The Structure and Growth Mechanism of Phosphate Conversion Coatings on AZ91D Magnesium Alloy

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ABSTRACT

In this study, AZ91D magnesium alloy is selected as experimental material. Meanwhile, choose zinc phosphate and sodium phosphate conversion solutions to process the experiment. The operating parameters studied included the solution temperature and immersion time. Using SEM, EDS and XRD to observe the surface morphology and analyze the chemical composition of coatings. At the same time, not only measure the thickness and weight of coatings, but examine the adhesives strength and corrosion resistance of conversion coatings by adhesion test and polarization test. From experimental results shown that the zinc phosphate coating contains two layers which including the upper crystalline layer and the lower cracking layer. However, for the sodium phosphate conversion coating, the coating is belong a non-crystalline layer which appear full of cracks and bulk area. The thickness、bulk area and cracks become larger and wider with increasing immersion time. In the aspect of shear strength of coatings, the test of zinc phosphate coating only can obtain the strength between layers, and the value of strength is not quite good. The components of zinc phosphate coating is formed by Zn3(PO4)2． 4H2O and AlPO4, which analyzed by EDS and XRD. The Zn3(PO4)2 is the major form of compound at the upper crystalline layer. And the components of sodium phosphate coatings is form by AlPO4 and Mg. The test of polarization did show both the zinc phosphate and sodium phosphate coatings can improve the corrosion resistance of the AZ91D magnesium alloy. Comparing the relationship between thickness of coatings and their corrosion current density, we can figure out the capability of resistance from upper crystalline layer is much weaker than the lower cracking layer. We also believed that the main factors determined the corrosion resistance are the thickness of coating, the width of cracks, and the quantity of cracks. Therefore, how to equalize these three factors to obtain the best corrosion resistance are the major concerns. The best operating parameters for zinc phosphate coating is at 45°C solution temperature and 25 minutes immersion time. If immersion time further increased which will result in the corrosion resistance decreased, the main reason is due to the wideness of cracks in the lower cracking layer increased. While, in sodium phosphate conversion coatings, the thicker the thickness of coating, the performance of corrosion resistance is better, and the best corrosion resistance parameters is under 70°C and 30 minutes immersion time. Although the performance of corrosion resistance in phosphate conversion coatings is not good as the chromate and vanadate coatings. But these results still can offer a good reference for future study. Hopefully, the researchers can toward the goal of non-chromate coating developing for better anti-corrosive result together.

Keywords : AZ91D Magnesium Alloy, Zinc Phosphate Conversion Treatment, Sodium Phosphate Conversion Treatment, Growth Mechanism, Polarization Curve, Corrosion Current Density.

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