Effects of Ca, Cu Concentration on Degradation Behavior of Zn Alloys In Hank's Solution- Review

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Abstract- *We come to discuss about the bio degradable properties of metal which found emerging application in medical science. By analysing the limitation of alloying component (Mg-Fe, Cu-Mn, etc) during bone replacement due to fracture. The discussion was made about the powder metallurgy which are suited for degradable and implant property with the help of previous review. By this way degradable pure Zn was identified and the research were done for alloying because of poor mechanical property. With the help of detailed description about the ca and cu alloying element were chosen (ca -4%, cu-2%). For too made further test (IMMERSION TEST, SEM, EDS, XRD, CYTOTOXICITY TEST) on this Zn alloy solidification were done by sintering process. The review about this paper gives the description about the medical application of Zn-Cu-Ca alloy.*

Keywords- Biodegradable Property, Powder Metallurgy, Sintering process, cytotoxicity.

I. INTRODUCTION

In this emerging world outstanding technologies and analytical methods were developed in engineering field but in medical field (surgical therapies) made a serious complication in osteomyelitis (bone infection). During fracture the treatment was done by packing the metal plate and made the arrangement according to original structure.

By this method metal must be removed by second operation that increase the risk of patient therefore with the number of biodegradable materials loaded with antibiotics available in Material Science, so that we made a research on material science.

The ability of PM to produce high quality, complex parts with close tolerances and high productivity presents significant advantages, such as energy efficiency, with potentially low capital costs.

Some of the degradable materials are Zn, Mg, Cu and some of the polymers. For the past final scientist become increasingly concerned about the antimicrobial ability of degradable metal implant that focused on Zn alloys which offer advantages such as biodegradable property, mechanical property and cost here that our aim is to introduce Zn based alloy with Ca, Cu in ratio 4:2 because of the limitation analysed in biodegradable material also some of them are Mg, carbide.

For making this alloy material there are five machining process is carried out. They are making of alloy component (Ball Milling), Powder compaction, Sintering, polishing. The material after completion undergoes various test to check the Mechanical Property, Bio compatibility and antibacterial activity. Some of the tests used for antibacterial activities are EDX, SEM. The detailed description is given below.

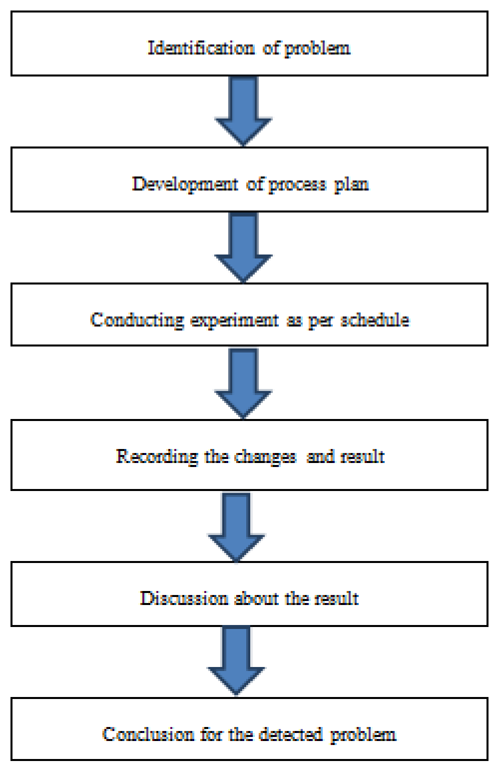


Figure 1.1 Methodology of the process

II. LITERATURE REVIEW

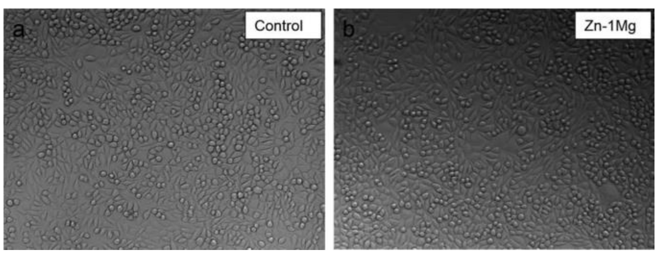
Most of the works have been carried out to study the growth of life cell on Zn alloy

Zn alloy metal of 5mm thickness plate was developed by the process of ball milling and sintering. Its microstructure has been identified for proceeding the further tests. Basic testing process are conducted for checking the mechanical property of metal piece

Experiments are conducted for viability of cell growth on Zn alloy and its life time without side effects. The researchers proposed the growth of life cell in Mg alloy and Zn alloy with varying metal. From the study of literature survey essential elemental powder (Zn, Ca, Cu, Ti, P) is consider, to analyse growth of life cell by following same procedure.

III. CELL CYTOTOXICITY

Indirect cytotoxicity test was performed according to ISO 10993-52009.[22] To prepare extract mediums, metal samples were cleaned, sterilized, and incubated in Dulbecco's modified Eagle's medium with 10% fetal bovine serum for 72 h under physiological conditions (5% CO_2, 20% O_2, 95% humidity,37C).



The supernatant fluid is withdrawn and filtered by 0.2 mm filter. Fibroblast (L-929) cells were seeded in 96-well plate at 5000 cells per well density for overnight. The medium was replaced with 100 ml per well metal extract (1:15 dilution) in the next day. After further incubation for either 24 h or 72 h, 10 mL 3-(4,5-Dimethylthiazol-2-yl)-2,5-Diphenyltetrazolium Bromide (MTT) solution (5 mg/ml, from Sigma-Aldrich) was added to each well.

IV. EXPERIMENTAL PROCEDURE

Cell Culture

Vero cells (African green monkey kidney cells)cell line was purchased from NCCS, Pune and cultured in liquid medium (DMEM) supplemented 10% Fetal Bovine Serum (FBS), 100 ug/ml penicillin and 100 µg/ml streptomycin, and maintained under an atmosphere of 5% CO_2 at 37ºC.

MTT Assay

The ZCCsample was tested for *in vitro* cytotoxicity, using Vero cells by 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) assay. Briefly, the cultured Vero cells were harvested by trypsinization, pooled in a 15 ml tube. Then, the cells were plated at a density of 1×10^5 cells/ml cells/well (200 µL) into 96-well tissue culture plate in DMEM medium containing 10 % FBS and 1% antibiotic solution for 24-48 hour at 37°C. The wells were washed with sterile PBS and treated with various concentrations of the ZCC sample in a serum free DMEM medium. Each sample was replicated three times and the cells were incubated at 37°C in a humidified 5% CO2 incubator for 24 h. After the incubation period, MTT (20 µL of 5 mg/ml) was added into each well and the cells incubated for another 2-4 h until purple precipitates were clearly visible under an inverted microscope. Finally, the medium together with MTT (220 µL) were aspirated off the wells and washed with 1X PBS (200 µl). Furthermore, to dissolve formazan crystals, DMSO (100 µL) was added and the plate was shaken for 5 min. The absorbance for each well was measured at 570 nm using a micro plate reader (Thermo Fisher Scientific, USA) and the percentage cell viability and IC50 value was calculated using Graph Pad Prism 6.0 software (USA).

Haibo Gong, Kun Wang et al.(2014) suggested that Corrosion rate of as-cast Zn–1Mg was found to be much lower than that of WE4. In vitro cytotoxicity test results indicated that Zn–1Mg alloy was biocompatible, as cells growing in contact with corrosion products of Zn–1Mg maintained high cell viability and healthy morphology.

Bahman Homayun, Abdollah Afshar (2014) suggested that the presence of Al up to 3 wt.% in the alloys resulted in lower degradation rates, higher corrosion resistances, and higher tensile and compression strengths due to its positive effect on microstructure refinement. In vitro Cytotoxicity assessments on this alloy demonstrated its good biosafety, making it a potential candidate to be considered for further investigations as a degradable biomaterial.

4.1 MATERIAL TO BE USED

Zinc plays a critical role in brain function and mood, and low levels are linked to an increased risk of depression. It's characterized by an impaired ability of muscle and liver cells to properly absorb sugar from your bloodstream. The weight % as in the review paper is about 5-7%.

4.2 CALCIUM AND COPPER

Calcium is used to help blood vessels move blood throughout the body and to help release hormones and enzymes that affect almost every function in the human body. Calcium is the second most abundant mineral in the body. It is present in every cell of the body. Most of the calcium in the body is used to increase the density found in the bones and teeth. The reason for using copper as alloying element are corrosion resistant, Antibacterial, easily joined, ductile, tough, nonmagnetic.

4.3 PHOSPHORUS

The main function of phosphorus is in the formation of bones and teeth. It plays an important role in how the body uses carbohydrates and fats. It is also needed for the body to make protein for the growth, maintenance, and repair of cells and tissues. Phosphorus also helps the body make ATP, a molecule the body uses to store energy.

V. ANALYSIS OF PHOSPHORUS BENIFITS AND IMPORTANCE

The phosphorus has many beneficial results for the human body.

1) Keeping the bones and teeth strong.
2) Helping the muscles contract.
3) Promoting healthy nerve conduction throughout the body.
4) To make proteins that grow and repair cells and tissues.
5) Heartbeat regulation.

VI. CONCLUSIONS

The corrosion resistance of the developed alloy was satisfactory and the hardness were found to be increases with the addition of Ca and Cu into the matrix. However, due to the processing route, this present alloy wound begins to corrode at faster rate and can be applicable for tissue, scaffolds, etc but not the bone. In future, the casted followed by mechanical forming such as forging, extrusion etc., has to be done to induce more strength and corrosion resistance for the Zn metal. Ductility can favor due to the additions of Cu in the alloy which will be affected by the formation of hard phases due to Ca. The alloying elements has to be compensated for both hardness and toughness.

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