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Stereometry specification of anodization surface of casting aluminium alloys

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Properties

ABSTRACT

Purpose: The aim of the work is presents the influence of casting method and anodic treatment parameters on properties of an anodic layer formed on aluminum casting alloys.
Design/methodology/approach: Investigations were carried out on the laser profile measurement gauge MicroProf from company FRT on two casting aluminum alloys which both were founding by pressure die casting and gravity casting.
Findings: The researches included analyze of the influence of chemical composition, geometry and roughness of anodic layer obtained on aluminum casts.
Research limitations/implications: Contributes to research on anodic layer for aluminum casting alloys.
Practical implications: Conducted investigations lay out the areas of later researches, especially in the direction of the possible, next optimization anodization process of aluminum casting alloys, e.g. in the range of raising resistance on corrosion.
Originality/value: The range of possible applications increases for example as materials on working building constructions, elements in electronics and construction parts in air and motorization industry in the aggressive environment.
Keywords: Mechanical properties; Metallography; Computational material science; Surface treatment

1. Introduction

It the continuous growth of use of alloys aluminum in different branches the wide comprehended industry as well as development of technology of production of aluminum and its alloys and composites with aluminum matrix was observed in last years in many scientific centres on all world [1-5].

The anodic layers have a protective - decorative function applying on the aluminum electronic elements, articles of home farm, part of instruments, the gardens - pieces of furniture, the touristic equipment and sport, the motor accessories and elements of aluminum woodwork [6, 7]. The oxides layers are produced on aluminum foil designed on electrode in condenser too. Hard anodic layers [8, 9] can be applied in air and motor industry.

Anodic oxide layers which are connected fixedly with the aluminum substrate are resistant on corrosion. The corrosion resistance can be reduced by the pores and pits in layer or the presence of harmful alloy-forming elements and admixtures, particularly the copper or by impurities [10]. The intermetallic phase of copper with aluminum dissolve during anodizing, which causes lowering the hardness and thickness of coats, and the enlargement the porosity [11].

The gain in thickness of the anodic layer in relation to the thickness of the formed oxide film amounts about to 0.001 μm per 1V. A porous and conducting layer forms from the basic layer, which is dissolved by electrolyte. The basic layer is simultaneously restored by formation of aluminium oxide that proceeds with the same speed as it transforms into the surface layer. In this way the basic layer maintains its thickness at almost constant voltage [12].

During the forming process the aluminum oxide occurring the small increase of mass element as well as his volume. The layer of oxides is fixedly with substrate very strongly. Dissolving of oxides layer is possible only in basic solutions or acid about larger pH than 8.8 relatively lower than 4.0 [13-15].

The goal of the work is to investigate the properties of anodic layer made on casting aluminum alloys in anodizing process and evaluation of influence of electrolyte and casting method on obtained anodic layer.

2. Material and methods

The analysis of geometry of surface was based on data acquired with measurement of selected fragments of casts, executed on laser profile measurement gauge MicroProf of the FRT company. Measurements were executed for 8 samples divided on two groups.

First of them was the starting material, in state directly after casting without any processing of surface. Material made up second group after apply an oxide layer by galvanic method.

Investigations were carried out on EN AC-AlSi12(b) as well as EN AC-AlSi9Cu3(Fe) alloys. For both EN AC-AlSi12(b) as well as EN AC-AlSi9Cu3(Fe) alloys, high pressure and sand casting was used. The chemical composition of these alloys is showed in Table 1.

Four elements were anodized:

- EN AC-AlSi12(b) high pressure cast alloy,
- EN AC-AlSi12(b) sand cast alloy,
- EN AC-AlSi9Cu3(Fe) high pressure cast alloy,
- EN AC-AlSi9Cu3(Fe) sand cast alloy.

Table 1.
Concentation of alloying elements in EN AC-AlSi12(b) and EN AC-AlSi9Cu3(Fe) alloys

Alloy	Elements concentration, % (mass)						
	Si	Mn	Fe	Zn	Mg	Cu	Al
AlSi12(b)	12.5	0.5	0.6	0.1	0.05	0.05	Rest
AlSi9Cu3(Fe)	9.5	0.5	0.9	0.5	1.5	3.0	Rest

To determine the influence of a kind of electrolyte onto homogeneity of pores in the oxides layer at the same conditions, the samples of EN AC-AlSi12(b) alloy were put under anodic treatment in the presence of the following electrolytes: 3% $H_2C_2O_4$, 4% H_3PO_4, 4% H_2SO_4, 3%CrO_3 (Table 2).

Table 2.
Anodizing parameters

Parameter	Value
Electrolyte	H_2SO_4 with a concentration 295-315 g/l
Temperature	-4 ÷ 2°C
Pulsating current	2 A/dm^2 during 0.25 s 1 A/dm^2 during 0.1 s
Concentration of aluminum ions	6-9 g/l

3. Results and discussion

The alloys used for investigation with similar chemical composition were cast by two methods: pressure and gravitational cast, therefore several factors as well:

- chemical composition of alloys,
- parameters of casting (pressure, to sand form),
- attendance of layer,

could have influence on the surface geometry formation.

Comparing the two- and three- dimensional surfaces figures (Fig. 1) as well roughness distribution can be clearly state that investigated samples any chemical composition influence on surface forming was found. This result can be found both for covered samples layer with oxide and materials in initial state.

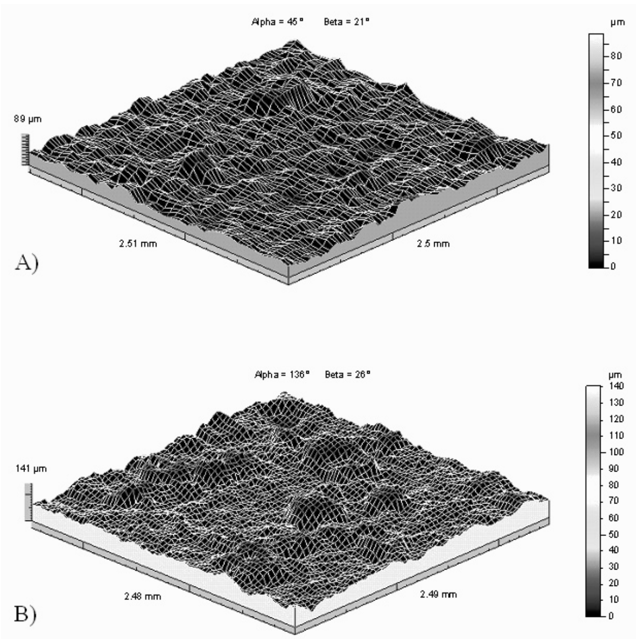

Fig. 1. The geometrical shape of fragment of studied surface, topography of 3D surface, sand cast alloys; A) EN AC-AlSi12(b), B) EN AC-AlSi9Cu3(Fe)

The surface shape geometry is clearly depending on the casting method applied. The surface images of the casts a very similar, regardless the anodizing method is used or not (Fig. 2). The roughness values achieves the maximum by 80 µm. Using the 3D images, it was possible to observe "islands" with regularly spread character of altitudes on surfaces. Comparing the geometrical shape of studied anodic layer can be found that it is a representation of substrate surface shape. The surface configuration keeps characteristic features even after applying of anodic layer. With other words the applying of anodic layer does not affect the geometry profile of surface.

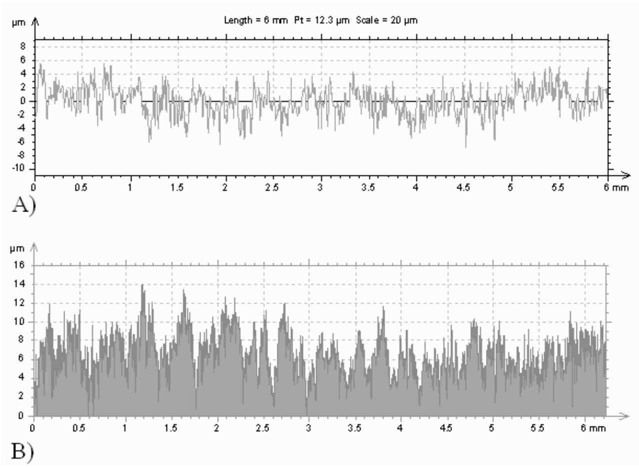

Fig. 2. Profiles 2D cut out from studied surface in plane N - S, EN AC-AlSi12(b) high pressure cast alloy; A) before anodization, B) after anodization

For high pressure cast materials, the maximum roughness value of surface does not exceed 15 µm. The roughness distribution on the whole analyzed surface is identical without of any anomalies. On the EN AC-AlSi 9Cu3(Fe) alloy surface there was observed an "acclivity" going across the investigated surface. This "acclivity" has a high of circa 5 µm. Its formation should be considered with any damage of the cast form (scratching or impurity). Taking into consideration that "acclivity" is forming on to the sample covered of oxide layer, its existence can be connected with discontinuity or local deformation of layer.To confirm this presumption any microscope investigations should be performed witch will be helpful for unequivocally genesis of this "acclivity" (Fig. 3).

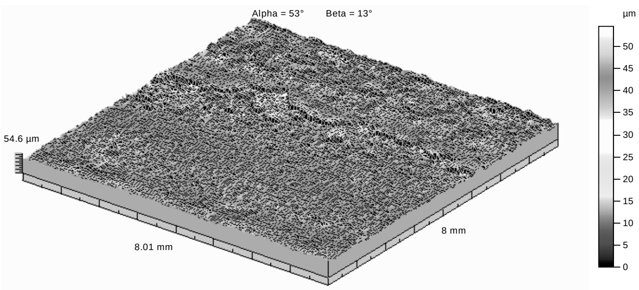

Fig. 3. Three-dimensional topography of surface sample of EN AC-AlSi9Cu3(Fe) high pressure cast alloy

Comparing of the results of obtained investigations for samples before and after applying the layer, it can be seen that applying layer hasn't any influence on geometrical characteristics of the surface. The roughness distribution observed on 3D images after applying of the layer doesn't not change. The distribution for each set (unanodized – anoidized sample) is identical, keeping all characteristic features, such as "islands" type of roughness formed during casting process. The presence of layer does not change such features like picks distribution (Fig. 4) or the preferred orientation (Fig. 5). The anodic layer hasn't any influence on roughness value of the surface (for casts high pressure max 15 µm, for casts sand 60 to 70 µm).

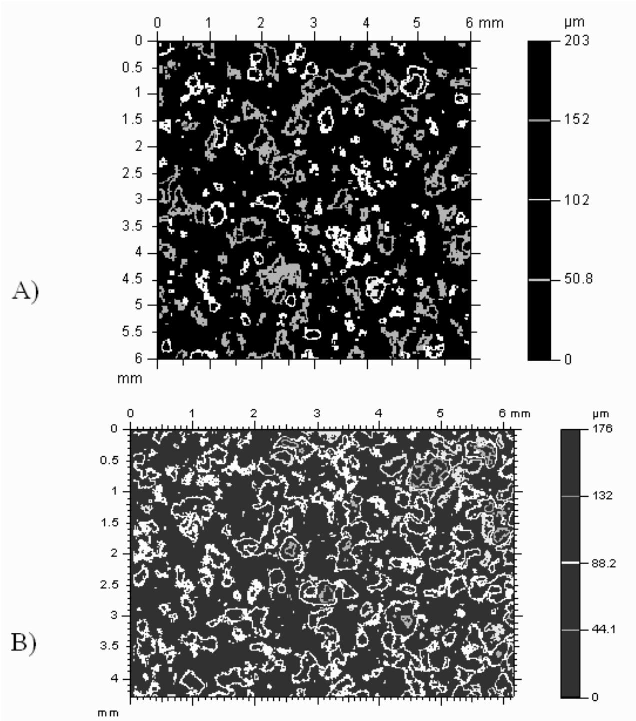

Fig. 4. The distribution of tops on surface of sample from EN AC-AlSi9Cu3(Fe) sand cast alloy A) before anodization, B) after anodization.

4. Conclusions

The analysis results of geometry investigations of anodic layer surface proved the technology of casting for studied group of materials determining the quality of surface, its geometrical features. Similar results were obtained in [16].

The applying an oxide layer reproduces the primary geometry of surface, shaped in casting process. The only attendance of applied kind of coat has not influence on characteristic features of surface.

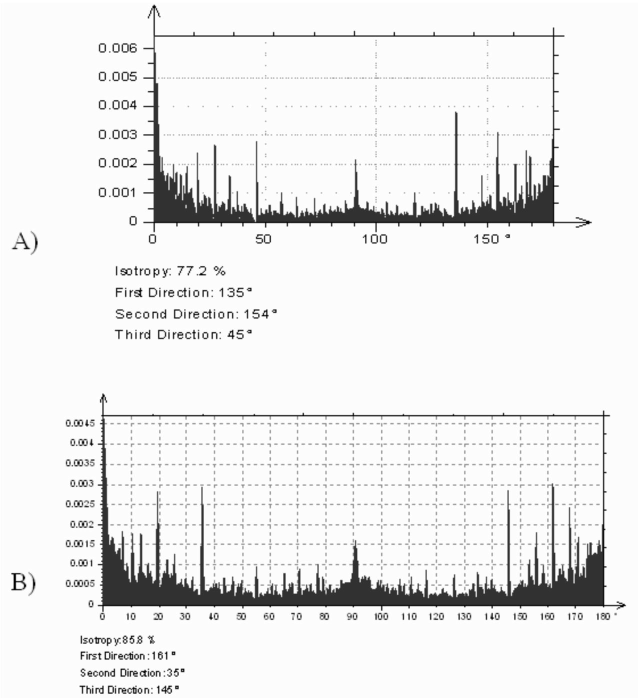

Fig. 5. The texture of surface (the schedule of characteristic directions) from EN AC-AlSi9Cu3(Fe) sand cast alloy A) before anodization, B) after anodization

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