Microstructure analysis and corrosion behavior of biodegradable Mg-Ca implant alloys

Abstract:

The calcium content in binary Mg-xCa alloys affects the microstructure, corrosion and solidification behavior of the alloys. In this study, binary Mg-xCa alloys with various Ca contents from 0.5 to 10wt.% were produced by casting process. Microstructural evolutions were characterized by optical microscopy, X-ray diffraction, scanning electron microscopy and energy dispersive X-ray spectroscopy. Solidification behavior was assessed via two thermocouple thermal analysis method. The corrosion resistance was examined in vitro by potentiodynamic polarization and immersion test in Kokubo solution at room temperature. The results revealed that the grain size and dendrite cell size decreased significantly with rising Ca content, whilst the content of Mg2Ca intermetallic phase in grain boundaries increased with increasing Ca content. Potentiodynamic polarization tests in simulated body fluid (SBF) indicated that corrosion rates of Mg-xCa alloy increased significantly with rising Ca content. Immersion tests in Kokubo solution also showed that dissolution rate of Mg-xCa alloy increased with increasing Mg2Ca content which lead to an increase in pH value. It was observed that corrosion damage in specimens with lower Ca content was more moderate and uniform than higher Ca content. Thermal analysis results showed that the fraction of primary a-Mg at dendrite coherency point (faDCP) decreased with increasing Ca content but the liquid fraction fL increased causing the rise in eutectic Mg2Ca intermetallic phase in grain boundaries, thus increasing the corrosion rate. Our analyses showed that Mg-0.5Ca alloy is a promising alloy to be used as biodegradable implants.