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The Effect of Pure Aluminum Cold Spray Coating on Corrosion and Corrosion Fatigue of Magnesium (3% Al- 1% Zn) Extrusion

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ABSTRACT

Pure aluminum powder was successfully sprayed on AZ31B extrusion flat and round coupons at low temperature. The corrosion and corrosion fatigue behavior of the coated and uncoated samples were examined by performing accelerated corrosion tests. The corrosion resistance of AZ31B samples with and without coating was investigated based on ASTM B117 standard salt spray with a concentration of 5% NaCl at 36°C, 100% relative humidity. The corrosion fatigue of bare and coated round samples was examined by producing a thin film of 3.5% NaCl solution on the surface of the fatigue samples via integrating a corrosion chamber into a rotating bending fatigue testing machine. Pure Al coating provided significant corrosion protection for AZ31B in 5% NaCl fog environment by improving its corrosion resistance from 90% average weight loss in 33 days for bare samples to less than 10% average weight loss in 90 days of continuous corrosion cycles. However, pure Al coating did not improve the corrosion fatigue strength of magnesium and samples with and without coating showed similar corrosion fatigue trends. Test results in salt solution showed fatigue life reduction of 88% when compared with test results in air. The microstructure examination of samples failed under cyclic load showed early cracking of Al coat which allowed the electrolyte penetration into Mg substrate creating a localized corrosion and premature failure. The early cracking was attributed to the lower fatigue strength of pure Al compared to AZ31B.

Keywords: Cold Spray, Pure Aluminum, AZ31B extrusion, Corrosion, Corrosion Fatigue.

1. Introduction

The low density of magnesium (Mg) and its alloys (1.74 g/cm^{-3}) which is two thirds of aluminum (Al) and one-fourth of steel densities[1], as well as their excellent specific strength, and machinability properties make them attractive candidates for structural lightweighting applications. The most prolific users of Mg are transportation industries like automotive and aerospace in which structural weight reduction is at the forefront of their design innovations. Magnesium, however, is one of the most electrochemically reactive materials and is therefore susceptible to corrosion in humid and aqueous environments. For this reason, the applications for Mg and its alloys have been limited [2-6]. The main benefit

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