Study of additive manufacturing processes of coatings on niobium substrate with a developed stereometric structure for mechanical engineering applications

A B S T R A C T

In the doctoral dissertation, the porous coatings fabricated on niobium substrate by plasma electrolytic oxidation processes under the DC conditions with voltage control, in electrolytes based on concentrated phosphoric acid with selected nitrates, are presented. It has been noticed that the change of the DC-PEO processes voltages, treatment times, as well as the electrolytes' compositions allows to fabricate coatings with the differential stereometric properties. The influence of the PEO process voltage, treatment duration and electrolyte composition on selected statistical parameters determined from the current intensity recorded during the PEO process and selected 3D roughness parameters used to describe the surface stereometry of the produced coatings were considered. The obtained results allowed to propose mathematical models taking into account the influence of PEO process conditions, such as chemical composition of electrolytes and interelectrode voltage on the values of selected parameters of the random component of the current intensity recorded during the PEO process. For the statistical analysis of PEO current signals, after cutting off the constant component, the expected value, standard deviation, range and skewness were used. It was noticed that in electrolytes based on concentrated orthophosphoric acid, the Sdr parameter value (mean of the relative surface increase index) for the produced surfaces of porous coatings ranged from 5.2% (5% H_3PO_4) to 92,3% (85% H_3PO_4). The range value in the current signal recorded during the PEO process ranged from 0,06 mA (5% H_3PO_4) to 60,71 mA (85% H_3PO_4). It was also noticed that the addition of calcium nitrate (V) to both concentrated orthophosphoric acid (85%) and water resulted in the production of porous coatings with the Sdr parameter ranging from 0,04% to 163,7% ($Ca(NO_3)_2{\cdot}4H_2O$ + 85% H_3PO_4) and up to 4,9% to 125,9% ($Ca(NO_3)_2{\cdot}4H_2O$ + H_2O). The range value in the current signal ranged from 2,34 mA to 44,97 mA ($Ca(NO_3)_2{\cdot}4H_2O$ + 85% H_3PO_4) and from 0,98 mA to 49,42 mA ($Ca(NO_3)_2{\cdot}4H_2O$ + H_2O). It was also shown that increasing the voltage in the PEO process causes an increase in the surface development of the coatings and the appearance of high-current peaks in the PEO current signal.