dip galvanized coating, Journal of alloys and compounds (2017) 728, 1002-1008.

[4] Goovaerts P., How geostatistics can help you find lead and galvanized water service lines: The case of Flint, MI, Science of the total environment (2017) 599, 1552-1563.

[5] PN - EN ISO 4287, Geometric structure of the surface. Profile method (1999).

[6] Żak T., Kolanko Z., A guide to galvanic engineering, Scientific and Technical Publishing, Warsaw (1985).

Note: Krajewska T. is responsible for English language, Katowice, Poland