Investigation of Cathodic Properties of Mg-Rich Primers for Protection of AA2024-T3

D. Battocchi [1,2], Kerry Allahar,[2]Nick Richter[2], G.P. Bierwagen[1,2], , Scott Hayes[3]

[1]Center for Surface Protection
North Dakota State University, Fargo, ND 58105, USA

[2]Coatings and Polymeric Materials Department
North Dakota State University, Fargo, ND 58105, USA.

[3]Akzo Nobel Aircraft Coatings, Waukegan IL, USA

Aluminum alloy 2024-T3 has good mechanical properties but is susceptible to corrosion. The Magnesium rich primers is a viable chromate replacement for protection of the alloy and its behavior was described elsewhere.[1] The mechanism of protection is still not fully understood and is under investigation, but is is believed that the Mg-primer provides cathodic protection, along with some other means.[2] This investigation is to characterize the cathodic or sacrificial mechanism during the protection of the aluminum alloy. This was done by placing a barrier layer between the metal substrate and the magnesium rich primer to stop electrical connection between the two conductive layers. The set up was repeated in a chromate rich primer over the same aluminum alloy. The properties were tested using electrochemical techniques including electrochemical impedance spectroscopy and open circuit potential.

Results and Discussion

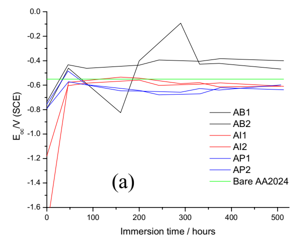
A Mg-rich primer consisting of a 20 µm average sized Mg particulate in an epoxy binder, with a 45% pigment volume concentration, was applied to AA 2024-T3 panels. The panels were topcoated and exposed to accelerated testing in B117 and constant immersion.. Three-electrode EIS measurements were performed with a saturated calomel electrode as the reference. The evolutions of the open circuit potential, E_{OC}, and the impedance modulus at 0.01 Hz, $|Z|_{0.01Hz}$, are shown in Fig. 1.

The open circuit potential (OCP) results show that the insulating layer stopped the cathodic protection of the substrate and the degradation of the coating is due to the degradation of the Mg layer by itself. The non-insulated sample showed a mixed potential lower than the alloy between that of magnesium and the aluminum alloy, as expected and as recorded in previous experiments, indicating that there is cathodic protection provided to the metal substrate by the coating system.[3]

The electrochemical impedance spectroscopy (EIS) showed the insulated sample and the blank control to have similar properties. The non-insulated sample had a lower impedance then the others which is expected due to the metal pigments allowing for electrolyte penetration but had superior corrosion protection. The phase angle shows the insulated and blank controls to have the same mechanism while the non-insulated sample shows a different mechanism.

This study shows that magnesium rich primers confirms the evidences of cathodic protection provides by the magnesium rich primer as a sacrificial coating. The behavior of this metal rich primer was modeled in previous publications.[4,5]

The chromated samples, insulated and non-insulated, both had similar properties to each other which is expected due to the leaching of the chromates from the primer.



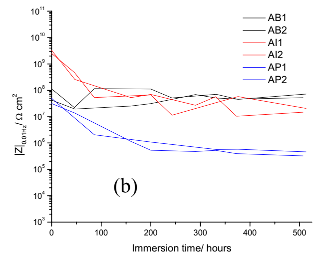


Fig. 1. Evolutions of (a) the open circuit potential, E_{OC}, and (b) the low frequency modulus, $|Z|_{0.01Hz}$,

References

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