Correlations between the Growth Mechanism and Corrosion Resistance of Plasma Electrolytic Oxidation Coatings on AZ31B Magnesium Alloy

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In the present work, plasma electrolytic oxidation (PEO) coatings with different microstructures were fabricated on AZ31B magnesium alloy. The thickness, morphology, phase composition and elemental distribution of the obtained coatings were characterized by X-ray diffraction (XRD), scanning electron microscopy (SEM), and energy dispersive spectroscopy (EDS). The corrosion behaviors of PEO coatings were measured by potentiodynamic polarization curves and electrochemical impedance spectroscopy (EIS). The results show that a composite dielectric coating is obtained with similar contents of MgO and MgF₂ (MgO-MgF₂ coating). During the discharge in the PEO process, by taking advantage of these two dielectrics' electrical performance and physical properties to influence dielectric breakdown, and utilizing the effect of blocking and heating in the two dielectrics, the molten materials ejected from the discharge channels decrease and more remains in the discharge channels; therefore, the thickness of the compact layer of the MgO-MgF₂ coating increases. Consequently, the coating thickness is approximately 3.5 μm, which is twice that of the coating with MgO as the main component (MgO coating). Furthermore, the results of electrochemical experiments demonstrate that the corrosion potential of the MgO-MgF₂ coating is 0.91 V larger than that of the MgO coating. As evaluated by EIS, the impedance of the inner compact layer is increased by more than 5 times from $7.652 \times 10^5 \Omega \cdot \text{cm}^2$ for the MgO coating to $4.933 \times 10^6 \Omega \cdot \text{cm}^2$ for the MgO-MgF₂ coating. These results indicate that the growth mechanism of the MgO-MgF₂ coating can increase the thickness of the compact layer and effectively improve the corrosion resistance.

Keywords: Dielectric breakdown; Dielectric constant; Compact layer; Growth mechanism; Corrosion resistance

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