THE ANALYSIS OF THE EFFECTS FORMATION IRON - TUNGSTEN CARBIDE LAYER ON ALUMINUM ALLOY BY ELECTRICAL DISCHARGE ALLOYING PROCESS

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Abstract

Aluminum alloy is very useful in fabricating lightweight structures. However, the tribological applications of this alloy are limited. This paper present a brief study of electro spark deposition using special prepare electrode. Kerosene was used as a dielectric fluid. Surface where modification using a Fe-WC electrode on electrical discharge machine. The layers were investigated with metallographic methods and EDS analyses. Using EDS analysis, there were identified a types of alloying elements and the extent of diffusion from the electrode into to aluminum alloy. Also, there was investigated of nanohardness. Microscopic examination was carried out to examine the structure of formed layers. Image analysis methods were used to observe the cross-section of the layer.The results of investigations showed that there is a possibility of obtaining the satisfying quality joint between the aluminum alloy and Fe-WC electrode layer.

Keywords: Surface layer, spark deposition, EDM, coating

1. INTRODUCTION

Due to the present trend in constructing machines, alloys of special properties are often used. These materials are characterised by mechanical durability and high resistance to abrasion and corrosion. The production of whole structures is associated with high costs, therefore often the surface layer is modified.

There are many methods of modification of the surface layer, one example of such a treatment may be electrical discharge alloying process (EDA)

Electrical Discharge Machining (EDM) is a controlled metal-removal process that is used to remove metal by means of electric spark erosion [1-9]. Electrode material is anodic (positive polarity) and the workpiece is the cathode (negative polarity). EDM works by eroding material in the path of electrical discharges that form an arc between an electrode and workpiece in a dielectric fluid, and the electric energy is converted into thermal energy. The high temperature between 8000 °C to 12000 °C initializes the melting of the materials at the surface of each pole. Reversing the polarity can cause changes the process of material removal, such that an appreciable amount of electrode material can be deposited on the surface of the workpiece [10-19].

Briefly, this work is to use the EDA process to modify aluminum alloy with solid iron - tungstencarbideas an electrode.

2. EXPERIMENTAL PROCEDURE AND RESULTS

2.1. Structure investigation after EDA

To presents the results of investigating electrical discharge alloying traces on the machined surface where capture and present on **Figure 1**.

The tests were performed on scanning profilometer which can not only give visual information on the shape of discharge traces but also enables measurement of trace geometry and give information on volume of pits and flashes.

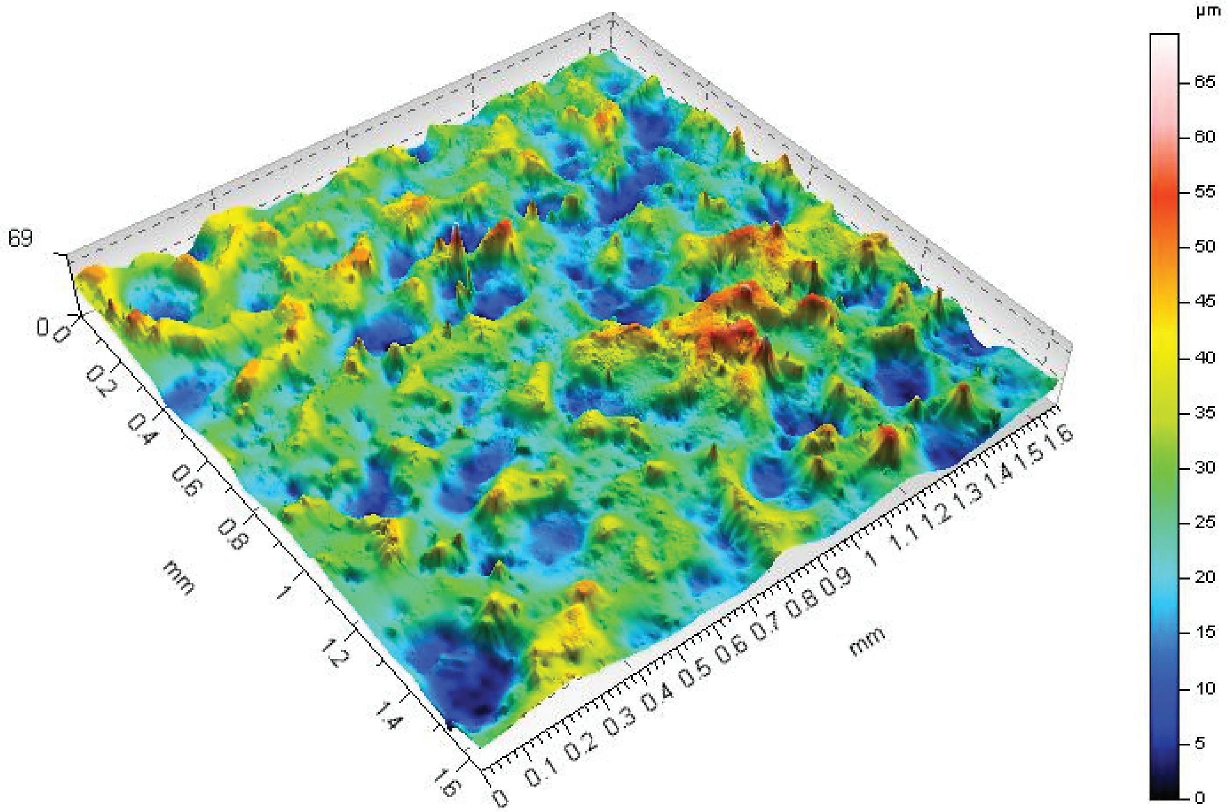


Figure 1 View of 3D on machined surface made by Talysurf CCI Lite-Taylor Hobson scanning profilometer type

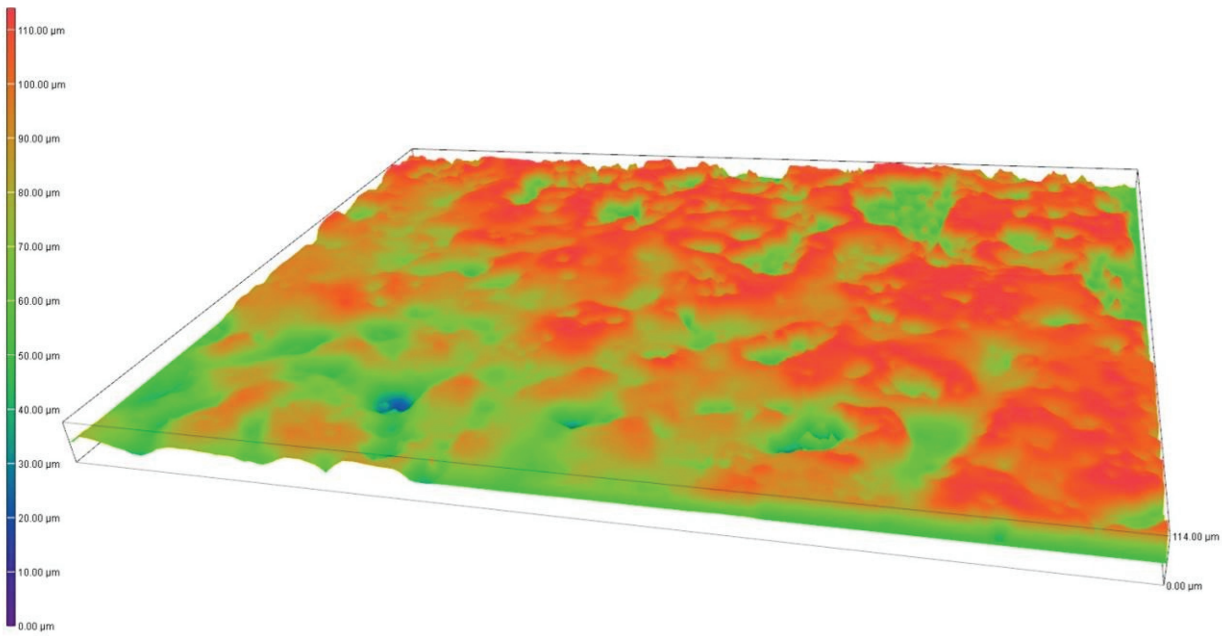


Figure 2 View of 3D topography on alloying surface made by Nikon Eclipse MA 200 microscope

To illustrate structures of EDA of Fe-WC electrode on analuminium alloy were used the optical microscopy. Microscope Nikon Eclipse MA 200 with the image analysis system NIS 4.20 to metallographic specimens testing was used. During the preparation process for the surface layer were cut across and mounted in resin. After proper polishing and etching the weld structure was observed.

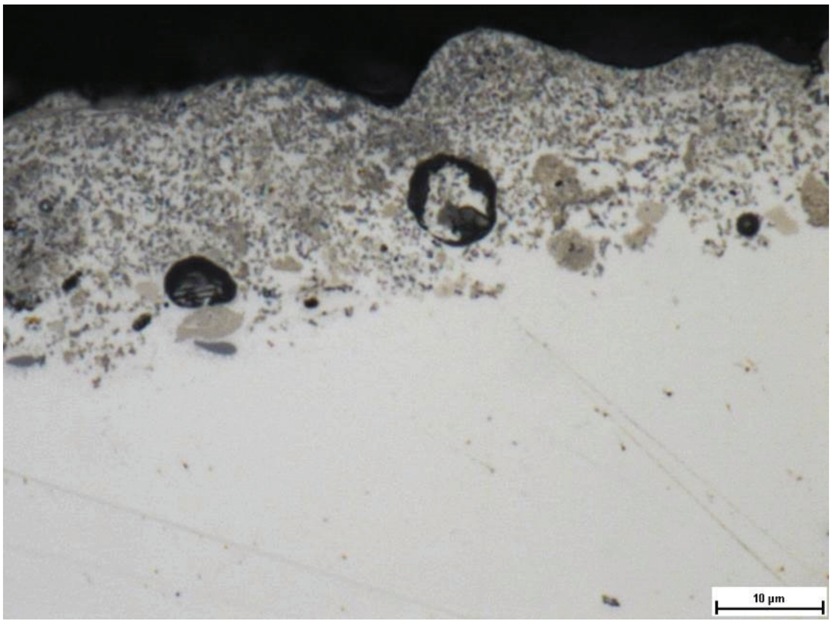
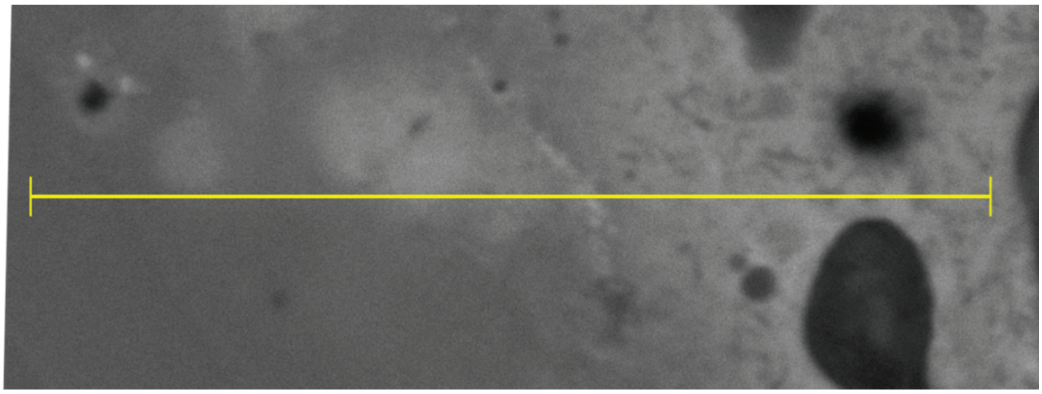


Figure 3 Micrograph image of cross-section of the surface alloyed after the EDA process

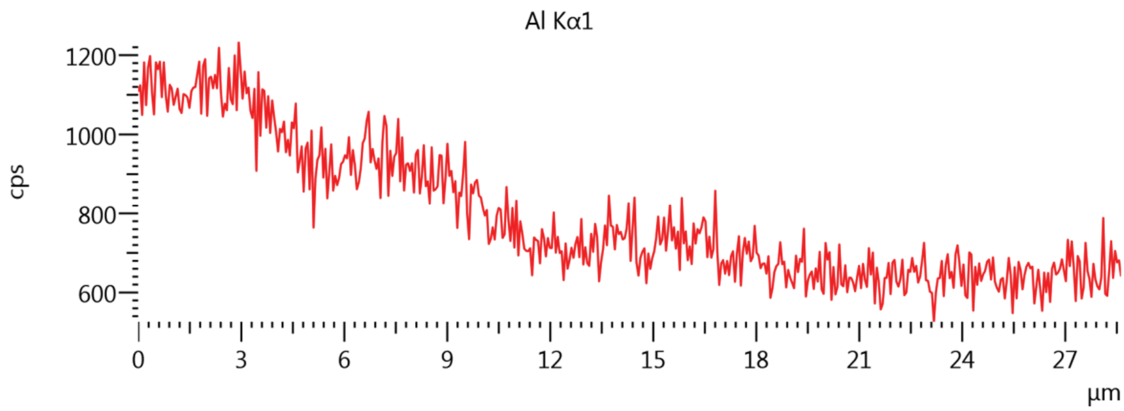
3. SEM EXAMINATION

The alloyed layer was examination by SEM cross-section view using a JEOL JSM 7100F microscope with field emission (Schottky). X-ray diffraction pattern obtained from the surface layer after the EDA process using a Fe-WC electrode shows **Figure 4**.

a)



b)



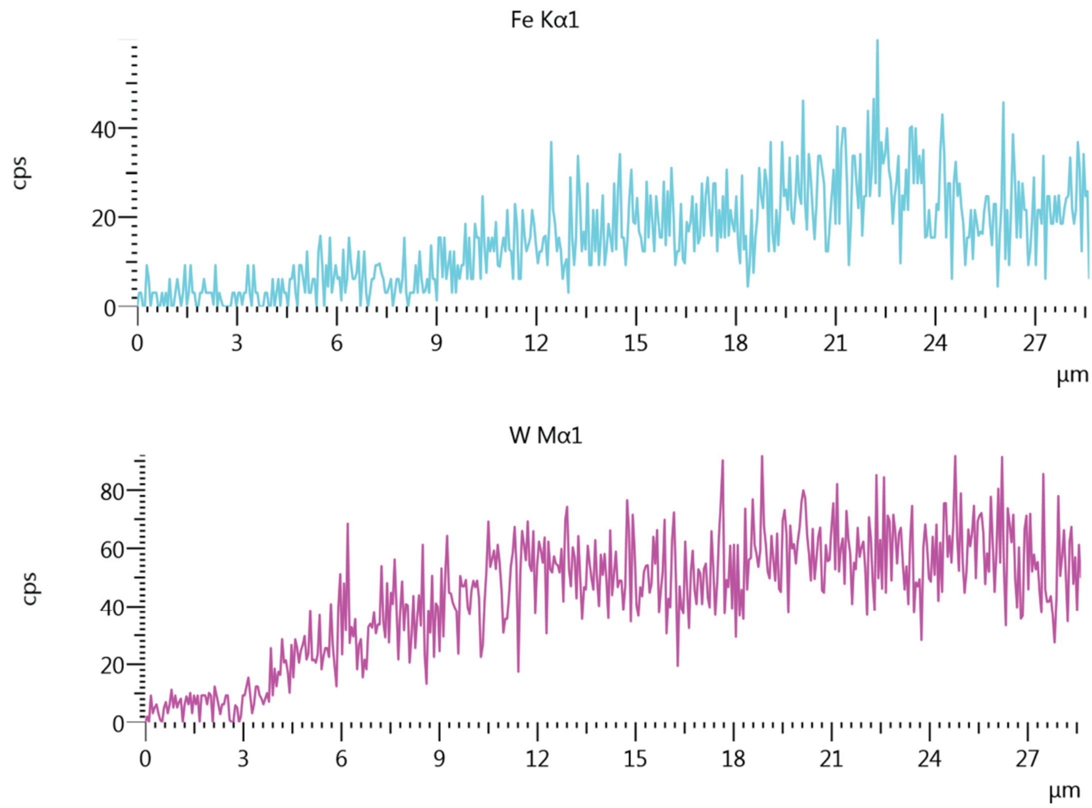


Figure 4 X-ray line scan of the surface layer after the EDA process using a Fe-WC electrode - a; chemical elements distribution in the sub-surface layer - b

4. DISCUSSION OF RESULT

Figure 5 shows a relatively thick EDA layer around 8-9 µm on the sample that was processed using a discharge current of 5 A.

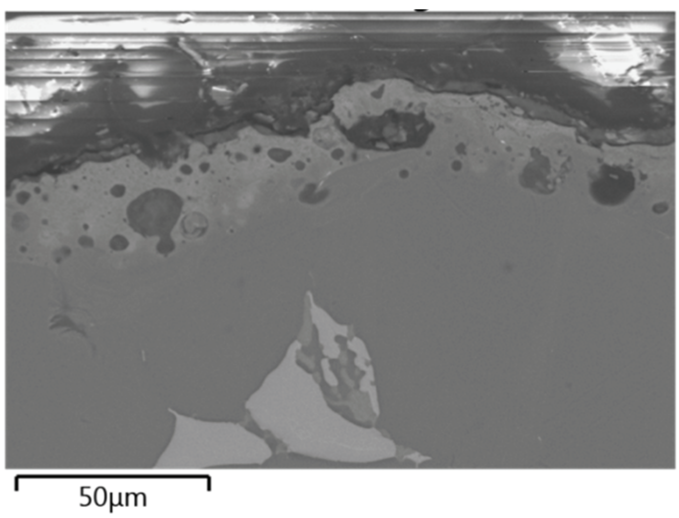


Figure 5 Cross-sectional micrograph of a coating - thickness of EDA layer between 6-10 micrometers

Chemical composition tests for surface layer have been carried out using X-ray micro-analysis. **Table 1** shows analysis of chemical composition in points, and we can observe the diffusion of the electrode in to material.

Table 1 Composition (in weight %) of the surface layer

Spectrum Label	Al	Si	Fe	Co	Cu	W	Total
Spectrum 1	65.38	12.23	11.23	0.78	3.19	7.19	100.00
Spectrum 2	64.38	12.69	11.44	1.00	3.71	6.78	100.00
Spectrum 3	64.71	9.12	13.13	0.69	4.07	8.28	100.00

Transfer advantages of alloying elements is the possibility of modifying the selected structural elements, and as a result reducing production costs and improving the properties of the material.

5. CONCLUSION

The investigations into electro-discharge deposition have shown that:

- the surface layer subjected to the deposition process contains chemical components of the electrode (cathode),
- X-ray analysis of the molten and resolidified layer shows an increase of tungsten (up to 6-9%) content,
- thickness recast layer achieved about 5-10 micrometers,
- the metallographic structure of the surface layer reveals properties that are typical of electrical erosion discharge machining,

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