B. OLEKSIAK, K. KOŁTAŁO

ISSN 0543-5846
METABK 59(3) 367-369 (2020)
UDC – UDK 673.4:673.8-621.793:620.18:658.562.002.4:620.193=111

THE STUDIES ON THE QUALITIES OF TIN COATINGS

Received – Primljeno: 2019-11-14
Accepted – Prihvaćeno: 2020-02-30
Preliminary Note – Prethodno priopćenje

In the paper presented the author aims at determining the effect of the parameters of tin coating process, run with galvanic method, upon the quality of the obtained coatings.

Key words: galvanizing, tin coatings, macrostructure, quality of coatings, corrosion

INTRODUCTION

Galvanic method is one of the most common techniques for the application of thin metal coatings, the properties of which are much better than those of metal base. Galvanic coatings, are often used for decorative or protective purposes. Favorable properties of coatings and cheaper materials used at manufacturing process of products allow optimization of products costs. Still the expected properties are retained. [1 - 3].

Tin coatings are one of the coatings applied with galvanic method. They found their wide application in coating cutlery and kitchen utensils as well as parts in automotive industry. However, tin sheets are used at cans manufacturing [4-5].

Tin coatings not only assure product protection against contact with steel plates but also secure the plates against corrosive effect of the product [6 -7].

In the paper presented the author aimed at determining the effect of the parameters of tin coating process, run with galvanic method, upon the quality of the obtained coatings.

METODOLOGY

The tin coating process required the use of QUASAR galvanizer, the main elements of which were a tub made of polypropylene, a rail supplying electricity to a graphite anode, a cathode made of steel plates and a power supply unit [8].

Steel plates (ST3) 0,1 dm × 0,03 dm, which were previously subjected to machining processes in order to clean their surface, were used in the studies [8].

Basic parameters of the tin coating process are shown in Table 1.

In order to determine the continuity of the obtained galvanic coatings, they subjected them to tests carried out on the Nikon SMZ745T microscope. Macrostructure tests of steel samples were carried out under double magnification for all tin coatings. The tested samples were placed under the microscope lens, evenly illuminated and the image was recorded with NIS - Elements Basic Reasearch, using a NICON camera. Two areas were selected for analysis: the middle and the final part of the sample to check uniformity of tin coatings.

Table 1 **Parameters of galvanizing process**

Simple No	Time / s	Current intensity / A
1	60	0,6
2	120	0,6
3	180	0,6
4	60	1,2
5	120	1,2
6	180	1,2
7	60	1,5
8	120	1,5
9	180	1,5
10	60	2,1
11	120	2,1
12	180	2,1
13	60	3
14	180	3

The next stage of investigations involved corrosion tests performed inside Erichsen CORROTHERM 610 salt chamber.

Steel samples with tin coating were exposed to a fog atmosphere obtained by spraying aqueous sodium chloride solution with concentration of 50 g/dm^3 in 35 °C. The tested samples were hung on non-metallic hangers in such a way that the corrosive solution dripping from one plate would not flow down to the other. The surface of metallic samples stayed wet due to the sprayed aqueous sodium chloride solution.

The process was stopped first after 24 hours and then after 48 hours, each time the weight of the samples was checked on Radwag analytical balance.

The final stage of the tests involved checking the adhesion of galvanic coatings with the use of Czylok FCF 22HP chamber furnace.

B. Oleksiak: Beata.Oleksiak@polsl.pl, Silesian University of Technology, Katowice, Poland
K. Kołtało - Silesian University of Technology, Katowice, Poland,

TEST RESULTS

Figure 1. shows tin coatings obtained with galvanic method.

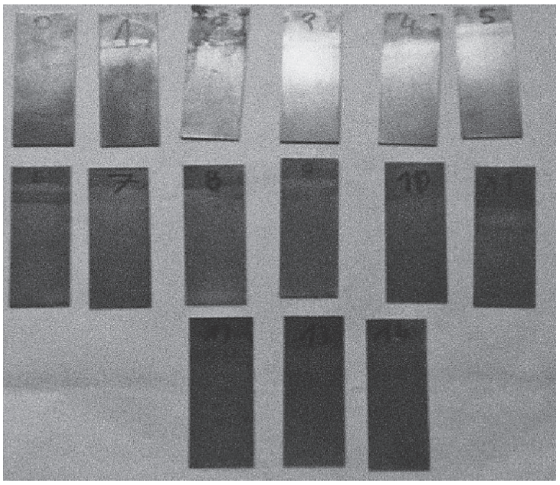

Figure 1 Tin galvanic coatings.

Figures 2 - 6 Exemplary images obtained from optical microscope. None of the cases shows discontinuity of tin coating.

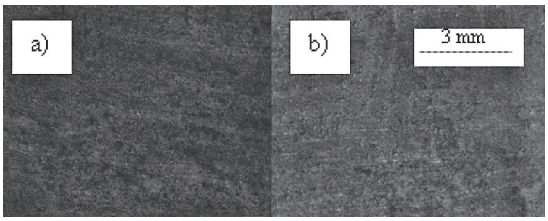

Figure 2 Sample macrostructure 1, a) middle part, b) final part.

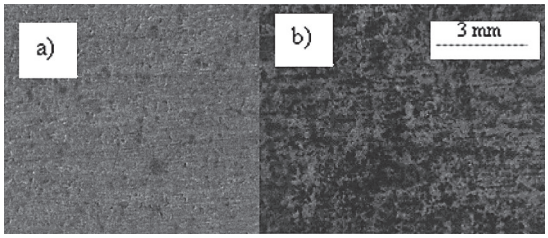

Figure 3 Sample macrostructure 3, a) middle part, b) final part.

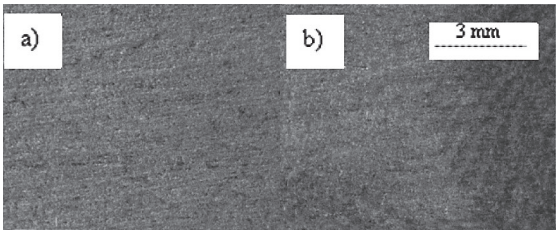

Figure 4 Sample macrostructure 5, a) middle part, b) final part.

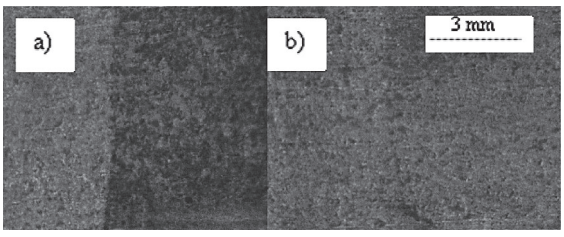

Figure 5 Sample macrostructure 7, a) middle part, b) final part.

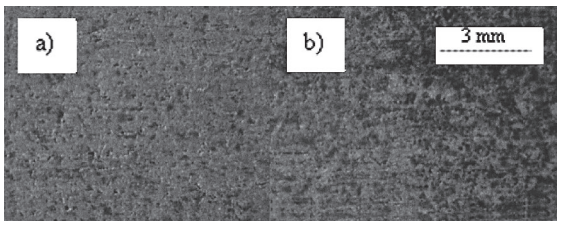

Figure 6 Sample macrostructure 10, a) middle part, b) final part.

Figures 7 - 9 show the results of corrosion test performed inside the salt chamber.

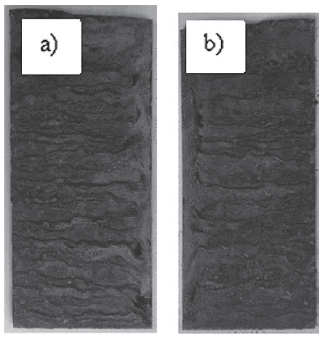

Figure 7 Tin coating after corrosion tests inside the salt chamber were completed (sample 1), a) 24h, b) 48h.

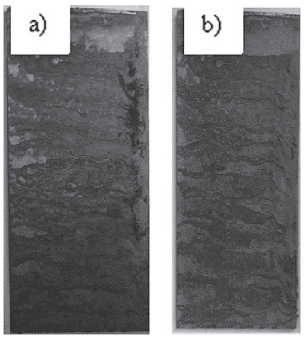

Figure 8 Tin coating after corrosion tests inside the salt chamber were completed (sample 6), a) 24h, b) 48h.

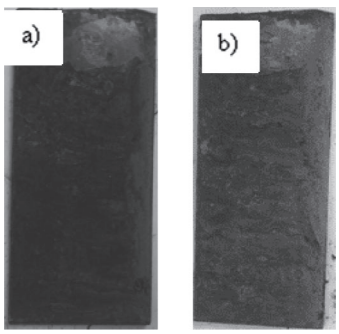

Figure 9 Tin coating after corrosion tests inside the salt chamber were completed (sample 14), a) 24h, b) 48h.

In order to compare corrosion progress, the corrosion rate (Vc) was determined for individual samples according to the equation:

$$Vc = \frac{m_0 - m_1}{S \cdot t} \quad (1)$$

where:

m_0 – sample mass before test /g,

m_1 – sample mass after test/g,

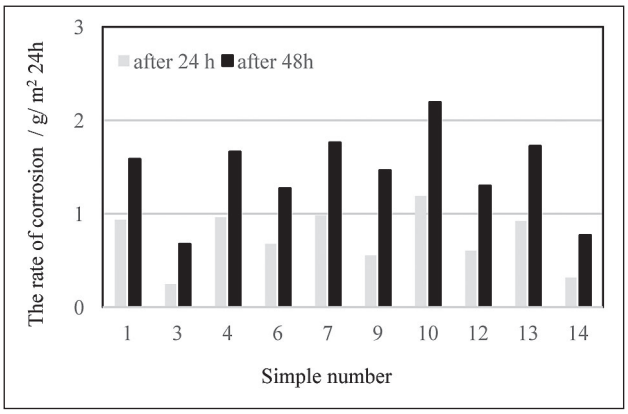

Figure 10 Corrosion process rate for tested tin coatings.

S – sample surface /m^2,
t – test duration, /24 h .

Corrosion rate test results presented in Figure 10.

The tests on the adhesion of tin galvanic coatings showed good temperature resistance up to 300 °C. The samples after testing had a damage-free compact coating (Figure 11).

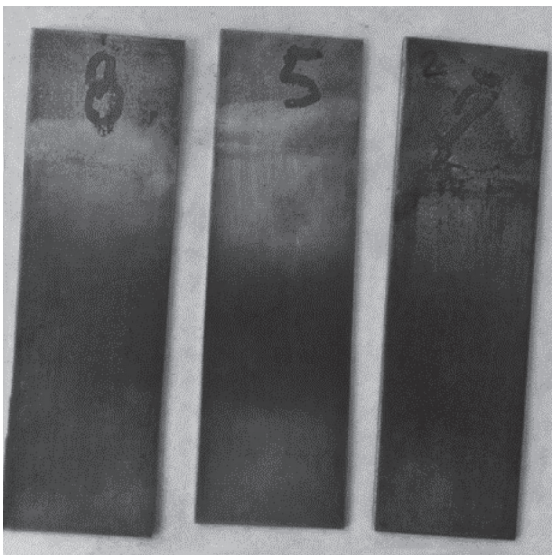

Figure 11 Exemplary steel plates tested with thermal expansion method.

SUMMARY

- Tin coatings obtained in the process featured compact and homogenous structure. In all cases the macrostructure of galvanic coatings demonstrated continuity and was free from pittings and chippings. Tin coating applied was uniform.
- Corrosion tests of steel plates covered with a tin layer in a salt chamber proved that the sample for which the electroplating process was carried out for 180 sec at a current intensity of 0,6A showed the smallest area covered by corrosion.
- The tests of tin coating adhesion showed their good adhesion in all studied cases.

REFERENCES

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

[2] Nasser K., Electroplating-Basic Principles, Processes and Practice, Atotech Deutschland GmbH, Elsevier, Berlin (2004).

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

[4] Zdanukiewicz A.: Galvanic coating technology, WSiP, Warsaw (1974).

[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 S. M., Hong S. Ch., Kim S. S., Low 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] 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