

Hydroxyapatite Coated Porous Magnesium with for Biomedical Applications

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Introduction: Magnesium (Mg) has promising properties as a biodegradable material. Mg is also one of the essential elements to promote bone growth [1]. Furthermore, porous Mg has the advantage of facilitating bone ingrowth and reducing the load shielding effect. However, there are limitations to the use of Mg because of its reactivity and high corrosion rate. Sintering of Mg is difficult due to its high reactivity with oxygen. One of the solutions is spark plasma sintering (SPS). The sintering process occurs as spark destructs the oxide film on Mg particles [2]. A very effective way to further improve corrosion resistance is through coating with hydroxyapatite (HA) directly in aqueous solution. This also improves biocompatibility of porous Mg because HA itself possesses good biocompatibility [3].

Methods: Mg powder was mixed with NaCl powder and sintered by SPS at 585 °C for 2h. After sintering, NaCl was dissolved in NaOH solution. Porous Mg was fabricated with different porosities (70, 60 and 50 %). Aqueous solution for HA coating was prepared by dissolving Ca(EDTA) and KH₂PO₄ in distilled water. The pH level of the solution was kept at 8.9, and the solution was heated to 90 °C [3]. Porous Mg with 60 % porosity was immersed in the solution for 6 h. SEM was used to observe the pore morphology of bare and HA coated surface on porous Mg with 60% porosity. Mechanical properties of bare porous Mg with different porosities and HA coated porous Mg were examined using compression tests, the specimen size being 4 mm x 4 mm x 6 mm (n =6). Corrosion behavior was observed by monitoring the change of pH after immersing bare and HA coated porous Mg specimens with 15 mm diameter and 1.5 mm thickness in SBF solution at 37 °C.

Results: Fig. 1 shows SEM images of bare and HA coated porous Mg. As seen in Fig. 1 (a), Mg powder was sintered well. A dense needle-shaped HA layer about 2 μm in thickness was formed uniformly on the surface and the inner pores, Fig. 1 (b) and (c). Fig. 2 shows compressive stress-strain curves of bare porous Mg with 70, 60 and 50 % porosity and HA coated porous Mg with 60 % porosity. Average compressive strength was 6, 16, 30 and 15 MPa respectively. All porous Mg specimens exhibited ductile behavior. After coating with HA there was no noticeable change in compressive strength and stiffness. Corrosion behavior was examined by the change of pH after immersing bare and HA coated porous Mg in SBF solution, cf. Fig 3. pH increased rapidly for bare porous Mg owing to its large surface area. However, after coating of porous Mg with HA, the increment of pH dropped sharply and the specimen maintained its dimensions for a longer time.

Conclusions: Porous Mg was fabricated by the space holder method with NaCl as a spacer and sintering by SPS. Porous Mg had good mechanical properties. Also corrosion of porous Mg was well restrained when HA coating by solution treatment was used. Further *in vitro* and *in vivo* evaluations are in progress and it is expected that biological properties of porous Mg with HA coating will improve in comparison with bare Mg. Thus, HA coated porous Mg is considered to be a promising material for biomedical applications.

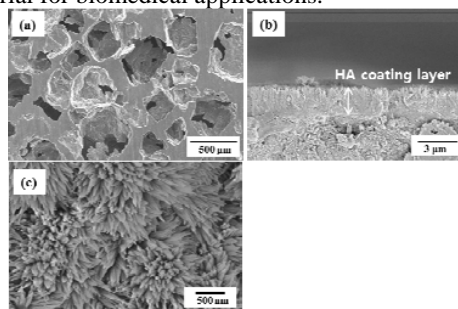


Figure 1. SEM image of (a) bare porous Mg, (b) cross-sectional view and (c) high magnification of HA coated porous Mg with 60 % porosity

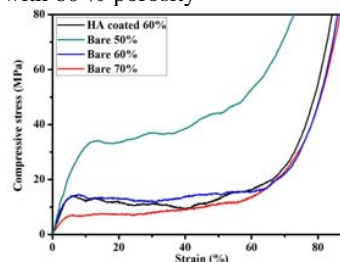


Figure 2. Compressive stress-strain curve of bare Mg with 70, 60 and 50 % porosity and HA coated porous Mg with 60 % porosity

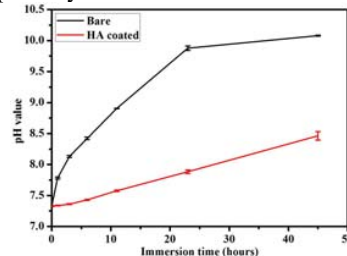


Figure 3. pH change after immersing bare Mg and HA coated Mg with 60% porosity in SBF

REFERENCES

- [1] Staiger MP et al. *Biomaterials* 2006;27:1728-34.
- [2] Muhammad WNAW et al. *J Alloy Compd* 2011;509:6021-9.
- [3] Tomozawa M et al. *Appl Surf Sci* 2011;257:8253-7.