Analysis of the surface layer after the alloying process (EDA) using the electrode Fe-WC

Analiza warstwy wierzchniej po procesie stopowania metodą EDA z zastosowaniem elektrody Fe-WC

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The article presents a brief analysis of the deposition layer using EDA. The surface layer was modified using electrodes Fe - WC on the machine electro-erosion. The layer was tested by metallographic methods and EDS. There were identified on the basis of which the transmission of alloying elements from the electrode to the weld overlay.
KEYWORDS: surface layer, spark deposition, EDM, coating

The development of material engineering and tendencies in the construction of machinery force the use of various materials, often with specific properties. These materials should be characterized, among others, by high durability, abrasion and corrosion resistance. All the construction of this type of material is costly and therefore often the desired effect, when the economic criteria of the manufacturing process are met, is obtained by modifying the surface layer.

There are many methods for modifying the surface layer, one of them being electrical discharge alloying (EDA).

Electro-erosion treatment (EDM) is a controlled material removal process. It is used to remove metal by electric discharge [1, 2, 4, 5, 6, 7, 9]. The electrode material is an anode - it has positive polarity - while the object is treated with cathode and has a negative polarity. The EDM is the erosion of material micro-volume due to electrical discharges, during which the arc forms between the electrode and the workpiece, and the electrical energy is converted into heat energy. Reversing the polarization promotes a change in the nature of the process so that a significant amount of material from the working (stopping) electrode can be deposited on the workpiece surface [3, 8, 10, 11, 12, 13]. As a result of mass transfer under the presence of liquid metal, favorable conditions are created for modifying the chemical composition of the surface layer.

Study upon geometric surface structure after EDA

To determine the distribution of discharges and the evaluation constituted by the process of alloying the geometric structure of the surface of the molten object, measurements using Talysurf CCI Lite profiler - Taylor Hobson – were carried out. An example of an area to be subjected to electric shocks is shown in fig. 1. The elevation map analysis and the ordinates distribution indicate that SGP is not deterministic. This indicates a uniform distribution of discharges on the molten surface and is a prerequisite for inferring that the process of mass transfer between the electrodes is evenly spread over the entire surface of the modified object.

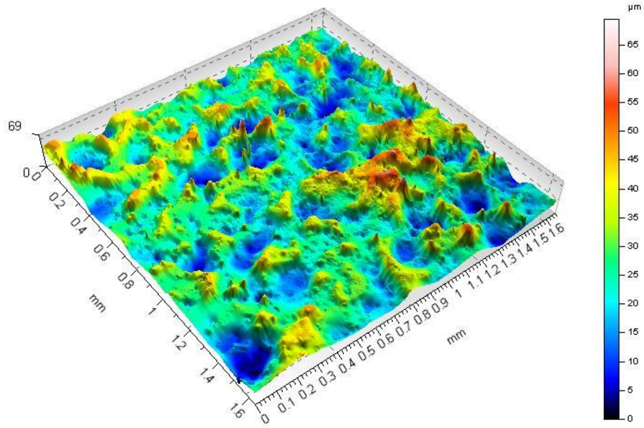

Fig.1. The 3D image after EDA treatment made using Talysurf CCI Lite profiler - Taylor Hobson

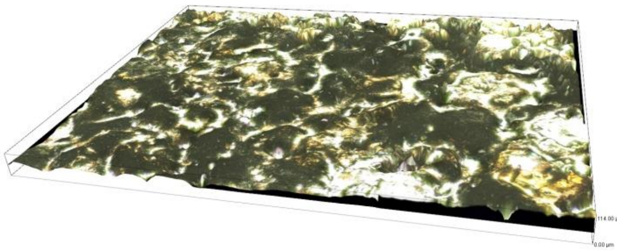

Fig. 2. The 3D image of EDA treated surface with Nikon Eclipse MA 200 microscope

To determine the topography of the surface after EDA treatment using the Fe-WC electrode, the Nikon Eclipse MA 200 optical microscope with the NIS 4.20 image analysis system and the *z* axis motors was used. Metallographic tests were done on standardized (polished and etched) extrudates. An exemplary metallographic structure of the surface layer is shown in fig. 3. The visible structural changes indicate the proper mixing of the alloy components with the native material, which was AlSi9Cu3 aluminum alloy.

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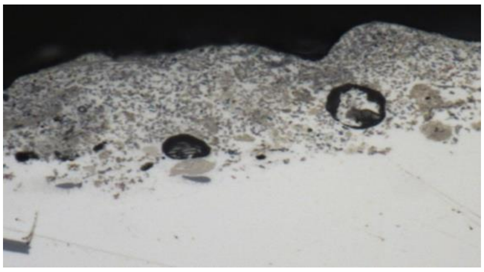

Fig. 3. Micro-photographic SEM microstructure of the metallographic layer after melting EDA

Linear SEM analysis

Metallographic microstructure studies were supplemented by linear analysis of chemical composition. It was carried out along the selected line on the surface of the sample so as to cover the native material and the modified layer. As a result of the analysis, the distributions of the selected elements (Fig. 4) were obtained in the area of the bonding of the layer applied to the substrate. The analysis was carried out using an electron microscope type OXFORDX-MAX.

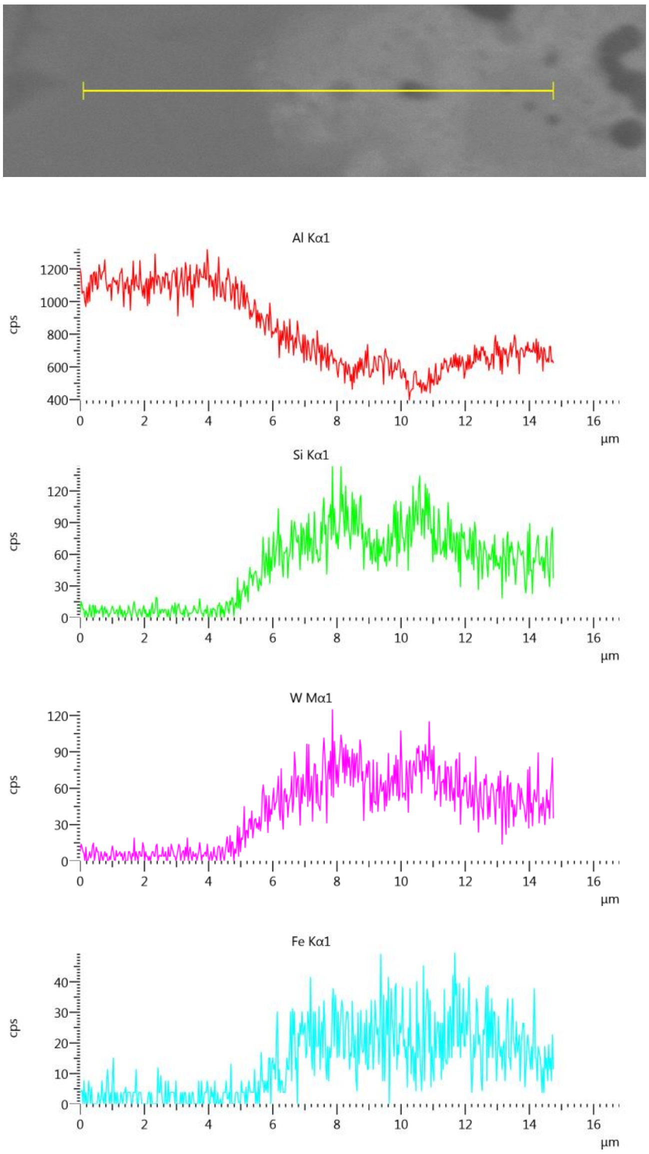

Fig. 4. SEM linear analysis of chemical composition of the modified layer

Observation of SEM microstructure and analysis of chemical composition using the EDS micro-probe indicate that the material has diffused from the working electrode to the parent material layer. Detailed results of the analysis of chemical composition are summarized in the table.

TABLE. Chemical composition of the surface layer after EDA treatment (weight in %)

	Al	Si	Fe	Co	Cu	W	Σ
Analysys 1	65,38	12,23	11,23	0,78	3,19	7,19	100
Analysys 2	64,38	12,69	11,44	1,00	3,71	6,78	100
Analysys 3	64,71	9,12	13,13	0,69	4,07	8,28	100

Conclusions

As a result of electro-alloying EDA with a WC-Fe electrode, the mass is exchanged between the stop electrode and the modified surface.

A detailed analysis of the linear and point-to-point chemical composition shows a significant increase in the tungsten content of the surface layer - from 6 to 9%.

The connection between the modified layer and the native material is diffusive.

The thickness of the modified layers reaches about 5-10 µm.

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