INFLUENCE OF ANODIC SPARK MODE PARAMETERS ON THE PROPERTIES OF MAO-COATINGS

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For the development of modern technique, it is necessary that the coatings provide a set of properties. Microarc oxidation (MAO) is a technology that allows obtaining the coatings that can be used for decision of multifunctional tasks. Therefore, the coatings are very promising for use in instrumentation, automotive, medicine.

The samples of the MAO-coating MANEL

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Experiment

Material of the samples - 2024 aluminum alloy
Plate - 50x50x2mm.
Coating area - 0.5 dm^2.

Equipment:
MAO bath with a volume of 240 liters
unipolar switching power supply
Alkaline electrolyte “Manel-W” (pH = 8)

Modes: U = 350V, 450V, 600V, pulse duration 100, 200, 400µs, frequency 70, 100, 300Hz.

The coating thickness was constant on all coated samples - 30 ± 3 µm.

The change in the MAO time was recorded at coating thickness of 20 µm, 30 µm, 50 µm 70 µm. The deviation in thickness was ± 3 µm.

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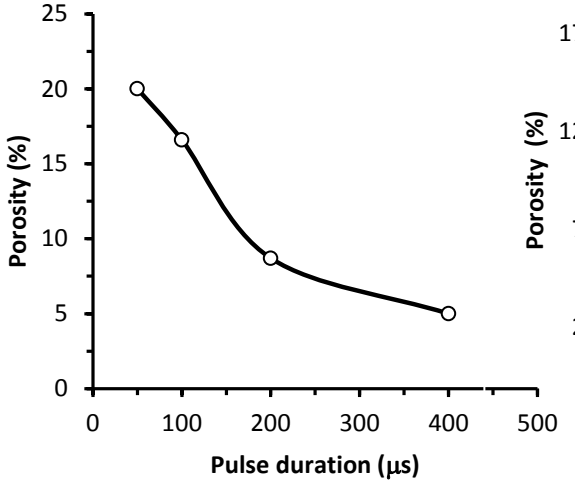
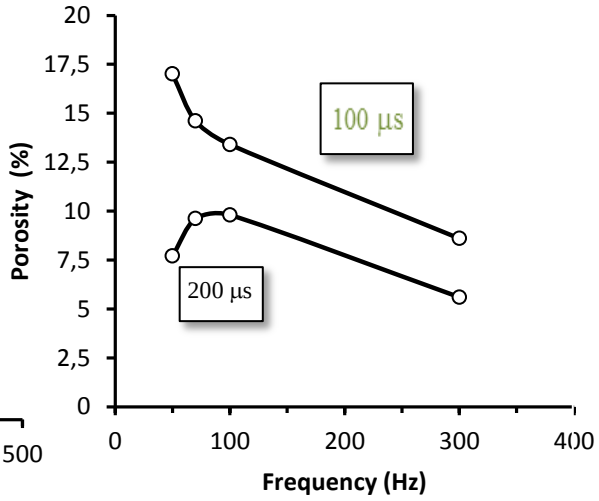
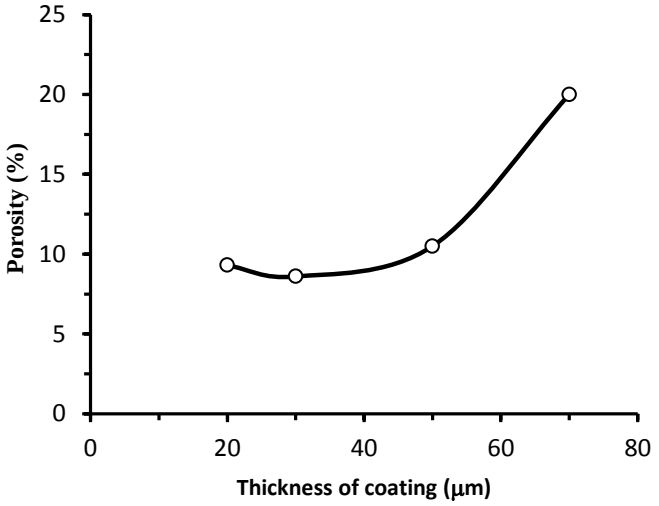
Influence of duration and frequency on the MAO-coating porosity



Dependence of porosity on pulse duration



Dependence of porosity on frequency with pulse duration of 100μs and 200 μs



Dependence of porosity on coating thickness at U=600V, H= 70Hz, δ=200μs

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The element composition of the coating, depending on the pulse duration, frequency and thickness of the coating

Regime	Parameters	Composition			
		O	F	Al	P
Pulse duration, μs					
600 V, 70 Hz	100	25,25	6,36	46,3	8,98
	200	26,82	4,52	51,04	7,62
	400	26,88	3,1	52,2	6,45
Frequency, Hz					
600 V, 200 μs	50	26,54	5,28	51,07	6,46
	70	26,94	4,41	53,07	5,94
	100	26,16	5,38	49,11	6,85
Thickness coating, μm					
600V, 70Hz, 200 μs	20	26,7	4,72	52,54	10,4
	30	26,35	5,27	52,05	8,49
	50	26,09	5,9	46,99	9,18
	70	23,47	9,37	37	13,02

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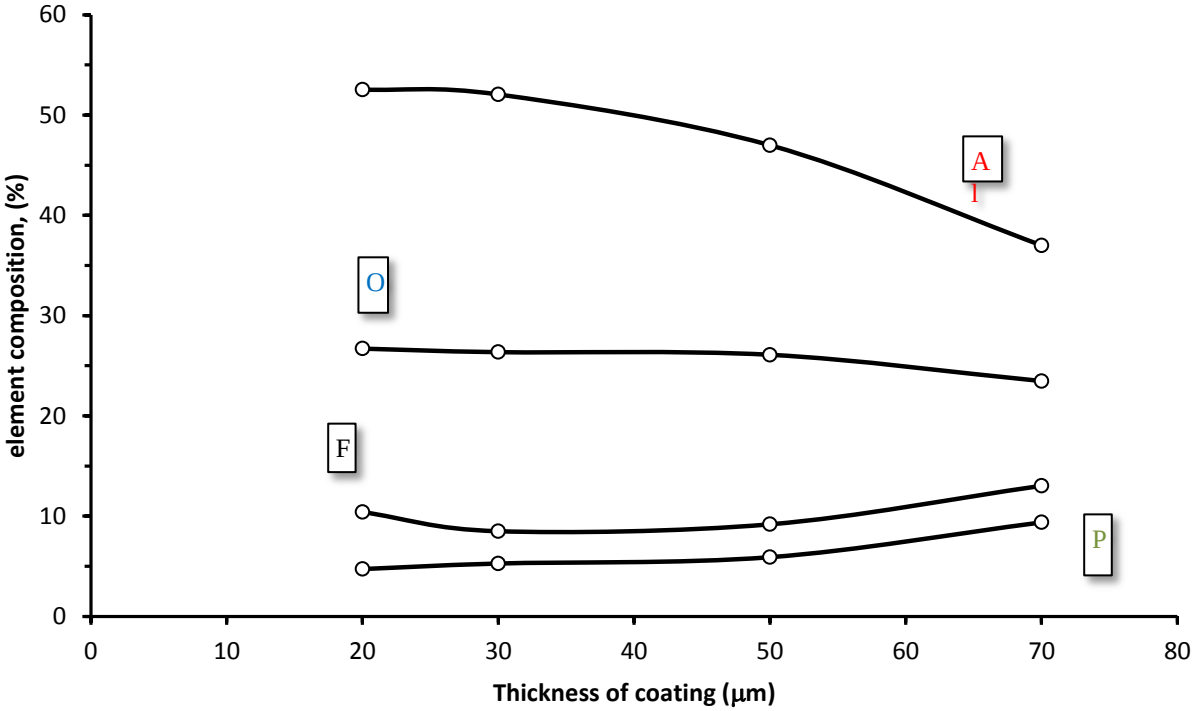

Dependence of element composition on coating thickness

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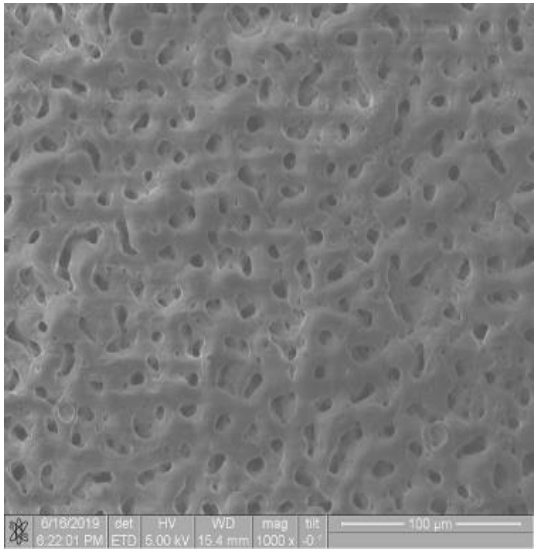
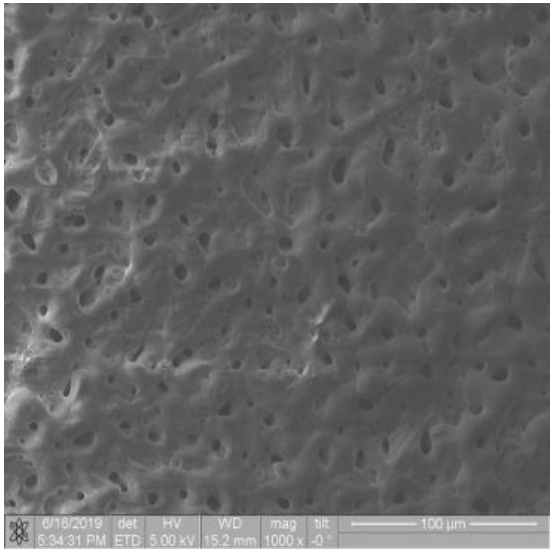
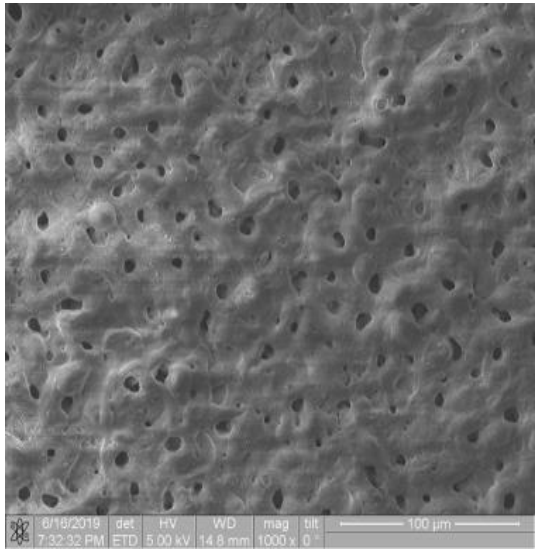
Effect of pulse duration on morphology



100 µs



200 µs



400 µs

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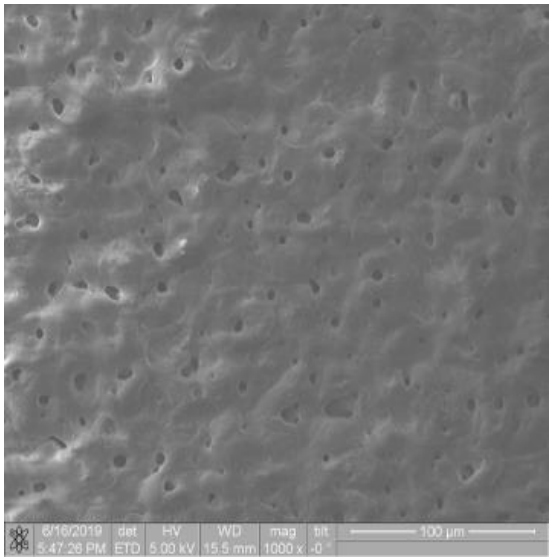
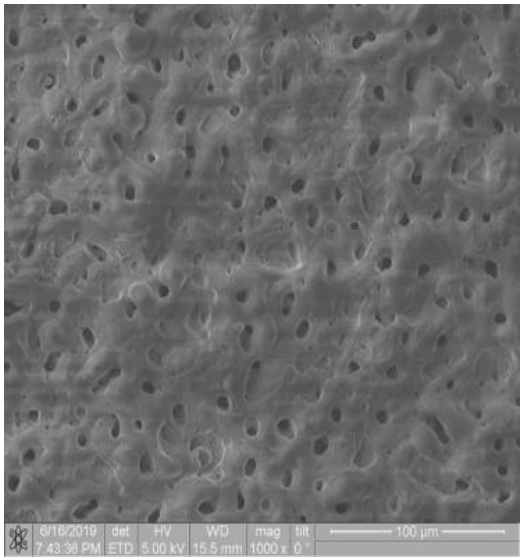
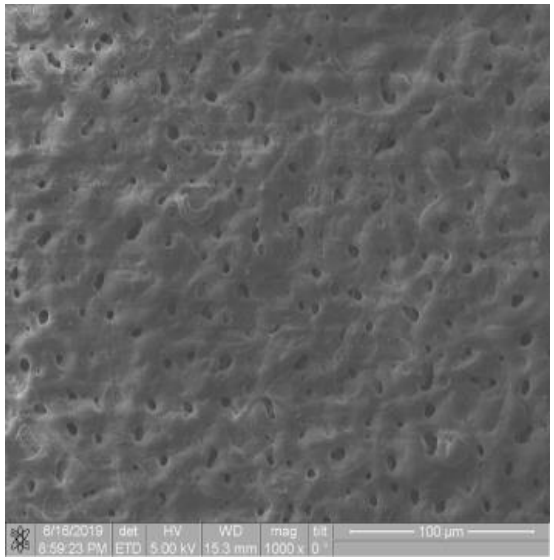
Effect of voltage on morphology



350V



450V



600V

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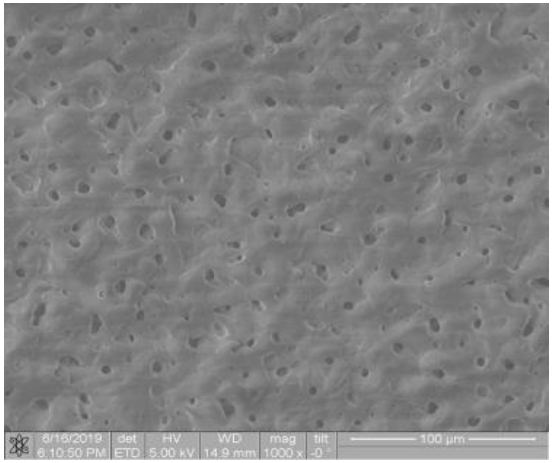
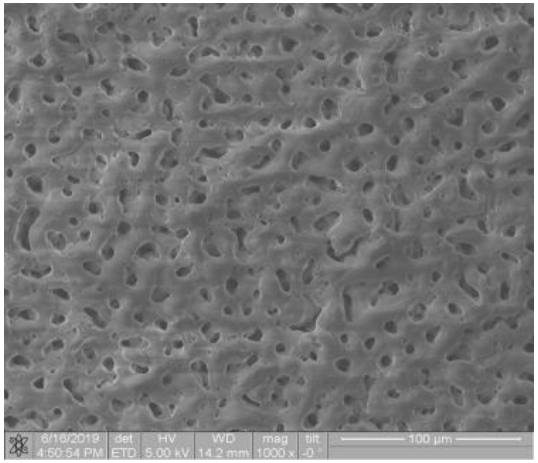
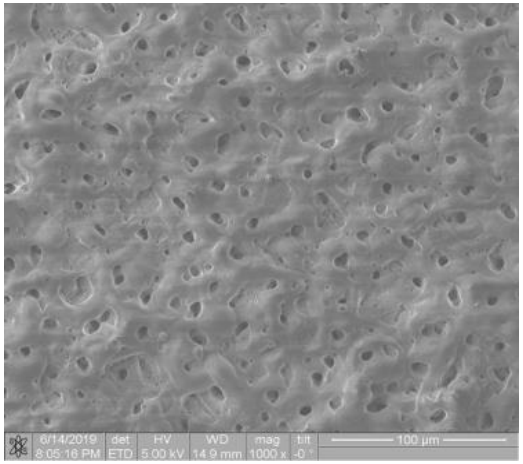
Effect of frequency on morphology



50 Hz



70 Hz



100 Hz

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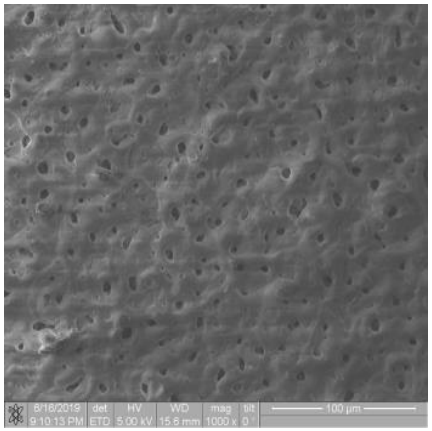
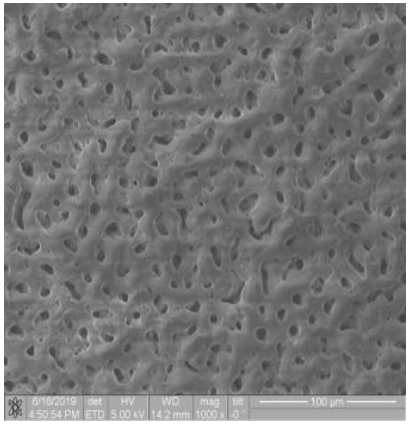
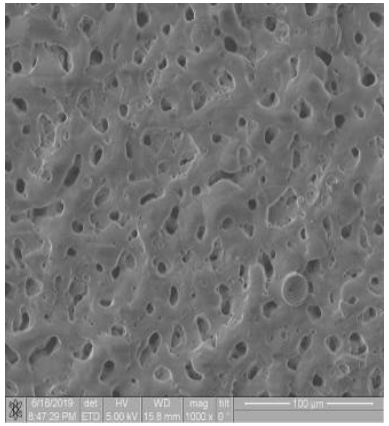
Change in morphology at different coating thickness



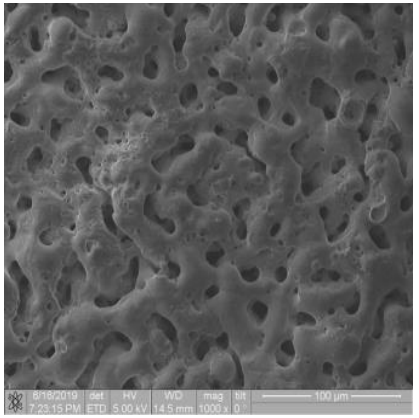
20 µm



30 µm



50 µm



70 µm

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At low pulse durations of 100μs and frequency of 50Hz,
electrolyte components are involved in the coating formation.
The XRD results show that in this case only the non-stoichiometric structure of Na_3AlF_6 is formed. Probably, the process proceeds at elevated temperature in the microplasma discharge zone according to the following reaction

$$12F^+ + 6Na^+ + 2Al^{3+} \rightarrow 2Na_3AlF_6$$

With increasing of pulse duration (200μs, 400μs) and frequency (70Hz, 100Hz), the γ-Al_2O_3 crystalline phase begins to form in the coating by the reaction

$$mMe + nH_2O \rightarrow Me_nO_m + 2nH^+ + 2ne \quad (2)$$

with increasing frequency and pulse duration, the microhardness of the coating increases 2.8GPa, 4.3GPa, 5.6GPa

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Conclusion

It is shown that when controlling the MAO parameters (voltage, pulse duration, frequency, process time), the most significant changes in the coating composition and morphology occur when the MAO time changes with pulse duration of 200μs, voltage of 600V, and frequency of 70Hz.

Rising in the pulse duration and frequency increases the intensity of the influence of microplasma discharges energy on the surface of the substrate, which leads to increase in microhardness of the coating and change in morphology of the coating surface.

However, it is promising to study a further increase in the pulse duration and frequency on the properties of MAO coatings to determine the optimal process performance and improve the quality of the resulting coatings

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