A R C H I V E S O F M E T A L L U R G Y A N D M A T E R I A L S
Volume 50 2005 Issue 2

M. OPYRCHAŁ*, J. ŻELECHOWSKI*

ELECTROLYTIC COATING ON THE TEXTURE GRADED ALUMINIUM SHEET

POWŁOKI ANODOWE GRADIENTOWO STEKSTUROWANYCH TAŚM ALUMINIOWYCH

Since many years the examination of texture has been of great practical value in an assessment of the sheet manufacturing technology. The influence of crystallographic preferred orientation on the thickness of the hard anodic coating has been determined. Samples were taken from the sheets of metallurgical 1050A aluminium alloy (Al 99.5%) used by industry. The standard chemical composition of this material allows for up to 0.25% Si, 0.40% Fe, 0.07% Zn, 0.05% Cu, 0.05% Mn, 0.05% Mg and 0.05% Ti. The macrostructure on the cross-section of the examined sheets was characterised by graded arrangement. It has been noted that the observed effect is a consequence of different textures. The sheet texture was examined by Schultz X-ray technique of back scatter. The texture on the surface of hot rolled sheets is fibrous and is characterised by {1 *k l*}<011> index. The one fourth sheet thickness is by {1 0 0}<011> texture characterised. In the half of the sheet thickness, a texture typical of cold rolled aluminium is present. The investigations carried out have proved an effect of preferred orientation sheet on the anodic coating thickness and parameters of treatments. It has been observed that the some hard anodic coating thickness depends on the texture of 1050A aluminium alloy sheets.

Keywords: functionally graded material, hard anodic coatings, texture analysis, aluminium sheets, macrostructure, microstructure.

Badania tekstur od wielu już lat odgrywają znaczącą rolę w technologii produkcji taśm aluminiowych. W niniejszej pracy określono wpływ tekstury krystalograficznej taśm aluminiowych na grubość wytwarzanych na nich twardych powłok anodowych. Próbki taśm z aluminium 1050A pobrano z produkcji przemysłowej. Zawierały one 0.25% Si, 0.40% Fe, 0.07% Zn, 0.05% Cu, 0.05% Mn, 0.05% Mg oraz 0.05% Ti. Na przekroju poprzecznym badanych taśm zaobserwowano gradientową strukturę warstwową, o zróżnicowanym stekturowaniu poszczególnych warstw. Teksturę tych warstw badano rentgenowską metodą promieni zwrotnych Schultz'a. W wyniku badań stwierdzono, że na powierzchni taśm walcowanych na gorąco występuje tekstura włóknista {1 *k l*}<011>. W $^1/_4$ grubości taśmy stwierdzono obecność tzw. skręconej tekstury sześciennej {1 0 0}<011>. W połowie grubo-

* INSTYTUT METALI NIEŻELAZNYCH W GLIWICACH, ODDZIAŁ METALI LEKKICH W SKAWINIE, 32-050 SKAWINA, UL. PIŁSUDSKIEGO 19

ści taśmy zaobserwowano natomiast teksturę typową dla walcowanego na zimno aluminium. Na odpowiednio spreparowanych powierzchniach w warunkach laboratoryjnych wytworzono twarde powłoki anodowe, a następnie zmierzono ich grubości. W wyniku przeprowadzonych badań stwierdzono, że grubość twardych powłok anodowych zależy od typu orientacji uprzywilejowanej powierzchni anodowanych taśm.

1. Introduction

Hard anodic coating is one of types of electrolytic conversion coating obtained on aluminium and its alloys. Properties of this coatings depend on chemical composition and structure anodized materials and parameters of anodic oxidation process. Hard anodic oxide coatings are produced on aluminium parts for tribologycal purchases [1-4].

2. Material and experimental procedure

Samples were taken from the 9 mm thickness sheets of metallurgical 1050A aluminium alloy (Al 99.5%) used by industry as natural functionally graded material. The investigations carried out have proved an effect of preferred orientation sheet on the hard anodic coating thickness. Hard anodic coatings are produced 1 hour by anodic current density of 3.5A/dm^2 in low temperature electrolyte (sulphuric acid pure 8% wt, 2 carboxylic acids pure 4% wt, glycerin pure 2% wt and water distilled) on the selection cross-section of sheets. The thickness of hard anodic coatings was measurement by Permascope EW typ EW.81d3T3 made in Helmut Fischer Gmbh + CO. The macrostructure of hot rolled sheets was revealed by etching in Tucker reagent (45 ml HCl, 15 ml HF, 15 ml HNO_3 and 25 ml H_2O). The microstructure of sheets was revealed by electrolytic Barker method (2 ml HBF_4 and 100 ml H_2O) and it was photographed under optical microscope using polarized light. The sheet texture was examined by Schultz X-ray technique of back scatter [5] and by the quantitative texture analysis [6, 7].

3. Results and discussion

The macrostructure and the microstructure on the cross-section of the examined hot rolled sheet was characterised by laminated arrangement visible on the photographs. Figure 1 illustrating the laminated macrostructure on a cross-section of 9 mm hot rolled sheet of 1050A aluminium alloy etched in Tucker reagent. Fig. 2 present microstructure on the longitudinal section of hot rolled sheets of 1050A aluminium alloy. Fig. 3 gives a number of {111} pole figures illustrating the texture on intersection of hot rolled 9 mm thick sheet. It has been noted that the observed laminated arrangement effect is a consequence of different textures components and differentiate standard

Fig. 1. Photograph of laminated macrostructure on a cross-section of 9 mm hot rolled sheet of 1050A aluminium alloy etched in Tucker reagent

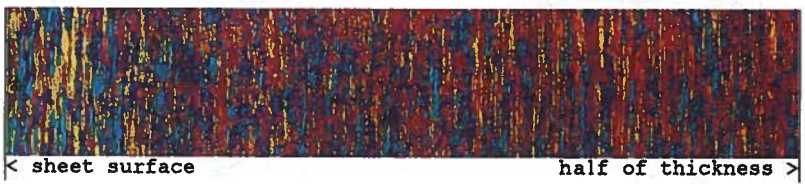

Fig. 2. Microstructure on the longitudinal section of hot rolled aluminium sheet

deviation of orientations distribution function as a fitting results from mathematical modeling. The fitting accuracy of standard deviation reaches a value of 0.5 degree. Figures 4 and 5 presents results of a thickness measurements of hard coatings layers and $\{h\ k\ l\}$<211> (superposition of {1 3 5}<211>, {1 4 6}<211>, {1 5 7}<211>, {1 6 8}<211>, {1 2 4}<211> and {2 5 9}<211>) texture components content on the examined section parallel to the sheets surface. It has been observed that the thickness of hard anodic coatings depends on the feature of aluminium sheets texture. On the surface of hot rolled sheets exist fibrous $\{1\ k\ l\}$<011> texture. The layer of 1.0 mm under surface presents by {1 0 0}<011> component. The half of the sheet thickness characterised typical texture of cold rolled aluminium. Additionally, in central area of sheet cross-section exist two kind of standard deviation of texture components distribution function, lower σ = 4.0° (from – 2.0 to -3.5 mm surface position) and higher σ = 5.5°. The area of low standard deviation gives thicker coatings, while high standard deviation gives thinner coarse coatings.

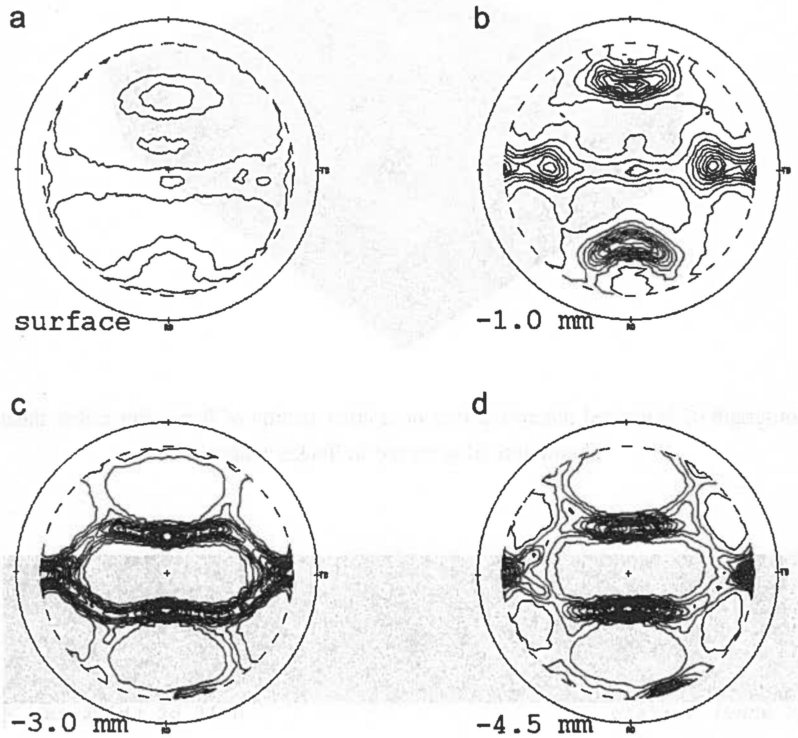

Fig. 3. {111} pole figures of the examined section parallel to the sheets surface. a) surface, b) 1 mm under surface, c) 3 mm under surface, d) 4.5 mm under surface

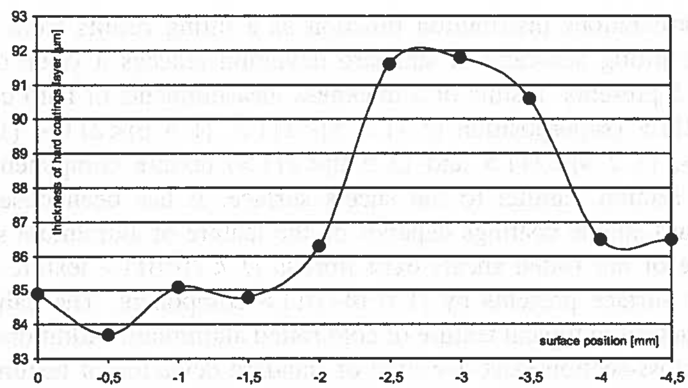

Fig. 4. Results of thickness measurements on hard coatings layers of the examined section parallel to the sheets surface

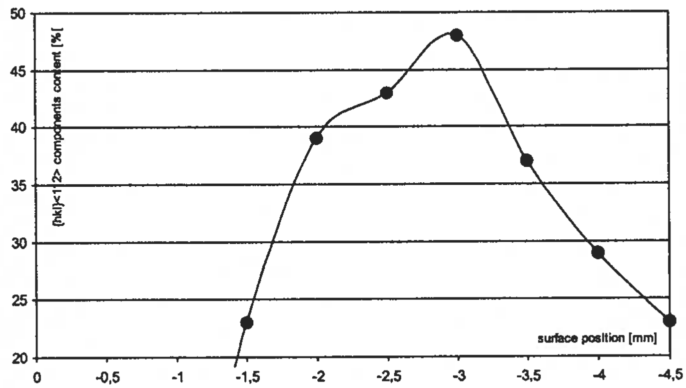

Fig. 5. The {*h k l*}<211> texture components content on the examined section parallel to the sheets surface

4. Conclusions

Hard anodic coating thickness depends on the texture parameters of texture graded aluminium alloy sheets. The {*h k l*}<211> components and low standard deviation of orientations distributions function gives thicker hard coatings layers.

REFERENCES

[1] S. Wernick, P. Pinner, P.G. Sheasby, The surface treatment and finishing of aluminium and its alloys, Finishing Publications Ltd., (1987).

[2] W. Hübner, C.-Th. Speiser, Die Praxis der anodischen Oxidation des Aluminiums, Aluminium verlag, Düsseldorf (1988).

[3] A.W. Brace, The fundamentals of the hard anodizing process, INTERALL Srl, Alusurface'98 Seminar Proceedings (H) 7.Nov (1999).

[4] H. Habazaki, K. Shimizu, P. Skeldon, G.E. Thompson, G.C. Wood, X. Zhou, Effects of alloying elements in anodizing of aluminium, Trans IMF **75** (1) 18 (1997).

[5] L.G. Schulz, J.Appl.Physics **20**, 1030 (1949).

[6] H.J. Bunge, Z.Metallkde Bd.**76** 7, 457 (1985).

[7] H.J. Bunge, Theoretical Methods of Texture Analysis, DGM Informationsgesellschaft, Oberursel (1987).

Received: 21 March 2005.