

Analysis of magnesiums mechanical properties through tensile test

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Abstract. Bone implant plates are only used temporarily during the healing process of a fractured bone. Once the healing process is complete, the implants need to be surgically removed. By using biodegradable material there will be no need for an implant removal surgery, because the implant plate will be degraded and destroyed naturally in the body. This biodegradable implant would need to be strong enough to handle the body's weight and movement to be able to replace the bone physiologic function until the fractured bone is completely healed. A possible biodegradable material that could be degraded and destroyed naturally in the body is magnesium. However, magnesium has its limitation; its ability to resist corrosive properties is faster than a fractured bone healing process. Therefore, the plastic deformation process is done by suppressing the plate with 1%, 2%, and 3% degradation. It will increase the magnesium's ability to resist the dynamic force and improve its mechanical properties, so that the biodegradable implant plate can perform its function as a substitute for the fractured bone until the healing process is completed and degraded naturally only afterwards. The corrosive body fluid environment and recurring loads retained by the implant plate during the bone fixation process lead to fatigue of the implant plate. The crack rate testing of deformed magnesium alloys after immersion process in the physiological fluid DMEM can provide useful information on magnesium mechanical strength enhancement and subsequently whether it is feasible to be used as biodegradable bone implant plate.

1. Introduction

Magnesium and its alloys have the potential as materials that can be used as lightweight construction of automotive and industrial machinery due to its mechanical properties which have low density, high specific strength, dent resistance, and dimming power against electromagnetic waves [1]. In addition, magnesium has biodegradable properties so that the researchers attention as an implant plate material in the body [2]. However, pure magnesium will experience unfavorable degradation under the physiological environment causing its strength to decrease.

Through the ECAP (Equal Channel Angular Pressing) process, the magnesium biodegradation rate in DMEM's physiological fluid immersion can be improved. Ultimate Tensile Strength (UTS), hardness of vickers, and bending strength can also be improved [3],[4].

Because the implant plate will replace the temporary bone function with repeated dynamic load, it is necessary to test the mechanical properties dynamically also through fatigue test and crack propagation analysis. As a first step, static analysis of mechanical properties needs to be done again as a control.



2. Experimental procedure

The magnesium material used is pure commercial magnesium with a 99.9% purity rate. For tensile testing, the material is cut and turned into a specimen in accordance with ASTM E8 / E8M (Standard Test Method for Metal Material Tensile Test) [1]. The specimen is cylindrical in diameter 12.5mm, the diameter of the holder is 20mm with the length of the reduced section 100mm and the length of each holder is 20mm. The surface of the specimen is purely a result of lathe and no surface work is performed.



Figure 1. Specimen on universal testing machine.

Two specimens were tested using Universal Testing Machine with base length 99mm and load speed of 5kg / s.

3. Result and Discussion



Figure 2. Specimen 1.



Figure 3. Specimen 2.



Figure 4. Faulty specimen 2.

The first specimen reaches the fracture stress not until it is completely broken (figure 2). Obtained data as follows:

- Ultimate force 765 kg
- Ultimate tensile strength 6,04 kg/mm²
- Elastic force 544 kg
- Yield Stress 4,30 kg/mm²

While the second specimen reaches fracture until breaking (figures 3 and 4). Obtained data as follows:

- Ultimate force 778 kg
- Ultimate tensile strength 6,14 kg/mm²
- Elastic Force 633 kg
- Yield Stress 4,99 kg/mm²

4. Conclusion

Pure magnesium without a plastic deformation treatment has been subjected to a tensile test and obtained that magnesium has a yield stress of 4.30 kg / mm² until 4.99 kg / mm² and an ultimate tensile strength of 6.04 kg / mm² until 6.14 kg / mm².

References

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