Hydroxyapatite coating on magnesium in aqueous solution for biomedical applications

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Statement of Purpose: Magnesium (Mg) has been regarded as a promising material for biodegradable implants due to its proper mechanical property, biodegradability and good biocompatibility [1]. However, there is a concern that Mg corrosion occurs too rapidly in the physiological environment, resulting in the generation of hydrogen gas bubbles and the changes in local pH change. Therefore, a variety of approaches to mitigate the degradation of Mg have been reported [2]. Among them, surface modification has been vigorously studied owing to its effectiveness to enhance corrosion resistance and biocompatibility. In this study, Mg was treated in Ca-EDTA/ KH_2PO_4 aqueous solution to produce bioactive hydroxyapatite (HA) coating on Mg [3]. Effects of the coating layer on the corrosion resistance and *in vitro* biocompatibility of Mg were evaluated.

Methods: Pure Mg plates polished up to 1200 grit with SiC papers were prepared with dimensions of 20mm × 20mm × 2 mm. Then, Mg samples were treated in 0.05M Ca-EDTA (ethylenediaminetetraacetic acid calcium disodium salt hydrate)/0.05M KH_2PO_4 (potassium dihydrogenphosphate) aqueous solution. During the treatment, pH was adjusted to 8.9 with sodium hydroxide (NaOH) and the temperature of the solution was raised from room temperature to 368K in an oven for 2 h. To evaluate the surface corrosion resistance, the Mg samples were soaked in simulated body fluid (SBF). At each time of immersion, evolved hydrogen volume was recorded. In order to examine biological properties of the samples, *in vitro* cell tests were performed using MC3T3-E1 pre-osteoblast cells.

Results and Discussion: Figure 1 shows the surface and cross section morphologies of the HA coated Mg samples. The HA crystals with needle-shape structure uniformly covered the Mg surface. When the samples were immersed in SBF, the volume of hydrogen gas produced from HA coated Mg was significantly reduced compared with bare Mg (Figure 2). The pre-osteoblast cells were well attached and spread on the coated surface, as shown in Figure 3(A). The cell proliferation assessed through DNA quantification after 5 d of culturing is represented in Figure 3(B). The DNA content of the cells on the coated samples was much higher than that on bare Mg. These results indicated that the HA coating improved the corrosion resistance and biocompatibility of Mg.

Conclusions: The needle-like HA was successfully produced on Mg surface by the treatment in Ca-EDTA/ KH_2PO_4 aqueous solution. The coating layer covered the surface uniformly and densely. Corrosion resistance of the sample was highly improved compared to the bare Mg, resulting in the decrease of hydrogen gas evolution in SBF. The *in vitro* cell tests revealed that the coating significantly enhanced the cellular responses. In conclusion, the HA coating significantly improved the corrosion resistance and the biocompatibility on Mg.

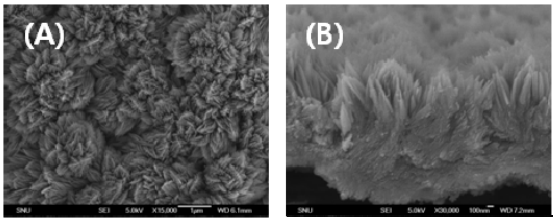

Fig 1. SEM micrographs of the HA coated Mg (A) surface and (B) cross section

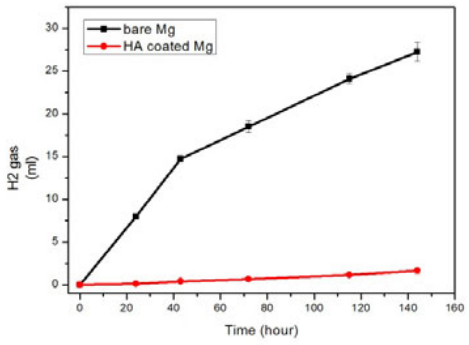

Fig 2. Hydrogen evolution in SBF

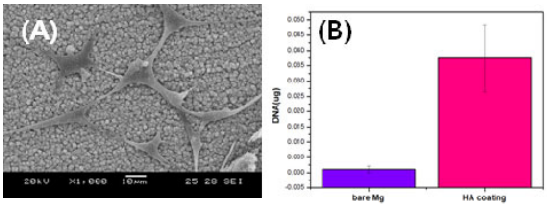

Fig 3. (A) SEM micrographs of the MC3T3-E1 cells on HA coated samples that cultured for 1 d and (B) DNA level of the cells after 5 d

References:

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2. Song, G.L., Song, S.Z., Advanced Engineering Materials 2007;9:298-302.
3. S. Hiromoto, A. Yamamoto, Electrochimica Acta. 2009;54:7085-7093.