INFLUENCE OF ULTRASONIC WAVES DURING MICRO-ARC OXIDATION ON STRUCTURE AND PROPERTIES OF CALCIUM PHOSPHATE COATINGS *

E.G. KOMAROVA[1], *E.A. KAZANCEVA*[2], *M.B. SEDELNIKOVA*[1], *YU.P. SHARKEEV*[1]

[1]*Institute of Strength Physics and Materials Science SB RAS, 2/4 Academicheskii pr., Tomsk, 634055, Russian Federation, e-mail: katerina@ispms.ru, phone: +7 (3822) 286-809*
[2]*National Research Tomsk State University, 36 Lenina pr., Tomsk, 634050, Russian Federation*

The aim of the present work was to study the effect of external uninterrupted ultrasonic (US) or pulsed ultrasonic (PUS) waves during the micro-arc oxidation (MAO) on the growth rate, structure and properties of calcium phosphate (CaP) coatings formed on the commercial pure titanium (Ti) surface.

Synthesis of the CaP coatings on Ti samples was carried out by the MAO method using the Microarc–3.0 installation in the electrolyte and under the conditions described previously [1]. There were three types of the coatings depending on the conditions of external US: 1) MAO-coating (without US); 2) MAO/US-coating (with US, P = 100 W, υ = 35 kHz); 3) MAO/PUS-coating (with PUS, P = 35 W, υ = 37 kHz).

It is seen in Figure 1a, during the MAO process the current density decreases monotonously due to the formation and thickness growth of the dielectric CaP coating. It should be noted that the MAO process under the action of US of PUS is characterized by a higher current density than that without additional US. Figure 1b, c confirms this by the fact that the increase in the coating thickness and surface roughness (Ra) occurs more intensively with additional US than without it.

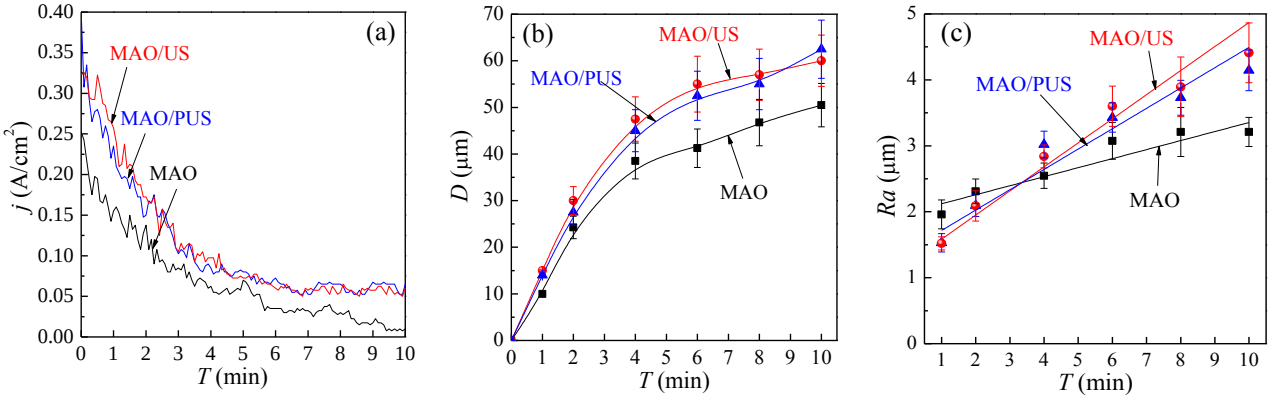

Fig. 1. Graphs of the MAO current density (a), the coating thickness (b) and roughness (c) against the MAO time for different types of the coatings

SEM studies showed that the applied external US field during the MAO process effects on the structural and morphological properties of the coatings. The surface morphology of the coatings formed without UV is represented by the structural elements of spheroidal shape (sphere) with open pores. However, under the action of external US there are destruction of structural elements and filling pore spaces with fragments, which leads to a decrease in surface porosity from 25 to 12 %. At the same time, the internal porosity of the coatings increased from 25 to 40 % due to the formation of macro-pores of 15-40 μm in sizes.

It was found that the external US increases the content of Ca and P in the coatings, and there is a structural-phase transition from the X-ray amorphous state to the amorphous-crystalline state with the content of CaHPO4 and β-Ca2P2O7 phases.

Thus, it was shown that high frequencies of ultrasonic vibrations at low amplitude create an acoustic field with a high level of energy, which allows intensifying the processes of mass transfer in the electrolyte, increasing the growth rate of the coatings, as well as controlling the composition, structure and porosity of the formed coatings.

REFERENCES

[1] *Sharkeev Yu., Komarova E., Sedelnikova M., Khlusov I., Eroshenko A., Litvinova L., Shupletsova V.* Bioactive microarc calcium phosphate coatings on nanostructured and ultrafine–grained bioinert metals and alloys. In: Bioceramics and Biocomposites: From Research to Clinical Practice / ed. I. Antoniac. – New Jersey: John Wiley & Sons, 2019. – P. 191-231.

* This work was supported by the Fundamental Research Program of the State Academies of Sciences for 2013-2020, direction of research III.23.