DESIGN AND DEVELOPMENT OF NEW MAGNESIUM ALLOY FOR MEDICAL APPLICATION

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ABSTRACT: *Magnesium(Mg) has a long history of use as a degradable biomaterial. The further experiments and improvements in technology shows that Mg can be used for medical applications such as vascular and orthopaedic activities. Due to its corrosive nature, Mg can't be used in orthopaedic activity. But by alloying and surface treatment the corrosion of magnesium can be controlled. As corrosion occurs, strength and such properties of Mg changes which affect the use of magnesium in orthopaedic activity. By alloying Mg with other biodegradable materials we can improve the corrosion nature of Mg. Surface treatment of the alloy is also a method for controlling corrosion. Here we study about the changes in properties of magnesium on alloying with other elements and surface treating and make it useful in orthopaedic activities.*

1. INTRODUCTION

Magnesium (Mg) and its alloys have been widely used due to its excellent physical and mechanical properties, such as low density, high strength/weight ratio, high stiffness, mechanical castability and good vibration damping character. However, the low corrosion resistance of Mg alloys in common ambient environments due to high electrochemical activity limits its applications, especially in marine environments. To reduce the corrosion of Mg alloys, several protective treatments have been investigated, such as element alloying and surface films. The latter methods can decrease corrosion rate of Mg alloys by a few orders of magnitude by providing a barrier between the Mg substrate and its environment, which is more efficient compared to alloy development.

Biometals used in orthopaedic implants include surgical grade stainless steel, cobalt-chromium at alloys, titanium, and titanium alloys. Stainless steel is not suitable for a permanent implant because of its poor fatigue strength and liability to undergo plastic deformation. The poor corrosion resistance has precluded the use of this metal as a porous coating for modern biologically fixed implants. Stainless steel is still commonly used for non-permanent implants such as internal fixation devices for fractures. In titanium and its alloys, the malleability allows pre-shaping and pre-stressing during the operation. Before the use of titanium, cobalt-based alloys (most notably Co-Cr-Mo and Co-Cr-Ni) had largely replaced stainless steel as materials for permanent implants. These alloys are generally more corrosion resistant owing to the formation of a durable chromium oxide surface layer, the so-called passivation layer. Despite the good corrosion resistance, ion release in-vivo is still of some concern.

2. LITRATURE REVIEW

2.1 M. P STAIGER studied about the orthopaedic application of magnesium and its alloys by considering different human body characteristics

2.2 EMILY K BROOKS and team studied about AZ91 alloys in inflammatory condition similar to human body. He also studied the corrosion behaviour of the alloy.

2.3 B. MINGO studied the corrosion nature of Mg 9Al with minor alloying elements such as Y, Mn, Sn. He also find out change in corrosion characteristics.

3. METHODOLOGY

3.1 CASTING OF ALLOY

Both AZ91 and element added (AZ91+ca+Sn) casted using permanent mould casting method using an electric muffle furnace having capacity of 3Kg and rating of 6 KW. The mould is rectangular in shape and having a capacity of 5 Kg. The molten metal is poured through the runner of the preheated mould and SF_6 gas is shown in the top of the mould for preventing oxidation. After hardening mould is opened and the metal is taken out.

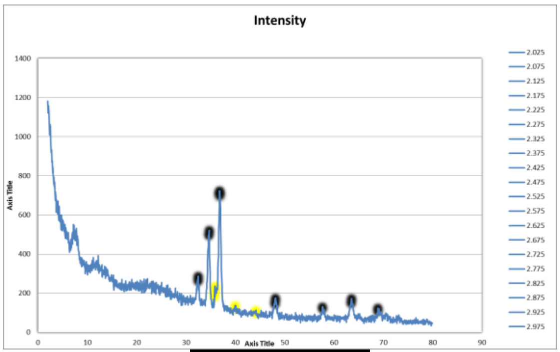
3.2 TESTS AND EXPERIMENTS

The alloys were subjected to optical testing powder XRD and SEM analysis. Mechanical properties such as tensile strength and hardness were found out.

4. RESULT AND DISCUSSION

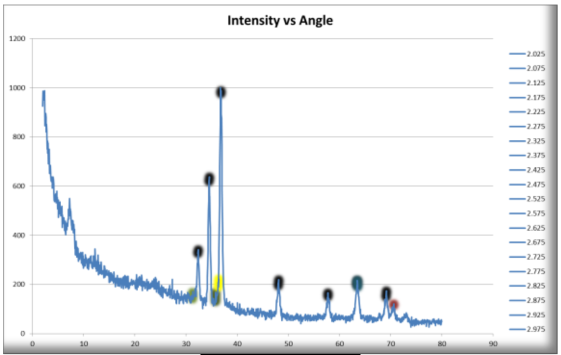
4.1 XRD TEST

XRD analysis is an analytical technique primarily used for phase identification of a crystalline material and can provide information on unit cell dimensions. Crystalline atoms cause a beam of incident X-rays to diffract into many specific directions. By measuring the angles and intensities of these diffracted beams, a crystallographer can produce an image of the density of electrons within the crystal. The XRD analysis of AZ91 (FIG 1) and XRD of AZ91+ Ca+ Sn (FIG 2) are shown below. In the comparison can clearly see that appearances of new compounds such as Al_2Ca and Mg_2Sn in addition with $Mg_{17}Al_{12}$



Mg	
Mg17Al12	

FIG 1; XRD OF AZ91



Mg	
Al2Ca	
Mg2Sn	
Mg17Al12	

FIG 1; XRD OF AZ91

4.3 HARDNESS

Specimen for hardness test using Vickers hardness testis made with a dimension of 15mm height with top rectangular in shape. The test results are also similar to that of tensile strength. The formation of Al_2Ca rather than $Mg_{17}Al_{12}$ causes this.

4.2 TENSILE STRENGTH

The specimen for tensile test using UTM (universal testing machine) is prepared with 200mm length and 15mm diameter. The result shows that tensile strength of new alloy is increased that's due to the presence of Al_2Ca which forms a massive structure and reduces the β phase $Mg_{17}Al_{12.}$ The reduction in grain boundaries increases the strength.

Fig 3: Optical image of AZ91 Alloy after corrosion Test

Fig 4: Optical image of AZ91+Ca+Sn Alloy after corrosion Test4.5 SEM ANALYSIS

The specimen for SEM analysis is prepared in the shape of a cylinder with a dimension of 15mm diameter and 10mm height. The result shows trace of oxidation over the polished surface of new alloy which may be the result of abundant formation of CaMgSn rather than Mg_2Sn, Thus the corrosion seems to increase.

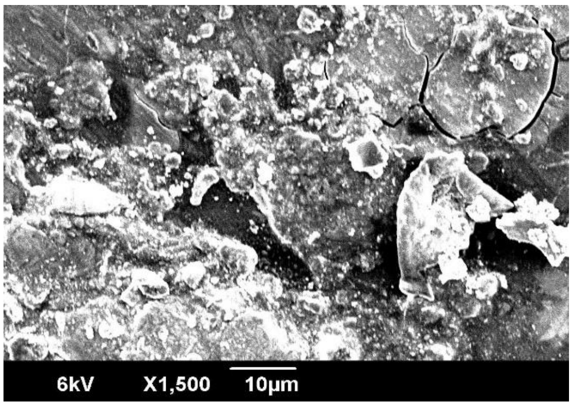


FIG 5: SEM ANALYSIS OF AZ91

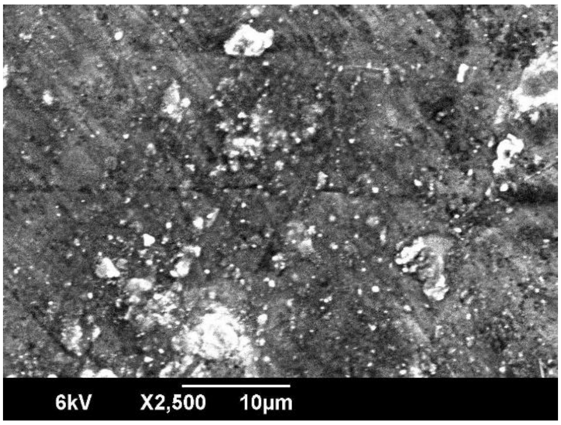


FIG 6: SEM RESULT OF THE AZ91 + Ca + Sn ALLOY

5. CONCLUSION

The Newly developed AZ91 + Ca + Sn Alloy has improved its mechanical properties compared to AZ91 alloy. Both tensile strength and hardness has been increased .Corrosion rate of new element added alloy is found to be increased.

6. REFERENCES

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