**Investigations on the stress corrosion cracking of microstructure modified and hybrid coated biodegradable magnesium alloys in simulated body fluid**

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Temporary orthopedic fixture devices made of magnesium alloys are designed to support the fractured bone till healed adequately, and then get absorbed in the body. The degradation of Mg alloy in the aqueous body fluid is electrochemical in nature, and is associated with release of ionic species and hydrogen gas, along with the formation of corrosion products. The composition control and corrosion rate of the Mg alloy ensures that toxicity due to excessof released ions is avoided inthe body. The combination of multiple loading modes along with the mass loss due to corrosion offer potential risks for premature failure unlike in conventional implants. One such failure mode, namely stress corrosion cracking (SCC), caused by simultaneous effect of tensile load and corrosive medium is investigated in the present work. This is a catastrophic failure mode in which the cracks initiated at the corrosion pits propagate rapidly leading to fracture of the material.

Even permanent implant materials such as stainless steel are reported to fail by stress corrosion cracking; hence such occurrences in degrading Mg alloys are expected. Current studies on stress corrosion cracking of Mg alloys are limited to commercial Al and/or rare earth containing alloys; usually conducted in distilled water or 3% NaCl. In addition, the effect of surface protective coatings on the stress corrosion cracking susceptibility of Mg alloys has not been investigated in spite of their role in reduction of corrosion rates. Hence the aim of the work is to understand the role of alloying additions, heat treatment and surface modifications on the stress corrosion cracking susceptibility of the Mg alloy.

The work is carried out in three steps: In the first part, Mg-4Zn alloy is chosen as the base material due to its good mechanical, corrosion and biocompatibility properties. The microstructure of Mg-4Zn alloy is modified by heat treatment and its effect on corrosion in simulated body fluid (SBF) and mechanical properties are investigated.Slow strain rate tests in SBF are carried out to assess the susceptibility to SCC. Fractographic analysis provides insights into the failure modes of the alloy with different microstructural features.

The second stage involves addition of minor amounts of Sr (0.1-2 wt.%) in the Mg-4Zn alloy. Microstructural observations indicate the presence of ternary phases which are not reported in existing phase diagrams, and these are confirmed by thermal analysis of the ternary alloys. The formation of ternary phases degrades the corrosion, mechanical and SCC behavior of Mg-Zn-Sr alloys.

The third phase of the work involves development of protective coatings to prevent contact between SBF and Mg alloy to minimize chances of failure by SCC. Chemical conversion coatings are developed with two different morphologies at 30 and 80°C, followed by a dip coating in poly (ε-caprolactone). The presence of coating increased the corrosion resistance of the sample in SBF; without affecting the bulk mechanical properties measured in air. However, the mechanical integrity of the coating layer under tensile load is crucial in determining the SCC susceptibility. Thin polymer over layers was found to be favorable for coating stability, while thicker layers resulted in detachment and poorer SCC performance.