

Biodegradable Magnesium-Polymer composite for enhanced corrosion resistance and mechanical strength

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Statement of Purpose: Magnesium (Mg) has attracted much attention as a biomedically applicable material because of its non-toxic and biodegradable properties. Mg ion is actually the fourth most abundant cation in human body and it is also known to promote bone growth [1]. However, its high corrosion rate and hydrogen gas generation during corrosion greatly limits its application. In order to overcome the limitations, in this study, we have introduced a Mg-polymer composite model using poly-L-lactide (PLLA). Taking advantage of the different degradation rates of magnesium and PLLA, the composite is expected to slowly create a porous polymer scaffold while Mg is degrading, therefore, maintaining some of its mechanical strength, with providing sites for cells to grow in.

Methods: Sintering of the Mg powder was done through Spark Plasma Sintering (SPS) with NaCl as a spacer material at 585°C for 2 h to fabricate Mg scaffolds with 60% porosity [2]. Subsequently, the NaCl spacers were dissolved in 1M of NaOH solution. PLLA was melted at 250°C and infiltrated inside the porous Mg using vacuum oven to produce the composite. The composite was polished using sand papers in order to generate a homogeneous surface and then was dip coated in 10% PLLA solution to make an outer corrosion protective layer. The morphology of Mg scaffolds and composites were examined using SEM. The corrosion behavior of the composites were monitored in terms of pH variation over time while their compressive strength was evaluated at different corrosion times (0, 24, 96, 120, 144 h) using a screw-driven testing machine (OUT-05D, Oriental TM, Korea) at a cross-head speed of 1mm/min (n=1).

Results: Fig. 1 shows the SEM cross sectional images of 60% porous bare Mg and the Mg-PLLA composite. Mg porous scaffolds were observed to be fully densified without any significant pores within struts (Fig. 1a). PLLA was also successfully infiltrated inside the pores of Mg scaffolds, having the continuous interface with Mg struts without defects (Fig. 1b). The corrosion behavior of bare Mg and Mg-PLLA composites was assessed over time through pH monitoring as shown in Fig. 2. The corrosion rate of the composite was greatly suppressed as compare to bare sample. The composite showed a gradual increase in pH while bare sample showed a rapid increase from the beginning. The compressive strength over time of the composite was exhibited in Fig. 3. The strength of the composite was maintained for one day but degraded rapidly afterwards. However, the remaining polymer still maintained the structural integrity without collapse.

Conclusions: Mg-PLLA composite was successfully fabricated with good interface between Mg and PLLA because of excellent degree of infiltration of polymer inside the Mg scaffold. The composite greatly enhanced

the corrosion resistance compare to bare Mg and appeared to maintain its structural integrity with some degree of strength.

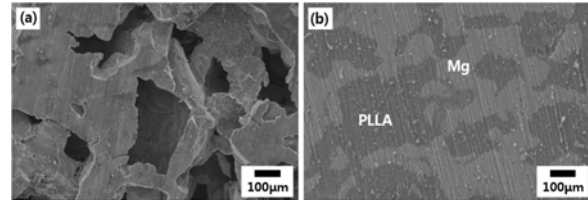


Figure 1. SEM image of (a) 60% porous Mg and (b) infiltrated PLLA inside 60% porous Mg

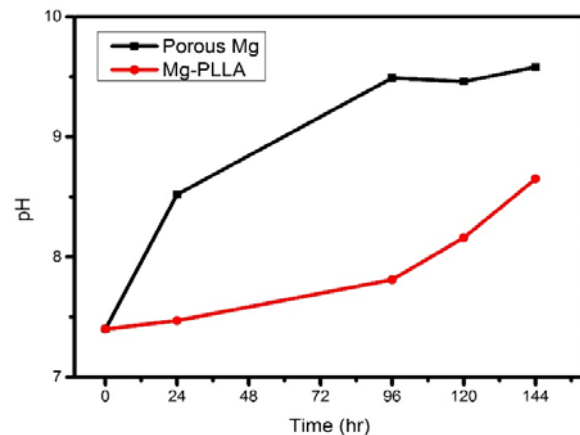


Figure 2. pH variation of bare Mg and Mg-PLLA composite in SBF over time

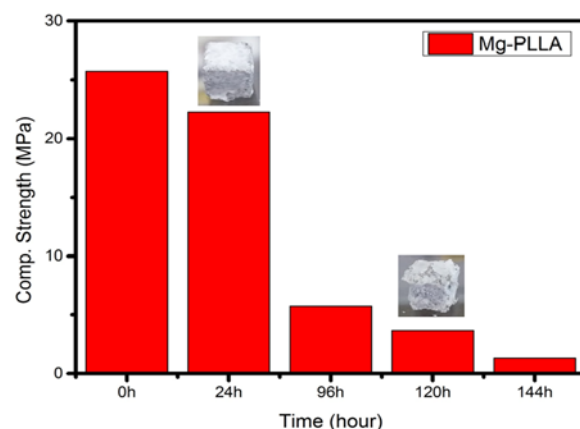


Figure 3. Compressive strength of Mg-PLLA composite at degradation times

REFERENCES

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