

Effect of Stannate Post-sealing Treatment on the Corrosion Characteristics of As-anodized AZ31 Mg alloy

Y. I. Choi*, S. Salman, K. Kuroda, M. Okido

Department of Materials Science and Engineering,
Graduate School of Engineering, Nagoya University,
Furo-cho, Chikusa-ku, Nagoya 464-8603, Japan

The world has seen rapid growth in demand for Mg alloys during last one decade in diverse lightweight applications such as electronics, modern automotive and aerospace industries. However, the applications are still restricted due to its extremely negative equilibrium potential and high corrosion susceptibility in chloride-containing neutral environments. This study examined the effect of stannate post-sealing on the surface morphology and resultant electrochemical characteristics of anodized AZ31 alloy. AZ31 coupons were anodized at 10 V_{Ag/AgCl} for 10 min in 2 M NaOH solution at 25 °C and, subsequently immersed in 0.4 M sodium stannate 3-hydrate (Na₂SnO₃·3H₂O) at 75 °C under stirring. After the stannate sealing-treatment for 10 min, the open pores which commonly found on the anodized coating were completely filled up and further leveled by the SnO₂ layer. The post-treatment solution supersaturated with oxide at high temperature seems to contribute to the nucleation and growth of SnO₂ on the anodized Mg alloy. This SnO₂ superficial layer was making up approximately 30 % of total coating thickness and was occupying void space within the porous coating. With the surface sealing, the stannate post-treated coating was controlled by the mass transport impedance with the restricted linear diffusion upon initial immersion, thereby displaying the ideally capacitive dispersion at low frequency. This is attributed to the extremely small charge leakage at the interface of coating/electrolyte, thereby achieving the slow corrosion rate in the NaCl environment. Hence, the post-treated sample exhibited 100 fold higher R_p during the initial immersion, and was 3 fold higher even after 24 h. Interestingly, the cathodic currents maintained almost zero during the potentiodynamic test and were independent of the cathodic overpotential. This phenomenon can account for the compensation of electric double-layer charging current in the electrochemical cell, thereby resulting in the infinite R_{cp} . Consequently, the stannate post-treatment afforded a higher corrosion potential E_{corr} and pitting potential E_{pit} than the anodized samples.

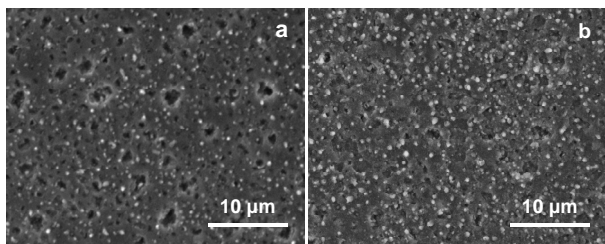


Fig. 1. Surface morphology of the (a) as-anodized coating and (b) stannated post-treated coating.

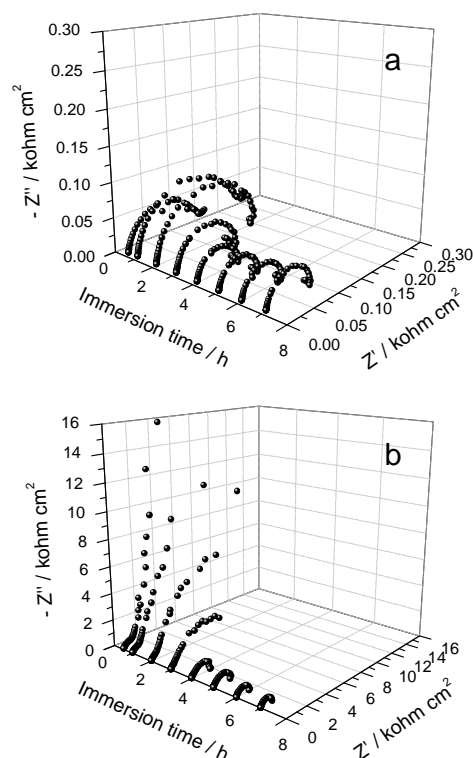


Fig. 2. Changes in Nyquist plots of the (a) anodized coating, and (b) stannate post-treated coating in 0.1 M NaCl solution.

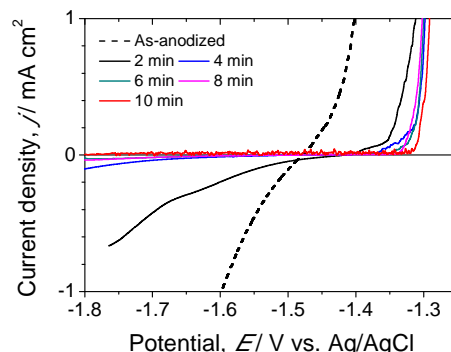


Fig. 3. Change in polarization behaviors of the as-anodized coating with the stannate post-treatment.