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Microstructural characteristics of oxide layer formed by plasma electrolytic oxidation: nanocrystalline and amorphous structures

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Abstract

The present study investigated microstructural characteristics of the oxide layer grown on AZ91 Mg alloy via plasma electrolytic oxidation (PEO) in order to reveal the formation of nanocrystalline and amorphous structures in the inner and outer parts of the oxide layer. For this purpose, PEO process was carried out under an alternating current condition at 50 $mAcm^{-2}$ in a phosphate-based electrolyte. The morphology of the oxide layer exhibited a porous structure with surface roughness value of ~0.2 μm due to intense plasma discharges during PEO. The inner part of the oxide layer close to the substrate comprised mainly amorphous structure together with some crystalline grains of MgO. On the other hand, the outer part of the oxide layer was found to show nanocrystalline grains based on the analyses of the ring-like diffraction pattern. The nanocrystalline grains took place when the amorphous structure was subjected to the thermal energy from the plasma discharges between the electrolyte and oxide layer. The formation of different structures in the oxide layer was discussed in relation to discharge models in plasma electrolysis.

Keywords: Coating materials; electrochemical reactions; microstructure; oxidation; TEM