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ON THE FUNDAMENTAL BASIS OF MEASURING THE MICROHARDNESS OF MICRO-ARC OXIDE COATINGS

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Currently, the development of information-measuring control systems for technological processes, including micro-arc oxidation, is actively developing. The most advanced of them make it possible to indirectly measure the thickness of micro-arc oxide coatings during their formation. And it is quite understandable: firstly, the coating thickness is the simplest non-electrical parameter in terms of measurement, which can easily be experimentally verified; secondly, measurement of the coating thickness provides an additional opportunity to automate the MAO process, in particular, to turn off the process current source when the coating reaches the required thickness. However, for most areas of MAO coatings application, the microhardness of the coatings rather than the thickness is of decisive importance. It is the microhardness, or rather, the content of crystalline oxides, that determines the outstanding coatings properties: high wear resistance and heat resistance, chemical stability and electrical strength. In this regard, the measurement of the crystalline oxides content in the coating being formed is of increased scientific and practical interest.

It is known that the MAO coating acquires its unique properties as a result of not only electrochemical but also plasma processes. Therefore, the mathematical model underlying the measurement method must also take into account all these phenomena. According to [1], there is currently no unified fundamental theory of plasma electrolysis, but there are significant scientific works that reveal certain aspects of the coatings formation [2, 3]. In particular, the monograph [4] describes the physicochemical foundations of micro-arc oxidation, in contrast to microplasma processes in detail. Thus, the purpose of this work is to establish the initial positions, on the basis of which a generalized mathematical model of the micro-arc oxidation process can be developed.

The following considerations can be taken as a starting point for the development of this model. The coatings microhardness is determined by the crystalline oxide content in the coating, which depends on the temperature in the micro-arc discharges channel according to the Kolmogorov-Johnson-Mehl-Avrami equation. This temperature is determined by the microdischarges power, which largely depends on the applied energy impact in the form of high-voltage process current pulses. The main idea of the work is to determine the relationship between the current pulses parameters and the temperature in the micro-arc discharges channel by modeling the physical phenomena that accompany the coating formation process. It can be done by calculating the microdischarges power according to the law of energy conservation, based on the total power supplied to the galvanic cell, which is calculated theoretically from the process current waveform or determined experimentally based on the results of measuring the instantaneous current and voltage values.

The work results can be used in the selection of technological parameters of the micro-arc oxidation process in order to increase its efficiency and the formed coatings quality.

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