FORMATION OF CORROSION RESISTANT OXIDE COATINGS ON ALUMINUM-SILICON ALLOYS

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High silicon aluminum alloys (silumins) exhibit a multitude of outstanding features, such as low density, high strength, small linear expansion coefficient, good dimensional stability, castability and machinability. Due to these superior characteristics, aluminum-silicon alloys are widely used as environmentally friendly structural materials for ships, airplanes and automotives. The presence of casting crusts on silumina surface prevents to high-quality painting of the metal surface, formation of chemical, electroplating and other coatings. To ensure reliable adhesion of functional coatings such as protective-decorative, electrical insulating, MW-conductive and others, it is required to remove the casting crust as well as to create an intermediate adhesive layer with a strong adhesion both to the metal and to the finishing coating [1–3].

To the date, one of the most important and desirable requirements to a metal is its corrosion resistance. One of the promising methods of formation corrosion resistant anodic oxide films is a method of high voltage electrochemical oxidation. Within this work thick corrosion resistant aluminum oxide films were obtained.

The composition of alloys are, wt%: 8.8 Si, 1.1 Fe, 0.2 Mn, 0.7 Cu, 0.2 Mg, 0.5 Zn and bal. Al (alloy 1) and 9.3 Si, 1.1 Fe, 0.9 Mn, 0.3 Cu, 2.2 Mg, 0.1 Zn and bal. Al (alloy 2). The test samples were cut as a circle of dia. 30 mm and 6 mm thick. Formation of oxide films were carried out under the following technological parameters: current density 3 A/dm^2; duration 30 min, electrolyte temperature 20°C. The aqueous solution of sulfosalycilic acid (electrolyte №1) and aqueous mixture of tartaric and sulfuric acids (electrolyte №2) were used as an electrolyte.

The thickness of the oxide layer on the surface of the samples was determined by UNIT UT342 gauge, the principle is based on the use of an ultrasonic probe that sends the analyzed pulse through the coating. The echo signal is digitized and analyzed to determine the thickness of the film.

The results of thickness measurement are shown in Table1.

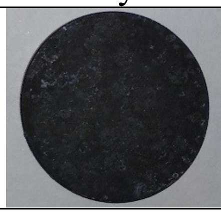
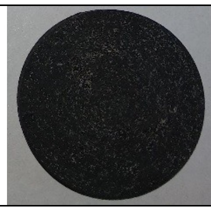
Table 1 – The coating thickness

Electrolyte	Thickness, µm	
	Alloy 1	Alloy 2
Electrolyte №1	40	36
Electrolyte №2	48	40

Corrosion testing of samples is carried out in the chamber Ascott ST 120ip. The essence of the method is to accelerate the corrosion process by increasing the temperature in the test chamber to 35°C and introducing into the atmosphere of the chamber 5 wt.% Sodium chloride solution, which is injected by the nozzle, thus creating salt mist (salt mist should have a dispersion of 1–10 μm (95% drops) and a concentration of 2–3 g/m^3). Before loading into the chamber, samples are degreased with ethanol. The samples in the chamber are arranged so that they do not touch each other. The chamber ensures the maintenance of the set temperature, the creation of salt fog and the duration of the test according to the program specified by the operator. During the test, the pH of the prepared solution of NaCl (pH 6.0–7.0 at 25°C), the pH of the solution collected in collections in the chamber (pH 6.5–7.2 at 35°C), the rate of filling of the solution (1–2 cm^3/h) and temperature in the chamber were monitored. Test results were evaluated visually.

The results of corrosion tests in salt fog for alloy 1 and alloy 2 are shown in Table 2. Samples of anodized alloys withstood corrosion tests.

Table 2 – The results of corrosion tests

Alloy	Bare alloy	Oxidized in Electrolyte №1	Oxidized in Electrolyte №1
Alloy 1			
	Suggestive corrosion	No corrosion	Extensive corrosion
Alloy 2			
	Suggestive corrosion	No corrosion	Separate corrosion sites

The use of the high voltage electrochemical oxidation method for anodizing of aluminum-silicon alloys allows obtaining the oxide coating with thickness of up to 48 μm at 30 minutes of treatment. The results of corrosion tests in salt mist showed that the resulting oxide films have a high corrosion resistance. It should be noted, that there is an optimal electrolyte composition that provides the outstanding corrosion results.

References

[1] V. Vijeesh, K. Narayan Prabhu, Trans. Indian Inst. Met., 67(1) (2014) 1–18.

[2] L.P. Troeger, E.A. Starke Jr, Mat. Sci. Eng. A, 277 (1-2) (2000) 102–113.

[3] Z.X. Liang, B. Ye, L. Zhang, Q.G. Wang, W.Y. Yang, Q.D. Wang, Mater. Lett., 97 (2013) 104–107.