3D MODEL OF ANODIC OXIDE COATING MODIFIED WITH CARBON PARTICLES

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Summary

In this paper shown three-dimensional model of composite hard anodic layer modified by carbon particles. Modifications were carried by vacuum sublimation by a graphite electrode. The modified layer is characterized by improved tribological properties (friction coefficient) compared to the unmodified layer. Test conditions and values of the coefficients of friction are presented for the combination of pin-on-disc pair in T-01M tester. The 3D model was made in parametric CAD program Solid Edge v19 pl, which allows to explain the decrease in the coefficient of friction.

Keywords: anodic oxide coating, carbon particles, 3D model, CAD, pin-on-disc.

MODEL 3D WARSTWY TLENKOWEJ MODYFIKOWANEJ CZĄSTKAMI GRAFITU

Streszczenie

W pracy przedstawiono trójwymiarowy model kompozytowej warstwy ceramiczno-grafitowej powstałej w wyniku modyfikowania anodowej powłoki twardej. Modyfikacje przeprowadzono w procesie napylania próżniowego. Warstwa modyfikowana charakteryzuje się lepszymi właściwościami tribologicznymi (współczynnik tarcia) w porównaniu do warstwy niemodyfikowanej. Warunki badań oraz wartości współczynników tarcia zestawiono dla skojarzenia trzpień-tarcza testera T-01M. Model 3D warstwy wykonano w parametrycznym programie CAD Solid Edge v19, który pozawala na wyjaśnienie zmniejszenia się współczynnika tarcia.

Słowa kluczowe: anodowa warstwa tlenkowa, model 3D, CAD, trzpień-tarcza, cząsteczki grafitu.

1. OXIDE CERAMIC LAYER

The object of the researchers was an oxide ceramic layer formed by using the duplex method which is obtaining the layer consists of anodic oxidation on aluminium. Al_2O_3 coatings were performed on the alloy EN-AW-5251 (disc) through hard anodizing in a three-component electrolyte of a constant temperature of 313 K and current intensity of 3 A/dm^2 and the time was 60 minutes. The examination was performed by using the transmission electron microscope (JOEL's JEM 2010 ARP) revealed a columnar-fibrous structure of Al_2O_3 coatings. The aluminium oxide fibres are oriented in parallel to the direction of coating growth as the effect of the electric field present in the electrochemical process (fig. 1). Oxide fibres are arranged in parallel to one another (fig. 2).

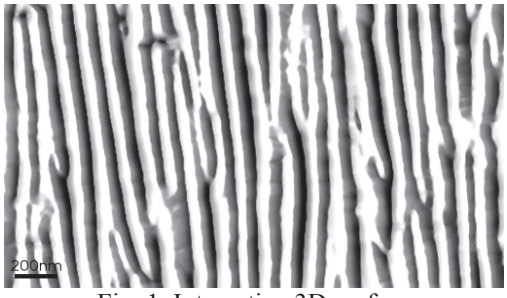

Fig. 1. Interactive 3D surface


Fig. 2. The columns 3D model of AOC created in Solid Edge.

2. COMPUTER IMAGE ANALYSIS

In the computer image analysis (CIA) of the ceramic-graphite oxide layer obtained using duplex method the following parameters were taken into account: the shape coefficient, average diameter and distance between fibres. The results along with the standard deviation are collated in Table 1. In the CIA was used specialist software for image processing and measuring namely: Metilo and ImageJ applications.

Table. 1. Parameters of measuring interfaces

Object of the analyses	Parameter	Value
Straight ceramic fibre	Shape coefficient	0.142 ± 0.002
Straight ceramic fibre	Average diameter	83 ± 1.8 nm
Ceramic fibre	Distance between the fibres	45 ± 5 nm

Based on the results from the computer image analysis, a 3D coating model was proposed which has not been present so far in the literature regarding the subject discussed. The following types of the oxide coating modification were used by vacuum sublimation by a graphite electrode. A Joel IEE-4B vacuum sprayer was used for this purpose.

3. TRIBOLOGY

Tribological tests were performed by using T-01M tester (Fig. 3). The sample (pin) was made of PEEK/BG which is coupling with a counter-surface (disc) which has a composite of graphite oxide (fig. 4). There were reductions in the coefficient of friction-modified layer deposition (0.1737 ± 0.00083) compared to the unmodified layer of the friction coefficient (0.2133 ± 0.00832). In explanation of this phenomenon may help a 2D and 3D models of the graphite ceramic composite layer.

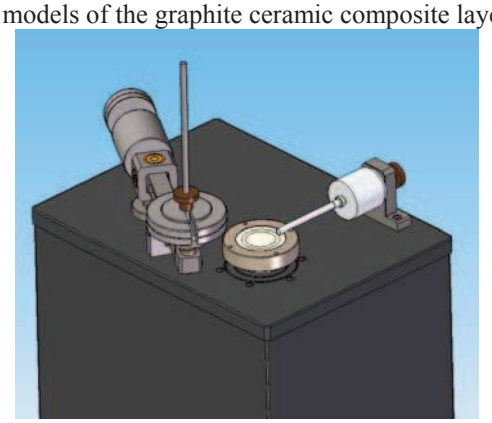

Fig. 3. Solid Edge 3D model of T-01M tester

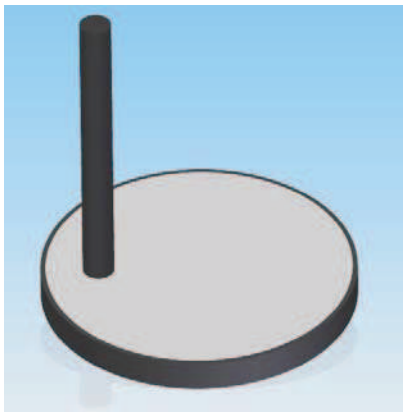

Fig. 4. Solid Edge 3D model of pin-on-disc couple

4. COMPUTER MODELS

The 2D and 3D models were made in a parametric program, Solid Edge v19 pl. The process of vacuum sublimation on a hard anode graphite layer, leading to a reduction in pore size and even to close them in case of pores less than 10μm. The tribological process is characterized by wear and exposure covered or graphite-filled pores. The pores in which were placed on graphite trays act as grease, consequently leading to lower friction coefficient. The vacuum sublimation process probably caused covering the amorphous carbon surfaces and the oxide layer and internal diameter of the pores which have a diameter greater than 5nm. In the case of pores which diameter is less than 5nm, there is possibility of closing and sealing.

2D and 3D models of layer was shown on figure 5 and 6.

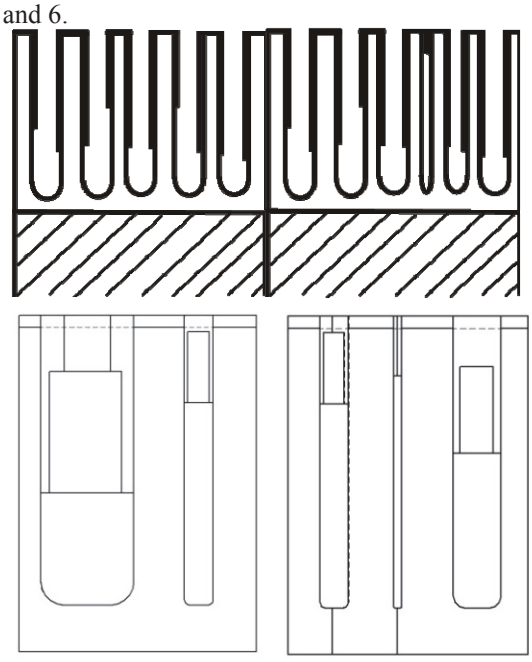

Fig. 5. Two dimensional models of anodic layer

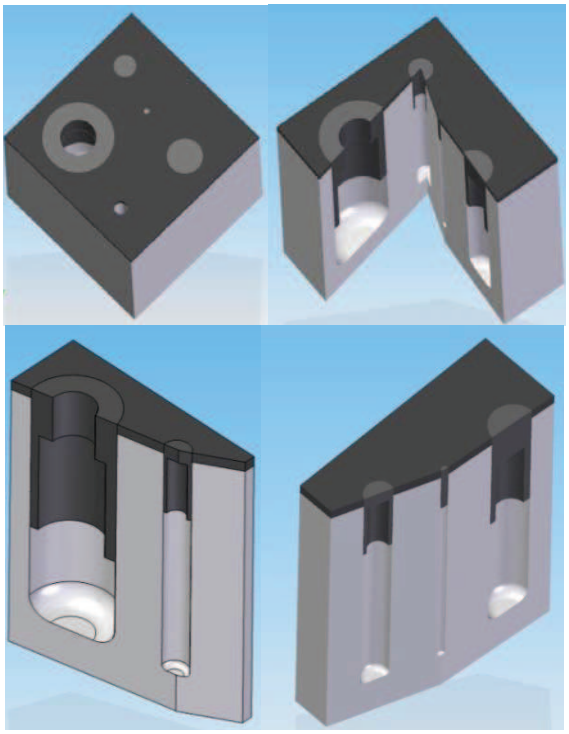

Fig. 6. Three dimensional models of anodic layer.

Stages of uncovering (abrasion) of next layers was shown on figure 7 and 8 in different angles.

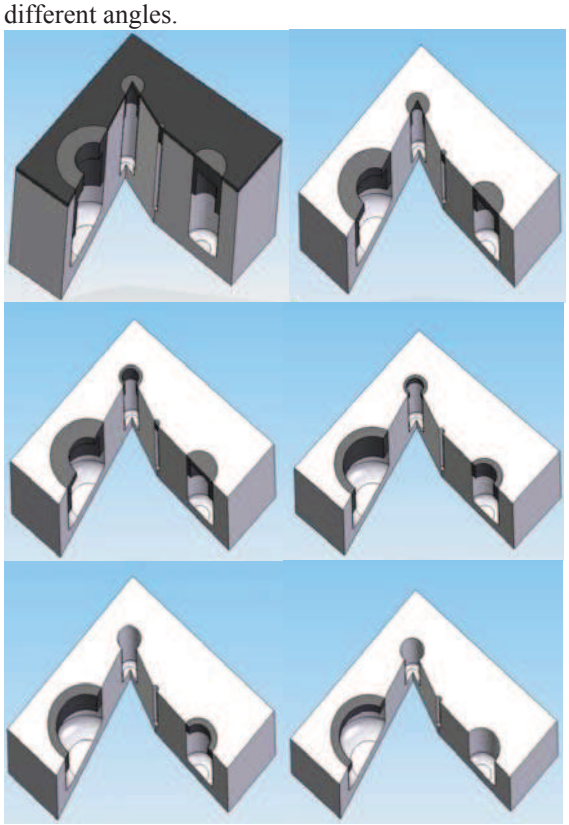

Fig. 7. Stages of uncovering (abrasion) of next layers

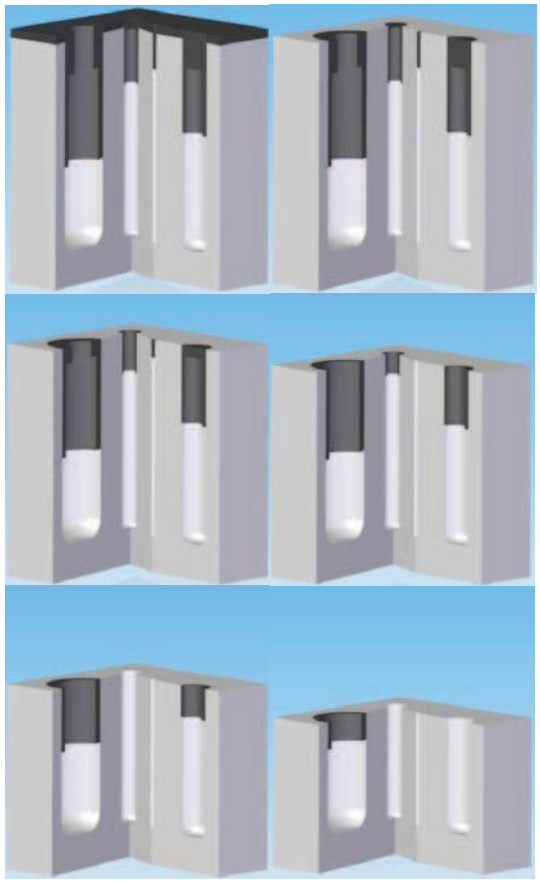

Fig. 8. Stages of uncovering (abrasion) of next layers

SUMMARY

Anodic oxide layer modified by the vacuum sublimation of carbon is characterizing of low values friction coefficient. Introduced graphite into the pores of acts as a lubricant, causing a permanent reduction in the coefficient of friction.

By means of CIA the ceramic-graphite layer composite is determined by average diameters of oxide fibres, average distances between the fibres and their shape coefficient.

Based on a qualitative CIA, of a 3D model of the ceramic-graphite duplex layer modificated by vacuum sublimation was proposed.

AWARDS

Silver medal at the International Fair of Innovation and Economic Research Intarg Katowice 2011- University of Silesia awarded a „Method for producing composite coatings on aluminum and it is alloys, whose authors are PhD Grzegorz Służałek and PhD Henryk Wistuba.

Fig. 9. Silver medal at the International Fair of Innovation and Economic Research Intarg Katowice 2011

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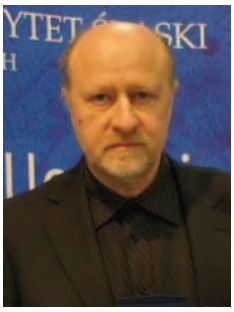

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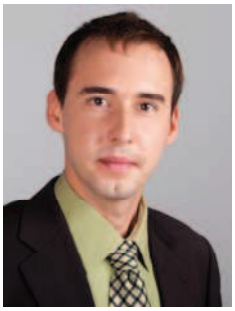

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