마그네슘-알루미늄 합금의 화성처리 공정 개발과 그 내식성 평가

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Development of chemical conversion coating process for Mg-Al alloy and its anti-corrosion property

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Abstract : The chemical conversion coating formed on magnesium alloy investigated for low cost and harmless in environment by using the colloidal silica as the main component. The film formed in 298 K is thick, the film, which was thought combination of Si-O, was formed. The film formed in 313 K is thinner than that in 298 K. The quantity of film formed at high temperature such as 333 K and 353 K is smaller than dissolved quantity. At the anodic polarization experiment, corrosion resistance in sealing by hot water after chemical conversion treatment in basic solution condition get worse than that in comparison with basic solution condition. In salt spray test, the ratio of black rust on specimen that did not conducted chemical conversion treatment was five times or more compared with those of chemical conversion treated specimen. The film thickness of chemical conversion coating produced by alkali treatment process is thinner than in comparison with that of specimen produced in basic chemical conversion treatment solution condition. It is thought, however, that it showed good corrosion resistance during salt spray test because the area of microcracks is small.

Key words : chemical conversion coating, magnesium alloy, anodic polarization experiment, salt spray test, alkali treatment

1. Introduction

Recently, demand of light metals for lightweight of automobile, cellar phone etc was increased. In order to improve the strength and casting characteristic of magnesium and aluminum, the other metal element should is added abundantly. Surface treatment is necessary since corrosion resistance is poor. Chromate chemical conversion coating was used from past 50 years or more as a surface treatment method of Mg-Al alloy etc because it has the superior corrosion resistance property. However, it was appointed to the carcinogenesis substance of class 1 at the pollutant release and transfer register (the PRTR)[1]. Metal finishing of Zn electroplating in order to improve corrosion resistance hasbeen used as a surface treatment of magnesium and aluminum die-cast materials. Influence to the automobile, the home appliance product, the machine metal product manufacturing industry becomes large. The regulation to the chrome, especially Cr^{+6}, have become strict ones. In Europe, using of the lead, mercury, cadmium and Cr^{+6} for the electric electronic product were prohibited. The plan for waste electric electronic equipment collection (the WEEE) was announced in June of 2000. Using of the $Cr^{+6}$was in prohibited until 2007 years, gradually[2]. In addition, order of the ELV about using restriction for the environmental load substance gradually starts from July of 2003. Using of the Cr^{+6} is prohibited from the July of 2007 at automobile industry[3]. Therefore, it has aimed toward the chrome free conversion, which does not use Cr^{+6}[4-7]. Regarding the domestic electric product, the guidance like automobile at present time is not announced. However, the consideration to environment, the removal of carcinogenesis and the harmful matter become very important matter. Regarding home appliance industry, the result of the lead free conversion during soldering of alloy was advanced favorably, interest has moved to counterplans regarding alternative of Cr^{+6}. Therefore, in this study, to develop of chemical conversion coating method of the non chrome type which does not use Cr^{+6} investigated with thinking of the safety aspect, recycling, cost, and the environmental aspect, comprehensively with extremely simple operation.

2. Experimental Section

The specimens used in this experiment were AZ91D and AZ31B. Specimen for chemical conversion treatment was mounted with epoxy resin, except for an exposed area of 1 cm^2, and polished with No. 2000 emery paper. The specimens were carefully degreased with acetone and water. Then, acid activation was executed in 2 mass % HNO_3 at 298 K for 5 s. The basic chemical conversion solution contains 200 mM colloidal silica (Nissan Chemical Industries, Ltd., Snowed) with 10 - 20 nm SiO_2 particles, 4.2 mM $Ti(SO_4)_2$, 1.8 mM $CoSO_4$, and 4.2 mM $C_2H_4(COOH)_2$. The solution pH was adjusted to 2 with HNO_3. Each specimen was rinsed with water after activation. The chemical conversion films formed on

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the specimens were dried at 353 K for 5 min. This solution is defined as basic chemical conversion treatment solution. In addition, process by activation, alkaline treatment, and hot water after chemical conversion treatment in basic solution were conducted. The electrochemical system consisted of a Pt coil as a counter electrode, and an Ag/AgCl sat. KCl reference electrode. The anodic polarization curve was measured to characterize the corrosion properties of the chemical conversion treatment film using a potentiostat with a scan rate of 1mV/s in 0.1M NaCl and 0.1M Na_2SO_4 solution at 298K. In addition, the salt spray test (SST) was carried out at a spray rate of 1.5±0.5 ml/(hr·80cm^2) using 50±5 g/L NaCl at 308±1 K. The surface of the coated film was observed by scanning electron microscopy (SEM), and analyzed by energy dispersive spectroscopy (EDS), X-ray diffraction (XRD) and Fourier-transform-IR spectroscopy (FT-IR).

3. Conclusions

The film formed in 298 K is thick; the film that was thought combination of Si-O was formed. The quantity of film formed at high temperature such as 333 K and 353 K is smaller than that of film dissolved. It is suggested that the dissolution of magnesium and formation of film in 298 K became good balance. At the anodic polarization experiment, corrosion resistance in sealing by hot water after chemical conversion treatment in basic condition get worse than that in comparison with basic condition. The ratio of black rust of specimen, which did not conduct chemical conversion treatment in salt spray test, was five times or more compared with those of chemical conversion treated specimen. The film thickness of chemical conversion coating produced by alkali treatment process is thinner than in comparison with that of specimen produced in basic chemical conversion treatment solution condition. It is thought, however, that it showed good corrosion resistance during salt spray test because the area of microcracks is small. The corrosion resistance by chemical conversion treatment in also AZ31B was improved.

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