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Dual incorporation of SiO₂ and ZrO₂ nanoparticles into the oxide layer on 6061 Al alloy via plasma electrolytic oxidation: coating structure and corrosion properties

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Abstract

The present work investigated the influence of SiO₂ and ZrO₂ incorporated nanoparticles on the coating structure and the corrosion behavior of 6061 Al alloy coated by plasma electrolytic oxidation (PEO). To achieve this purpose, a set of PEO treatments were conducted in alternating current condition at a constant current density of 130 mAcm⁻² in phosphate electrolytes containing each and both nanoparticles, respectively. Microstructure observations revealed that when SiO₂ or/and ZrO₂ nanoparticles were added to the electrolyte, both size and fraction of micropores tended to be decreased, which would be attributed to the incorporation of nanoparticles. SiO₂ nanoparticles were preferentially embedded in the vicinity of micropores, meanwhile ZrO₂ nanoparticles preferentially filled the cracks. *m*-ZrO₂ was mostly converted to *o*-ZrO₂ while SiO₂ were partly converted to *o*-SiO₂ and another part to mullite. Based on potentiodynamic polarization tests in 3.5 wt.% NaCl solution, the coatings containing both SiO₂ and ZrO₂ nanoparticles exhibited excellent corrosion protection properties due to the combination of their roles as the micropores blocker and cracks filler so that the microstructural defects were minimized.

Keywords: Coating materials; Plasma electrolytic oxidation; SiO₂; ZrO₂; Corrosion resistance; Potentiodynamic polarization test

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