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New Surface Treatment Process in Magnesium Alloy for Wheelchair

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Abstract One of the most important characteristics of Mg alloys is the high ratio of strength to weight. This is why there is a high demand for applications with these alloys in the transportation industries to reduce the fuel consumption and to save energy. In addition, magnesium (and its alloys) is of considerable interest as a structural material, especially in the aerospace and automotive industries thanks to its low density. However, its major drawback is its high sensitivity to corrosion. Therefore, its use requires the application of a surface treatment.This study used a die-casted AZ91D Mg alloyand all the samples were annealed (in 120 °C). The surface microstructure and phase distribution in thin-walled AZ91D magnesium components cast on a hot-chamber die-casting machine were investigated by optical microscopy and scanning electron microscopy. The reflectance differences in the bulk state comparison with the annealing state are caused by hydrogenation presence of the Mg layer under an oxidation surface layer.

Key words magnesium, wheelchair, surface treatment, AZ91D, die-casting.

1. Introduction

Electric wheelchair, manual wheelchair workforce by driving the wheels and wheel drive powertrain that can be divided. Also, Rear wheels on both sides of the rear frame of the wheelchair drive wheels on both sides of the room, and install the leading edge of the frame on both sides, install the front wheel, or move the installation is easy.

AZ91D magnesium alloy, which has better mechanical properties and excellent casting properties, is one kind of die-casting magnesium alloy with great application potential. Many studies have shown that, alloying is a useful means of improving the performance of AZ91D magnesium alloy, in which rare earth's function such as refining structures, solid solution strengthening and dispersion strengthening have been widely recognized. AZ91D magnesium alloy belongs to an aging alloy, so aging heat treatment is also an effective way to improve the performance of AZ91D magnesium alloy. A number of advanced surface treatments have been developed for magnesium to enhance corrosion and wear performance, including chemical conversion coatings, laser surface treatment, electroplating and physical vapor deposition(PVD) coatings, but all of them have their particular limitations. Plasma electrolytic oxidation (PEO) is a novel surface engineering technology, which involves the creation of plasma discharges around a metal component immersed in an environmentally friendly electrolyte, has been used to rapidly and economically produce oxide coatings on magnesium alloy components of almost any shape and size.

The necessity to the high stiffness to weight ratio makes AZ91(magnesium-aluminum-zinc alloy) one of the most attractive alloys in the automotive industry. The relatively poor corrosion resistance of this alloy is, however, the main barrier in its extensive utilization. The low corrosion resistance of the magnesium alloys generally originates from the galvanic attack by Fe, Cu and Ni based impurities. The resulting microstructure of AZ91 has been reported also to have significant influence on the corrosion behavior of this alloy. It is agreed that b-phase(Mg17Al12), precipitates on the grain boundaries, acts as corrosion barrier.

Magnesium and its alloys, which have long been regarded as good candidate materials for electronic applications, have been used in a variety of engineering fields due to their abilities to exhibit the lowest densities among metals and high specific strength. In spite of their good mechanical properties, these alloys are prone to corrosion especially under a corrosive environment, thus restricting their appli-

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cations. To enhance the corrosion resistance, several surface treatments such as electrochemical plating, conversion coating, etc, have been widely used to apply a coating layer that improves the surface properties of the magnesium alloys. Even with such efforts, however, technical problems arising from complex manufacturing processes, low production rates, and waste disposal remain unsolved. As such, it is necessary to introduce an advanced surface treatment in order to overcome these issues.

Mg alloy is expected that applications, in particular involving motion or portability of the component, will increase in the future because of the material's high strength-to-weight ratio and a relatively high stiffness.[1-2] Magnesium and its alloys are increasingly implemented into a number of components where weight reduction is of great concern. However, the poor corrosion resistance of Mg and its alloys has limited their applications in corrosive environments.[3-5] Recently, the creep behavior of AZ91 Mg-alloy has attracted much attention due to its useful value in practice. However, the conventional AZ91D magnesium alloy has a relatively low resistance to creep at elevated temperatures in contrast to Al-alloy, which has restricted the development of Mg-alloy. And Magnesium alloys have many good properties which make them ideal materials in a number of applications. However, poor corrosion resistance and high chemical reactivity have hindered the wide applications of magnesium alloys. Therefore, surface treatment is necessary to improve the corrosion resistance of magnesium alloys. In this investigation, the effects of annealing and burning in die-cast AZ91D Mg alloy by treatment($CH_3OH + CH_3COCH_3 + NaBr$ rate-spray Mg alloy surface) were studied.

2. Experimental Procedure

Modulation spectroscopy is an important technique for the study and characterization of semiconductor thin films and heterostructures. Techniques such as contactless electroreflectance(CER) and reflectance(RE) are very useful in probing the characteristic of the metal and semiconductor since they measured the differential reflectance change and are sensitive to surface or interface electric fields. It is a particularly useful technique to probe the band structure of the semiconductors when the conventional technique such as photoluminescence is not useable because of the bad sample quality. Because it is contactless, CER requires no special mounting of sample, and can be performed in a variety of transparent ambiance. In the CER measurement, the sample is placed between two capacitor plates. The size of the spacer is such that there is a very thin layer of air between the front surface of the sample and the conducting part of the first electrode. There is nothing in direct contact with the front surface of the sample. The CER spectra as a function of photon energy can be fitted using a famil,iar Aspnes derivative function in the, low electric field limit[6,7]

$$\frac{\Delta R}{R} = \mathrm{Re}\sum_{j=1}^{p} C_j e^{i\theta_j}(E - E_{gi} = i\Gamma_j)^{-n} \quad (1)$$

Here R is reflectance, ΔR is the induced change in the reflectance by modulation light, E is the photon energy, p is the total number of spectral structures to be fitted. Egj ; Γj ; Cj, and θ_j are the transition energy, broadening parameter, amplitude and phase of the j th feature corresponding to a critical point, respectively.

The research works were performed on the specimens of magnesium alloy AZ91D, the chemical compositions are: Al 8.0-8.7%, Zn 0.45-0.7%, Mn 0.12-0.35%, Si < 0.05%, Cu < 0.035%, Fe < 0.004%, Ni < 0.001%, others < 0.01%, balance Mg. And the performance of the phosphate conversion coatings is dependent on the crystal structure as well as the morphology. For example, a microcrystalline structure is usually optimal for corrosion resistance or subsequent painting. A coarse grain structure impregnated with oil, however, may be the most desirable for wear resistance. These properties can be tailored by selecting the appropriate phosphate solution, using various additives, and controlling bath temperature, pH, ion concentration, and phosphating time. As a result, this prompts further questions regarding the experimental conditions, such as bath temperature and pH, amenable for the synthesis of stable low-valence Mn-PO_4 coatings on Mg alloys and a study of their corrosion resistance.

The AZ91D specimens were cut into pieces of $15 \times 25 \times 4$ mm. Die-casted AZ91D Mg alloy was used. The 2-mm thick as-cast plate was cut into square samples each with a dimension of $2 \times 2\ cm^2$. All samples were annealing(in 120 °C) and then burning in the $CH_3OH + CH_3COCH_3$ NaBr rate(a-annealing: 2:3:0.5, b-annealing: 1:3:0.5). After annealing, the surface morphology was examined by a Hitachi S4200 scanning electron microscope (SEM).

3. Results and Discussion

Magnesium alloys possess low density, high durability and can be easily processed; they can therefore successfully compete with steel and aluminum alloys in automotive, aerospace and defense industries, as well as in production of personal computers and mobile communication devices. Their main disadvantage however is in their low corrosion and wear resistance. Due to a high affinity to oxygen, the surface of magnesium is always covered by a native oxide film of magnesia.

The annealing environment was carried out in 120 °C Fig. 1 shows the optical reflectance spectra of an oxi-

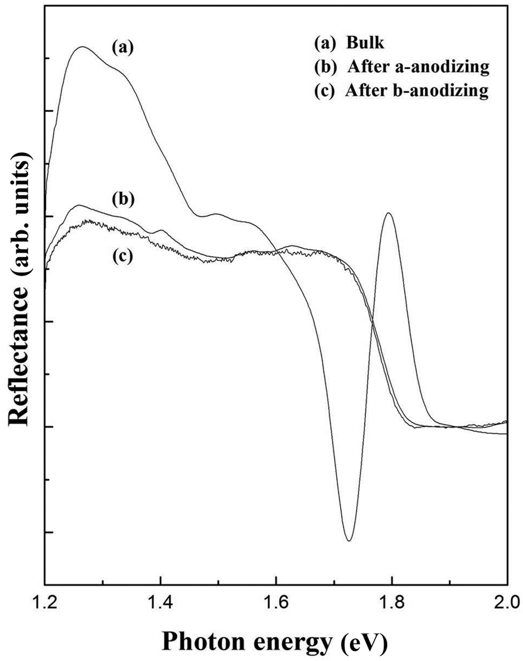

Fig. 1. The optical reflectance spectra of an oxidation layer in the bulk state and after annealing.

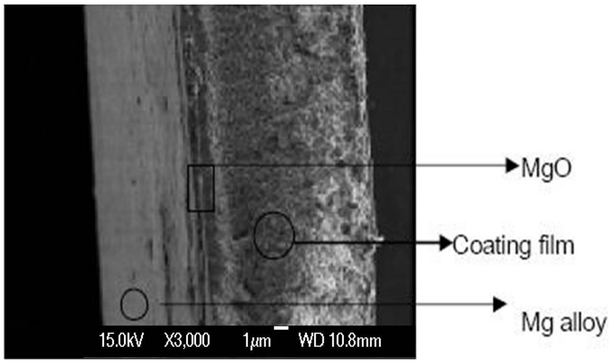

Fig. 2. Cross-section micrographs of AZ91D Mg alloy after annealing(in 120 °C) in a $CH_3OH + CH_3COCH_3 + NaBr$(1:3:0.5).

dation layer in the bulk state and after annealing. A large reflectance change is observed in the photon energy range from 1.71 to 1.85 eV. The amount of change is maximum at 1.71 eV. The decrease of photon energy, the relative change increases gradually. The reflectance amplitude is minimum in the low photon energy region around 1.85 eV. The bulk state and after annealing state reflectance differences are caused by hydrogenation presence of the Mg layer under oxidation surface layer. The shape of hydrogenation presence's reflectance shows a-annealing and b-annealing samples in the Fig. 1. This large reflectance change means that a considerable amount of MgH_2 is formed in the Mg layer under oxidation surface layer.

Fig. 2 shows SEM micrographs in Mg alloy by burning treatment($CH_3OH + CH_3COCH_3 + NaBr$; 1:3:0.5). Where, the shows some evidence for the occurrence of MgO.[8)]

And The addition of NaBr induces strong adsorption of gemini surfactant 12-s-12 containing a long and flexible spacer chain at the air/water interface, resulting in the formation of the double layers with the core-shell structure in the sub phase below the main adsorption layer. The immunity region for Mg is located at very low potential regions, and both Mg^+ and Mg^{2+} ions appear to be the dissolution products below pH 11. At and above pH 11, the formation of $Mg(OH)_2$ could be expected on the metallic Mg surface.

The Reflectance spectra for Mg alloy bulk and annealing treatment samples are shown in Fig. 3(a, b, c). the oxidation state of surface can suppose, That was grown to do uniform if form of spectrum is clean. The results indicated strongly effect on the uniform thickness of the oxidation.[9)]

On the basis of the data reported by the present authors, dehydration of $Mg(OH)_2$ to induce MgO by subsequent annealing was desirable for enhancing the anti-corrosion properties of AZ91 magnesium alloy.

And thermal stresses produced at the Mg sub/MgO Coating sample interface are accommodated by the formation of top coating zones. The dislocation density can increase only up to the moment when the top coating zones in the matrix begin to overlap.

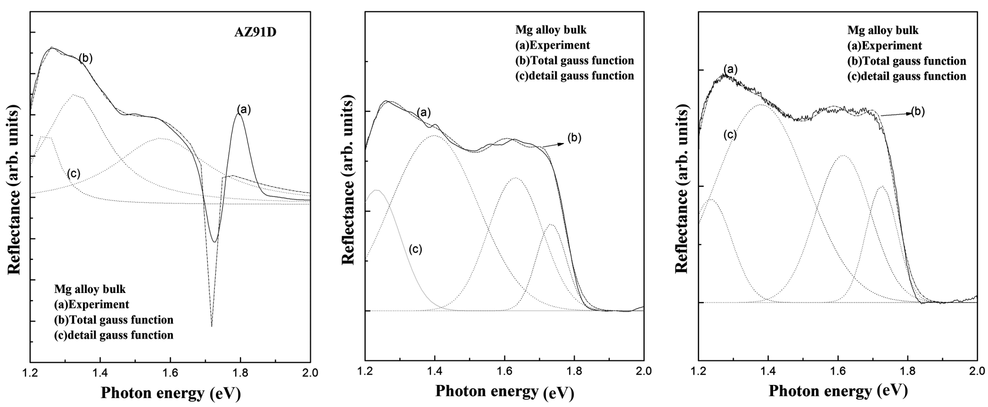

Fig. 3. The reflectance spectra in the bulk state and treatment state by annealing(a : Mg alloy bulk, b : after a-annealing c : After b-annealing).

4. Conclusion

A large reflectance change is observed in the photon energy range from 1.71 to 1.85 eV. The reflectance amplitude is minimum in the low photon energy region around 1.85 eV. The bulk state and after annealing state reflectance differences are caused by hydrogenation presence of the Mg layer under oxidation surface layer. And from SEM results, a $CH_3OH + CH_3COCH_3 + NaBr$ rate is main point in the surface treatment. In general, the magnesium hydride, MgH_2, is made by a chemical reaction of Mg with hydrogen under 573-673 K and 24-400 atm. the covalent interaction of an adjacent Mg to M with a H atom around it would be sensitive to the substitution of M. It is also found hat in $Mg(M)H_2$ some weaker hydride forming elements than Mg would form a little stronger bonds with hydrogen than Mg-H ond in MgH_2. This large reflectance change means that a considerable amount of MgH_2 is formed in the Mg layer under oxidation surface layer.

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