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Optimization of Mechanical Properties for Pulsed Anodizing of Aluminum

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Abstract

Mechanical properties such as thickness, hardness, and wear resistance of an anodic oxide layer on aluminum must be high enough for industrial purposes. Due to burning phenomenon, hardness and wear resistance of anodic oxide layer decrease as the thickness of the layer increases. These properties of oxide layer fabricated by regular anodizing on aluminum in mixed sulfuric-oxalic acid electrolyte were optimized using pulsed currents. For this purpose, four variable response surface design (duty cycle, frequency, maximum and minimum current densities) was utilized. Desirability function was used to maximize thickness, microhardness and wear resistance of the anodic oxide layer. Wear resistance of the layer was measured by means of 'pin on disk' method according to ASTM G89 standard. The determined optimal anodizing conditions were: duty cycle= 65%, frequency= 326 Hz, i_{max}= 3.5 and i_{min}= 0.5 A/dm^2, while the corresponding estimated responses values were 170 µm, 526 $Hv_{0.1}$ and 2.12×10^{-7} g/N.m for thickness, microhardness, and wear rate, respectively. Frictional behavior of optimized pulsed, and direct current anodic oxide layers was discussed in terms of friction coefficient and examination of worn surfaces.

Keywords: Mechanical properties, Aluminum, Anodic oxide layer, Pulsed current, Direct current, Response surface.