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Mechanical and morphological investigation of bio-degradable magnesium AZ31 alloy for an orthopedic application

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ABSTRACT

Metallic materials are used for several surgical implants. Biomaterials are widely used to replace the degenerated organs. The non-biodegradable material must be removed by a secondary surgical procedure which causes additional risk to the patients. The magnesium alloys are used as a potential biodegradable material which is essential to human metabolism and found naturally in bone. In this study, Bio-absorbable magnesium alloy AZ31 is used as base material with 1%Zn-3%Al-1-6%Mn which is prepared by stir casting technique and evaluated under mechanical and morphological aspects. Finally the alloy can be preferred as an orthopedic implant for load bearing application.

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1. Introduction

Nowadays the need of advanced engineering materials for various applications goes on increasing. Bio material is a multidisciplinary science which combines the basic science, engineering science and medical science. Metallic materials continue to play an essential role on bio materials for the replacement of bone tissue. Metals are more suitable for load bearing applications compared with ceramic or polymeric materials due to their high combination of high mechanical strength and fracture toughness.

Biomaterials adapt for a medical application which performs a natural function and also used every day in dental applications and in orthopedic application for bone replacement. The success of a bio material is depending on properties, bio compatibility of the implant.

The study deals about the biomaterials are most successful material used for the medical application of orthopedic implants. Metallic biomaterials significantly improve properties of implants including high load bearing capacity, bio compatible, high tensile strength, toughness hardness, low density and good wear resistance compared to others. The study deals about preparing the bio-degradable magnesium AZ31 alloy for an orthopedic application which is fabricated by stir casting process.

Once the material is implanted, it should retain its mechanical properties then it absorbed and excreted by the body without leaving any trace. They designed to overcome the disadvantages of permanent metal based devices. The reasons for failure of implant are mechanical, chemical, tribological, surgical, manufacturing and biocompatibility issues. Out of all these issues, failure due to corrosion is one of the challenging clinical problems.

The implant faces severe corrosion because of blood and other constituents of the body such as water, sodium, chlorine, proteins, plasma, amino acids along with mucin in the saliva. The accepted corrosion rate for metallic implant is about 2.5×10^{-4} mm/yr. The corrosion will be occurred either by oxidation or reduction reaction and the kinematic barrier such as surface oxide layer which physically prevents corrosion reactions. The commonly approved biomaterials are Cobalt-Chromium alloy, Stainless Steel, Titanium based alloys.

The stainless steel may excessively corrosive in some cases and susceptible to fatigue cracking with very high modulus. In this the addition of poly methyl methacrylate (PMMA) content may cause fracture or tissue reaction. This Co-Cr-Mo known to be toxic in ionic form with high modulus. In titanium material, they has poor wear characteristics, so if a new material has to replace them it should possess similar mechanical strength and it should be present for 12–16 weeks till the bones have sufficiently healed.

When the implant is complete solid, during bone growth it restricts the growth as they act as barriers. From literature survey, magnesium implants are light weight degradable implants. To

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