The preparation and characterization of a nano-CeO2/phosphate composite coating on magnesium alloy AZ91D

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The preparation and characterization of a nano-CeO_2/phosphate composite coating on magnesium alloy AZ91D

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Abstract: A nano-CeO_2 modified phosphate composite coating was prepared on magnesium alloy AZ91D by chemical conversion. The nano-CeO_2/phosphate composite coating was composed of $Zn_3(PO_4)_2 \cdot 4H_2O$, $Zn_2Mg(PO_4)_2$ and CeO_2, with less mud-cracks and pores. With nano-CeO_2 modification, the corrosion resistance and the mechanical performance of the nano-CeO_2/phosphate composite coating were improved significantly compared with those of the single phosphate coating. The coating resistance and the corrosion current density for the composite coated alloy were respectively larger and lower than those for the single phosphated alloy, particularly for the alloy with the composite coating containing 1.02 wt.% CeO_2, which was formed in the treatment bath containing 2.0 g/L nano-CeO_2. The adhesive force and the micro-hardness of the nano-CeO_2/phosphate composite coating were higher than those of the single phosphate coating. The mechanism of nano-CeO_2 modification on the electrochemical and physical properties was very closely associated with the effects of nano-CeO_2 particles on the grain refinement and the dispersion strengthening.

Keywords: Phosphate coating; Magnesium alloy; Chemical conversion; Nano-CeO_2; Corrosion resistance

1. Introduction

Magnesium alloys are applied in the industrial fields of aerospace, aircraft and automobile widely due to their attractive combination on low density, good conductivity, high strength to weight ratio and so on, and the modification of commercial magnesium alloys and the development of novel magnesium alloys are focused on by scientists and engineers recently [1-3]. However, the natural oxide film on the surface of magnesium alloys is thin, porous and inhomogeneous, resulting in that the film cannot provide good corrosion resistance for the alloy substrate [4]. Corrosion-resistant conversion coatings are one of the most common and universal surface protection techniques for metal engineering materials, especially for carbon steels [5] and magnesium alloys [6]. Chen and Birbilis et al. [7] reviewed the various conversion coatings on the surface of magnesium and its alloys in detail, such as chromate coatings, phosphate coatings, fluoride coatings, stannate coatings, rare earth coatings and other conversion coatings. It is