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# Dual incorporation of $SiO_2$ and $ZrO_2$ 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 $SiO_2$ and $ZrO_2$ 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 $SiO_2$ or/and $ZrO_2$ 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. $SiO_2$ nanoparticles were preferentially embedded in the vicinity of micropores, meanwhile $ZrO_2$ nanoparticles preferentially filled the cracks. *m*-$ZrO_2$ was mostly converted to *o*-$ZrO_2$ while $SiO_2$ were partly converted to *o*-$SiO_2$ and another part to mullite. Based on potentiodynamic polarization tests in 3.5 wt.% NaCl solution, the coatings containing both $SiO_2$ and $ZrO_2$ 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; $SiO_2$; $ZrO_2$; Corrosion resistance; Potentiodynamic polarization test