Flexible Polyetherimide-Silica Hybrid Xerogel Coating on Magnesium

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Introduction: Magnesium (Mg) is recently known as a promising implantable material due to its bioresorbable properties**.** However Mg corrodes too rapidly in biological environment. Protective layer is needed to decrease the corrosion rate of Mg. Polyetherimide (PEI) was recently introduced as good protective coating layer because of the good adhesion with Mg [1]. Furthermore PEI has good biocompatibility [2]. However, PEI coated Mg barely degrades and has low bioactivity. To control the degradation rate, nano-scale silica was hybridized with PEI because silica is a bioresorbable material. Moreover, bioactivity of PEI can be improved because silica has hydrophilic characteristic and good bioactivity. Furthermore, the hybridization of mesoporous silica with PEI is expected to fabricate drug eluting protective coating layer on Mg.

Methods: Tetramethylorthosilane (TMOS), distilled water, and hydrochloric acid (HCl), 1-methyl-2-pyrrolidone (NMP) are mixed at a volume ratio of 5 : 1 : 0.02 : 6 for the reagent of silica sol. NMP was added to prevent the phase separation while mixing silica sol and PEI solution. PEI were dissolved in NMP at weight ratio of 15 %(w/v) for PEI solution. Silica sol was added to PEI solution by 0, 20 and 40 vol% of silica. Hybridized solution was spin-coated on Mg substrate with dimension of 15 mm x 15 mm. Mg spun at 3000 rpm for 40 s. Coated specimen was dried at 4 °C and 70 °C. Porous PEI coating formed at 4 °C and dense PEI coating formed at 70 °C. SEM was used to observe morphology of the coating layer. FT-IR analysis was performed to confirm PEI-silica hybrid chemical structure. Corrosion behavior was evaluated by monitoring pH value after immersing the specimen in simulated body fluid (SBF) solution at 37 °C (n = 3). Initial cell adhesion was observed by seeding pre osteoblast cell (MC3T3-E1) at densities of 5 x 10^4 cells/ml and cultured for 5 h.

Results: Fig. 1 (a) and (b) show SEM image of PEI coating layer hybridized with silica in 20 vol%. Dense layer and porous layer were formed without any cracks. From the FT-IR analysis intensity of Si-O-Si peak increased as silica contents increased and silica was formed without any other reaction with PEI. Fig. 2 shows the pH change after immersing the specimen in SBF solution. Dense and porous PEI coating layer restrain the rapid pH increase of bare Mg and pH increases faster at magnesium with porous PEI coating compared with dense one. Furthermore pH value can be controlled with the ratio of silica. Fig. 3 shows the SEM image of attached cell morphology on the specimen. The cells on porous PEI had well spread and flat morphologies than those of dense PEI. Similarly the cells well spread out and flattened on the PEI-silica hybrid coating than those on the pure PEI coating.

Conclusions: Both dense and porous PEI-silica hybrid were coated uniformly without any cracks on Mg substrate by spin-coating method. We can assume by the pH change of SBF solution that it is possible to control the corrosion rate of Mg with the ratio of silica in PEI. Furthermore biocompatibility was improved by hybridizing silica with PEI.

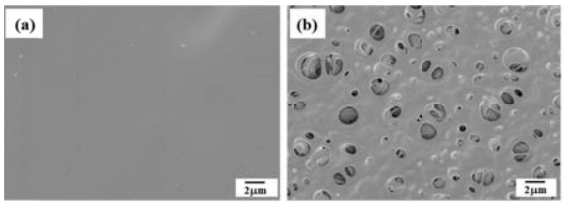

Figure 1. SEM image of (a) dense and (b) porous PEI coating layer hybridized with 20 vol% of silica

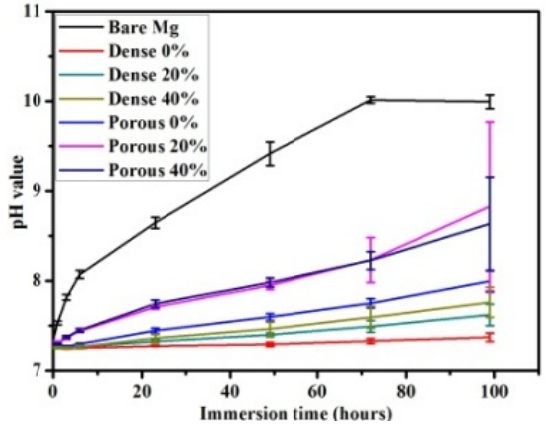

Figure 2. pH change after immersing bare Mg, 0, 20, 40 vol% of silica hybridized dense and porous PEI coated Mg in SBF

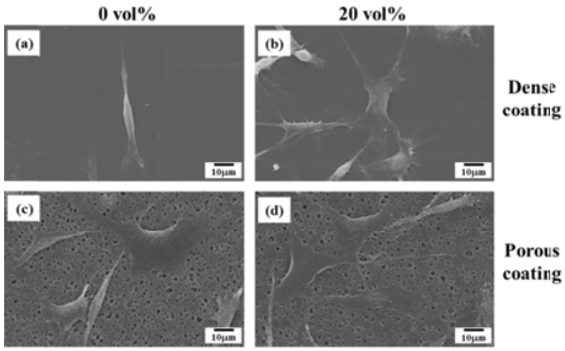

Figure 3. FESEM image of cell morphology after 5 hours on dense PEI with (a) 0 and (b) 20 vol% of silica and porous PEI with (c) 0 and (d) 20 vol% of silica

REFERENCES

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