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Biocorrosion behavior and mechanical properties of Mg based alloy for orthopedic implants

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Magnesium alloys have become an interesting candidate as a bioactive substance in the field of biodegradable implant materials such as stents, bone fixtures, plates, and screws. However, the magnesium alloys currently under investigation as implant materials are mostly commercial alloys such as AZ31, AZ91 and WE43. But, due to some disadvantages associated with the commercial magnesium alloys, the researchers turn to develop new biodegradable magnesium alloys and have recently designed some novel biodegradable magnesium alloys and developed surface treatment technology to slow down the corrosion rate, such as Mg-Ca [1,2], Mg-RE [3,4].

The aim of this work is to study the biocorrosion behavior and to compare the mechanical properties of Mg based alloy with and without containing Ca in order to prove the suitability of these alloys as orthopedic implants. Microstructures and room temperature mechanical properties of the alloys prepared by bottom pouring stir casting process was analyzed. Corrosion behavior was analyzed by immersion test, scanning electron microscopy (SEM), and energy dispersive spectroscopic (EDS) analysis.

Mechanical properties of the cast alloys strongly dependent upon how the external applied load is transferred to the reinforcing particles. The tensile specimens were prepared according to the ASTM standard B557M-10. Three tensile samples were prepared and tested for each alloy. Table 1 shows the ultimate tensile strength, yield strength and percentage elongation of both the Mg alloys under consideration. The tensile properties of the Mg based alloy with Ca are better as compared to Mg based alloy without Ca. Results showed that the strength and elongation of the alloy after adding Ca was improved significantly.

Figure 1 shows the corrosion rates of both the Mg alloys under consideration. Simulated body fluid (SBF) was used as the test solution. The immersion test lasted for 7 days and the immersion solution was renewed every 24 h in order to keep a relative stable pH value. It reveals that the corrosion rate of the alloy containing Ca is slower than that of without containing Ca.

Table 1: Comparison of mechanical properties of Mg based alloy with and without containing Ca at room temperature

Samples	UTS (MPa)	YS (MPa)	Elongation (%)
Mg-RE alloy	226	139	19
Mg-RE-Ca alloy	231	144	24

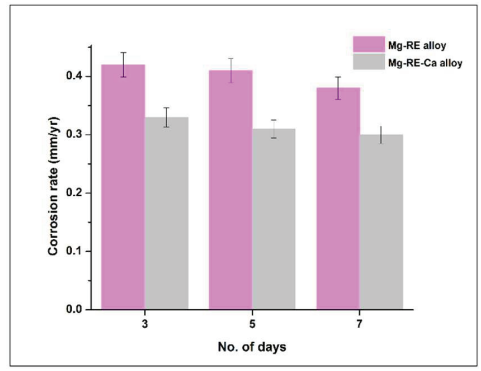

Figure 1: Corrosion rates of the Mg alloys with and without Ca immersed in SBF for 3, 5, and 7 days

Results showed that Mg based alloy under consideration is a promising biodegradable alloy due to higher mechanical properties and better corrosion resistance. The addition of Ca improved the biodegradation corrosion resistance and proved the suitability of these alloys as orthopedic implants.

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