Enhanced Corrosion Resistance via Hybridized PEI/Silica and Hydroxyapatite Dual Coating on Porous Magnesium

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Statement of Purpose: Magnesium (Mg) has gained great attention as a promising biodegradable orthopedic implant because of superior osteoconductivity and comparable mechanical properties to that of the human bone. In particular, porous Mg is capable of facilitating bone ingrowth and reducing the load shielding effect by controlling porosity and pore size. However, rapid corrosion of porous Mg in aqueous solution requires proper surface treatments in order to exhibit acceptable corrosion rates after implantation [1, 2].Thus, in this study, we have introduced the dual coating layer of hybridized PEI/silica and hydroxyapatite (HA) on the surface of porous Mg for the remarkable improvement of corrosion resistance, yet still possessing good biocompatibility and bioactivity.

Methods: Porous Mg with 60% porosity was fabricated via spark plasma sintering (SPS) and then was coated with HA in aqueous solution which Hiromoto's group has introduced [1, 3]. Subsequently, the HA-coated samples were coated with PEI/silica xerogel through dip coating method with a mixture of PEI solution and silica sol, where silica sol was prepared by mixing Tetramethylorthosilane (TMOS), distilled water, and hydrochloric acid (HCl) at a volume ratio of 5 : 1 : 0.02. After the specimen was dried at 70 °C, morphology of pores and coating layers was observed by SEM. Corrosion behavior was monitored by change of pH after immersion of Mg samples in SBF solution at 37 °C (n =3). Initial cell adhesion of pre osteoblast cell (MC3T3-E1) was also observed after 12 h culture.

Results: Fig. 1 shows surface SEM images of dual-coated porous Mg with PEI/silica and HA. Pores were not blocked with PEI/silica xerogel and PEI/silica was coated on needle shape HA without any defects. Corrosion behavior of bare, HA-coated, PEI/silica coated and dual-coated porous Mg was examined by the change of pH as shown in Fig. 2. Although corrosion was slowed down for HA coated and PEI/silica coated porous Mg, still the corrosion occurred rapidly. However, after dual coating on porous Mg, corrosion resistance was improved extensively. Initial cell adhesion morphology shows that cells prefer dual-coated surface to both bare and HA-coated surfaces, showing the elongated shape with good surface coverage rather than round shape with minimal contact to the surface (Fig. 3). Stability of Mg surface is likely to determine the cell affinity, indicating reduced corrosion of dual coated Mg remarkably improves biocompatibility.

Conclusions: Porous Mg fabricated by SPS was dual-coated with PEI/silica hybrid and HA without any cracks and blocking of the pores. Corrosion of porous Mg was well restrained when it was dual-coated with PEI/silica and HA. Moreover biocompatibility was improved after dual-coating. Further *in vivo* evaluations are in progress and it is expected that biological properties of dual-coated porous Mg will improve in comparison with bare and HA coated porous Mg. Thus, dual-coated porous Mg with PEI/silica and HA is considered to be a promising material for biomedical applications.

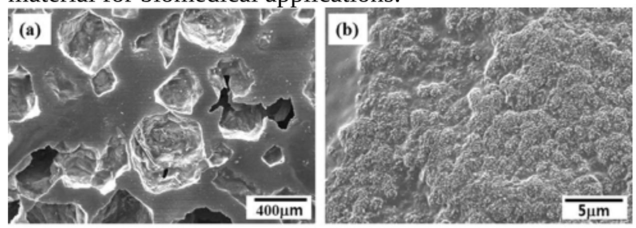

Figure 1. Surface SEM image of (a) low magnitude and (b) high magnitude of dual-coated porous Mg

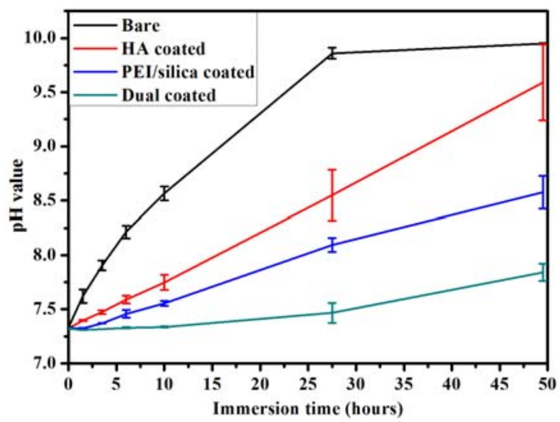

Figure 2. pH change after immersing bare, HA coated, PEI/silica coated and dual-coated porous Mg in SBF solution

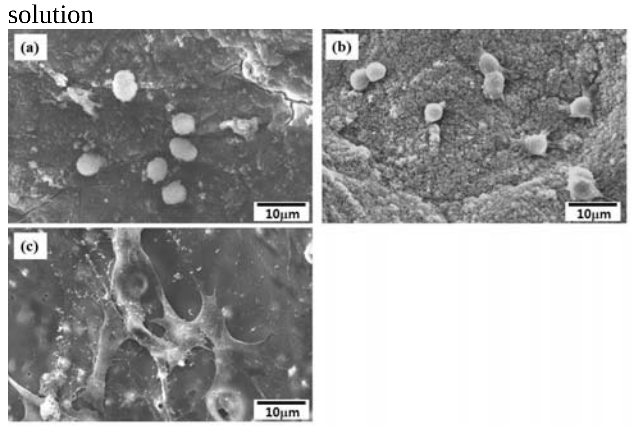

Figure 3. SEM image of cell attached morphology after 12 h on (a) bare, (b) HA coated and (c) dual-coated porous Mg

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