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# Effect of Microstructure on Corrosion behaviour of Magnesium Alloys

*Abhinav Sharma[1], Shri Krishna Mishra[2], Rahul Kumar[3], Dr. Neeraj Kumar[4]*
*[1]M.Tech Scholar, Department of Mechanical Engineering*
*[2 3]Assistant Professor, Department of Mechanical Engineering*
*[4]Professor, Department of Mechanical Engineering*
*Suresh Gyan Vihar University, Jaipur, India*

*shinyabhinav1@gmail.com*

***Abstract***

Magnesium is a highly common metal that can be alloyed with a variety of other elements. Fabrication and formability in engineering metallurgy is an extremely essential topic of debate for those working in the field of product development. A spot analysis approach is used in this paper to investigate the Corrosion over the casted rim of magnesium alloys on the micro scale. The results are presented in this paper. Sets of specimens are cut into little pieces and transported to the laboratory for final examination. The tensile strength and hardness of the weld connection will be determined over the specimen/casted rim using an optical microscope and an ultrasonic testing machine. Various improved measures have been used to improve the quality of welded joints as well as the strength of the weld.

*Keywords*— Microstructure, corrosion, Magnesium alloys, SEM Test.

## I. INTRODUCTION

The high specific stiffness of magnesium alloys, as well as their outstanding damping qualities, allow them to perform at levels demanded by the automobile industry. magnesium and its alloys, which are the eighth most abundant element in the Earth's crust, are good candidates for a wide range of applications, including medical devices, because of their intrinsic properties such as high electrical and thermal conductivity (for example, in portable laptops), good electromagnetic shielding (for example, in mobile phone casings), dimensional stability, machine ability, and recyclability.

This encompasses technologies such as home utensils, electronic devices, and biomaterials. While economically pure magnesium is rarely utilised, magnesium alloys are frequently used in a variety of applications. Magnesium aluminium alloys (Mg Al alloys) are the most widely used type of alloys due to their advantageous mechanical and casting qualities. Fig. 1 shows the relationship for a reversible metal by Butler Volmer & Tafel Relation and table 1 shows the allowing having corrosion rate.

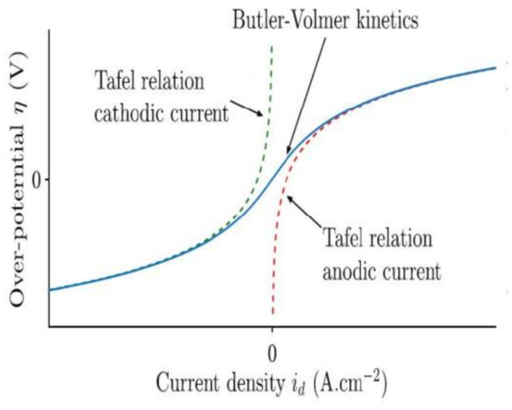


Fig. 1 Relationship for a reversible metal by Butler Volmer & Tafel Relation

*Corresponding author: Abhinav Sharma, Department of Mechanical Engineering, Suresh Gyan Vihar University, Jaipur*
*E-mail address: shinyabhinav1@gmail.com*

There are four primary categories in which implementation functions may be categorized: -

- Automotive body and chassis applications
- Propeller shaft & blades of Aeroplanes.
- Ships external body parts for the corrosion protection.
- To replace body components that have been injured, sick, or worn out (e.g., arthritic joints, spine curvature etc.)

TABLE I
ALLOYS HAVING CORROSION RATES

| Corrosion Rates | Medium | Method |
|---|---|---|
| AZ80 > AZ91 > AZ3 | NaCl | EIS |
| AM60 > AZ31 | NaCl | Weight Loss |
| AZ91 > AM50 | Na2SO4 | EIS |
| Pure Mg > AZ91 > ZE41 | NaCl | Weight Loss, Hydrogen |
| AZ 31 > AZ 61 > AP 65 > Mg | Mg (ClO4)2 | EIS |
| ZK31 = WE54 > EZ33 | NaCl + NaOH | Electrochemical |
| ZK60 > AM60 > AZ31 > AZ91 | NaCl | EIS |

The purpose of this research is to better understand the corrosion of magnesium and magnesium alloys in the presence of oxygen. When exposed to dry air, the surface film that forms on magnesium is believed to be protective; nevertheless, when exposed to excessive humidity, magnesium and its alloys corrode. First, it is crucial to comprehend the Mg surface coating's protective state in order to grasp the transition to its non-protective state and identify the properties of this film. Current corrosion protection for cold rolled steel, galvanized steel, and aluminium alloys used in automobile body and chassis applications is provided by phosphate conversion coatings (PCCs), which are applied using a phosphate solution. Magnesium, on the other hand, is still constrained by the high costs of mining, which make the metal approximately 20% more expensive than aluminium. Most magnesium is used in aluminium alloys, which are highly sought after because of their strength, light weight and resistance to sparking properties. Because of their high strength, low weight, and spark resistance, these alloys are commonly employed in automobile components.

Zeng et al. [1] Corrosion fatigue (CF) and stress corrosion cracking (SCC) were also explored.

Velikokhatnyi and Kumta [2] The corrosion characteristics of AZ91D weld material were studied, and a mechanism for pitting corrosion produced by AL Mn particles was hypothesized. In order to lower the amount of iron in the molten metal, manganese is often added by the manufacturers.

Birbilis et al. [3] The coating must adhere well on magnesium for it to be effective. Magnesium has superior corrosion resistance, good toughness, environmental friendliness, and better fatigue and wear resistance than most other metals.

Hamu et al. [4] the aforementioned approach was used to evaluate the properties of the oxide films produced on the molten magnesium in this investigation. A quartz tube with an internal diameter of 1 mm was used to release the air bubbles into the cast sample at a pressure of 0.2 atm.

Xin et al. [5] an oxide film's thickness may be estimated using two alternative techniques, including determining its thickness by measuring its folds' width. The oxide coatings were porous and rough on the microscopic scale.

Shin et al. [6] Because of the non-protective nature of oxide coatings, this has been blamed. Oxide films produced on pure molten magnesium under dynamic circumstances are crystallised MgO, according to XRD patterns.

Song [7] Microstructural factors like as composition, grain size, and precipitations have not been quantified in relation to corrosion rate. In order to forecast corrosion rates, a novel model was constructed using microstructural features.

Pu et al [8] According to this concept, materials with ultra-fine grains, alloying compounds with minimal Volta-potential differences compared to the matrix, and a low proportion of secondary phase may achieve extremely low corrosion rates. Temperatures ranged from ambient temperature to 350 °C throughout the tests. Scanning electron microscopy was used to investigate the microscopic structure of the sample with increasing deformation temperature, twinning decreased in importance and the LPSO phase's kinking grew more apparent.

Cha et al [10] there were no LPSO phase fractures or deboning at the LPSO phase/Mg matrix contact at temperatures greater than 200 °C. Deformation of the alloy was mostly caused by dynamic recrystallization of Mg matrix at 350°C due to loss of strengthening effect from LPSO phase.

*Corresponding author: Abhinav Sharma, Department of Mechanical Engineering, Suresh Gyan Vihar University, Jaipur*
*E-mail address: shinyabhinav1@gmail.com*

## II. Gap Analysis

- The grain size of a material is a critical component in determining its mechanical characteristics and corrosion behaviour.
- The Cr process generates poisonous solutions that pollute the environment. When a Ni film is damaged during the assembly process, it will make galvanic corrosion easier to occur.
- Corrosion experts face a difficult task in the development of a proper covering for magnesium alloys.
- Magnesium's potential is still limited, however, by the high costs of extraction, which make the metal approximately 20% more expensive than aluminium in comparison.
- The methodology that has been established can be applied to a wide range of magnesium alloys in order to evaluate their behaviour.
- New ways to limiting the corrosion rate of magnesium alloys have also been reported, including the use of tiny cathodic currents and the use of ethylene glycol as the exposure medium.

## III. Scope of Work and their Objectives

As stated in this thesis, the goal was to examine the impact of microstructure on corrosion of magnesium alloys. Alloy microstructure has been overlooked in many prior studies on magnesium corrosion and the role played by the alloy microstructure in bulk characteristics and corrosion measurements.

This study used a spot analysis technique to investigate corrosion on the micro scale in magnesium alloys cast with a cast rim (see Figure 1). An optical microscope was used to identify the microstructural characteristics that played a part in this process.

This research, which aims to understand corrosion propagation in magnesium alloys, used electron microscopy to examine specific regions of interest on the alloy surface before, during, and after corrosion.

The microstructural properties of the magnesium alloys AM50 and ZEK100 are examined extensively in this thesis for their impact on corrosion.

## IV. Preparation of Alloy

Casting of materials done at different temperatures to caste the materials in the Rim shape. We select the different materials with their weight percentage content as shown below in Table-2, to form the samples:

- Sample size of 3inch x 1inch for their property testing should be form.
- Dimension of Rim (8 inches) of Día.

### A. Material weight percentage

The core of a material consists of a number of different constituents. When a substance is combined with other substances, it is known as an object. Whether in pure or impure, living or non-living materials, their physical and chemical qualities, biological function, and geological origin all contribute to their continued existence.

Fig. 2 Alloy Materials used to caste the Rim

The melting and boiling points of various materials vary widely over a wide range of chemical compounds. The furnace was chosen to melt the materials and shape the samples in accordance with their specifications. To get an accurate sample weight, the proportion of each sample was measured before and after the melt. In the table below, you can see the weight proportion of each ingredient in table II and Fig. 2 shows the Alloy Materials used to caste the Rim.

*Corresponding author: Abhinav Sharma, Department of Mechanical Engineering, Suresh Gyan Vihar University, Jaipur*
*E-mail address: shinyabhinav1@gmail.com*

TABLE II

Alloys having corrosion rates

| S.No | Materials | wt% Content | Wt in (gram) | Influence |
|---|---|---|---|---|
| **1** | Iron (Fe) | 34.60% | 340 | 1.Improves their tensile strength<br>2.Improve the hardening capacity<br>3.Reduce the brittleness |
| **2** | Aluminium (Al) | 22.40% | 220 | 1.Improves their strength<br>2.Decrease in ductility<br>3.Improves the overall corrosion performance |
| **3** | Zinc (Zn) | 13.70% | 137 | 1.Reduce the corrosion rate<br>2.More compact and increase corrosion resistance |
| **4** | Manganese (Mn) | 17.30% | 173 | 1.Increase the tensile strength<br>2.Improve the hardening capacity |
| **5** | Molybdenum (Mo) | 12.00% | 120 | 1.Reduce the brittleness<br>2.Improve the surface abrasive resistance |
| **5** | Chromium (Cr) | 12.00% | 120 | 1. Improve hardness to their extent<br>2.Reduce Corrosion<br>3.Its plating gives polished mirror surface to metal. |

**Note: Dimension of Rim in (8 inches) of** Día

## V. Conclusions

Summary of the results and the suggestions for future work on the areas which need extended research will be finalized later as per the readings observed after experiment and their final testing will be shown in the coming paper.

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*Corresponding author: Abhinav Sharma, Department of Mechanical Engineering, Suresh Gyan Vihar University, Jaipur*
*E-mail address: shinyabhinav1@gmail.com*