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NICKEL COATINGS APPLIED WITH GALVANIC METHOD

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The presented work attempts at determining the effect of the parameters of the nickel coating process with the galvanic method i.e. current density, time and temperature, upon the quality of the coatings obtained.

Key words: galvanizing, nickel coatings, quality of coatings, current density, profilometer.

INTRODUCTION

One of the most common technique for applying metallic coatings is the galvanic method. The method is used where nickel plating is performed. In the nickel plating process the Watt's baths are most often used, the main components of which are nickel sulphate, nickel chloride and boric acid [1, 2].

Galvanic nickel coatings, due to their attractive appearance, high corrosion resistance and favorable mechanical properties, are often used as decorative, protective or technical coatings. They are used, among others, in the automotive and chemical industry as well as haberdashery [3 - 6].

In the presented paper the authors tried to determine the influence of galvanic process parameters upon the quality of the obtained coatings.

RESEARCH METHODOLOGY

The investigation of the nickel coating process required the use of QUASAR galvanizer, the main elements of which were a tub made of polypropylene and equipped with 3 rails supplying electricity to steel anodes, a temperature controller and a power supply unit.

Copper plates (dimensions of the galvanized surface 0,1 dm × 0,03 dm), which were previously digested in sulfuric acid in order to clean the surface, were used in electroplating studies.

The parameters of the nickel plating process are shown in Table 1.

In order to determine the quality of the obtained coatings, they subjected them to roughness tests carried out on the SURFTEST SJ - 500 profilometer. Rz (mean height of roughness profile) and Ra (arithmetic mean deviation of the roughness profile) were determined. Details of the measurement methodology are included in the works [7 - 9].

Table 1 **Parameters of galvanizing process**

Simple No	Time / s	Temperature / K	Cathode current density / $A \cdot dm^{-2}$
1	300	293	1
2	300	293	1
3	600	293	1
4	600	293	1
5	900	293	1
6	900	293	1
7	300	318	1
8	300	318	1
9	600	318	1
10	600	318	1
11	900	318	1
12	900	318	1
13	300	318	1,5
14	300	318	1,5
15	600	318	1,5
16	600	318	1,5
17	900	318	1,5
18	900	318	1,5
19	300	318	2
20	300	318	2
21	600	318	2
22	600	318	2
23	900	318	2
24	900	318	2

Microscopic examinations on the continuity of the sample coating after galvanizing process were carried out both with Nikon SMZ1000 stero microscope and HITACHI scanning microscope S-4200.

In order to determine the adhesion of nickel coatings to the substrate the authors conducted the bending tests. In the method applied the sample subjected to double bends until the rupture occurs in the substrate. The bends cause cutting stresses between the substrate metal and the coating metal. Stresses, in case of poor adhesion of coatings, induce peeling and delamination along the edge of the breakthrough [1].

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TEST RESULTS

Measurement results of roughness of the received nickel coatings are presented in Table 2 and Figures 1- 3.

Table 2 **2D measurement results of roughness of the received galvanic coatings**

Simple No	R_a / µm	R_z /µm
1	0,26	1,66
2	0,28	1,76
3	0,27	1,72
4	0,30	1,52
5	0,37	2,51
6	0,19	1,16
7	0,17	0,95
8	0,14	0,89
9	0,25	1,84
10	0,19	0,87
11	0,17	0,94
12	0,20	1,02
13	0,18	0,90
14	0,72	2,75
15	0,21	1,49
16	0,34	1,55
17	0,28	1,65
18	0,37	2,37
19	0,31	1,78
20	0,17	1,13
21	0,29	2,22
22	0,18	0,98
23	0,28	2,03
24	0,23	1,43

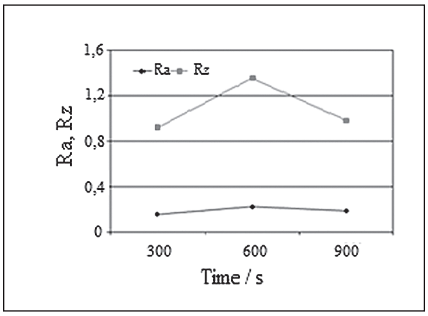

Figure 1 Relationship between roughness parameters of nickel coatings R_a and R_z and application time (cathode current density 1 / A·dm^{-2}, temperature 318 K).

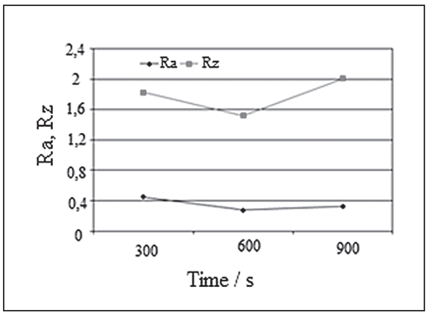

Figure 2 Relationship between roughness parameters of nickel coatings R_a and R_z and application time (cathode current density 1,5 / A·dm^{-2}, temperature 318 K)

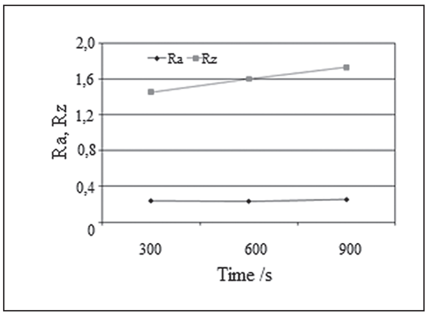

Figure 3 Relationship between roughness parameters of nickel coatings R_a and R_z and application time (cathode current density 2 / A·dm^{-2}, temperature 318 K).

Sample images of the obtained nickel coatings from the stereo microscope are shown in Figure 4, while the image obtained with a scanning microscope together with an exemplary microanalysis of the chemical composition of the coating is shown in Figure 5. Observations on both types of microscopes indicate the continuity of nickel coatings obtained. Adhesion tests of nickel coatings by bending also confirm good adhesion of the obtained coatings to the substrate.

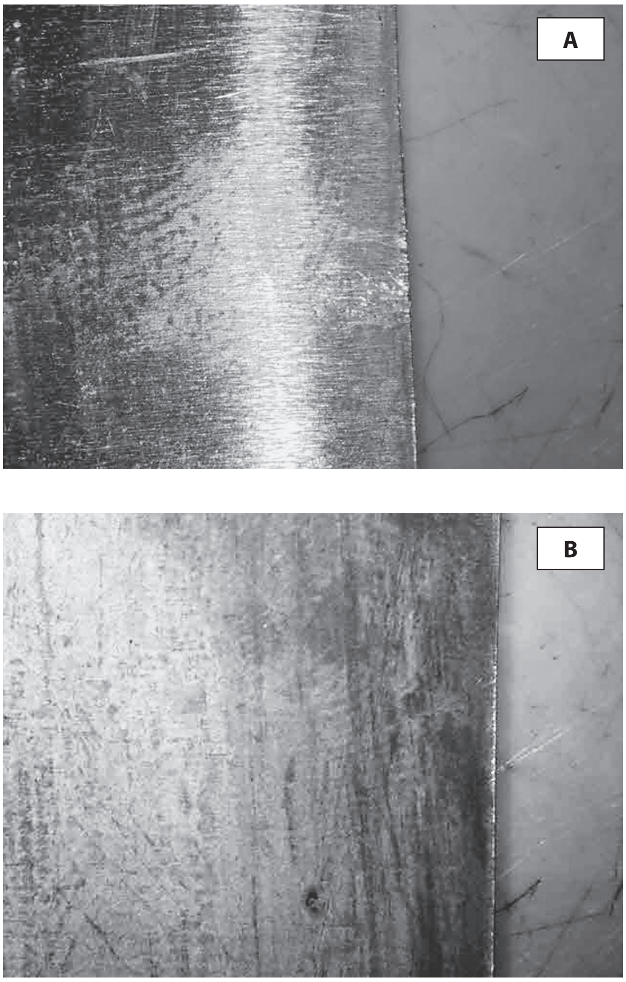

Figure 4 Images of nickel coatings from stereo mocroscope (A – simple 1, B- simple 20).

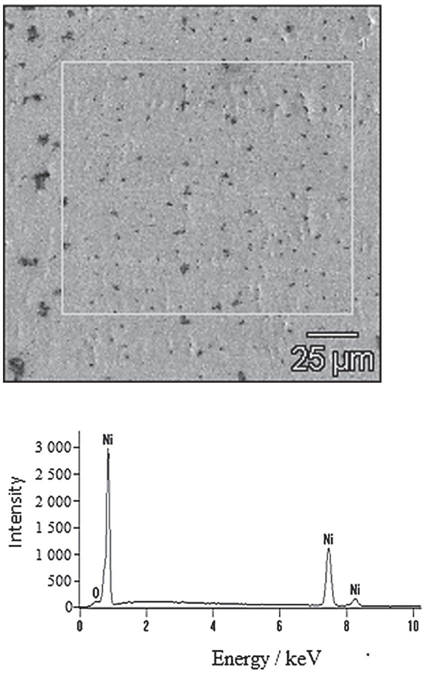

Figure 5 Microanalysis of chemical composition performed upon nickel coating surface

SUMMARY

The tests on the nickel coating process with the application of galvanic method indicate that when cathode current densities in the range of 1 - 2 A dm^{-2} are used then good quality coatings can be obtained in a few minutes. This is confirmed by the results of the roughness measurements obtained with the SURFTEST profilometer SJ - 500. The results prove that the process of galvanic application of nickel coatings onto the copper surfaces should most preferably be performed at a cathode current density of about 1,5 A dm^{-2} in about 600 seconds. Temperature fluctuations in the range of 293 - 318 K do not significantly affect the process. The tests performed with the aid of both stereo microscope and scanning microscope show good quality and maintain the continuity of nickel coatings upon the entire surface of the tested samples. Good adhesion of the obtained nickel coatings to the substrate in all cases was confirmed by bending tests.

REFERENCES

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

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

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

[4] 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 728 (2017), 1002-1008.

[5] Langer C., Wendland W., Honold K., Schmidt L., Gutmann J. S., Dornbusch M., Corrosion analysis of decorative microporous chromium plating systems in concentrated aqueous electrolytes, Engineering Failure Analysis 91 (2018), 255-274.

[6] Lee Hong S. M., Kim S. Ch., Low S. S., Temperature steam methane reforming over Ni based catalytic membrane prepared by electroless palladium plating, Journal of Nanoscience and Nanotechnology 18 (2018) 9, 6398-6403.

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

[8] 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.

[9] Wańkowicz-Lis A., Oleksiak B., Siwiec G., Wieczorek J., Tomaszewska A., Decorative metallic coatings applied with galvanic method, Metalurgija 57 (2018) 3, 165-167.

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