Hybrid Coating of Silica Xerogel/Chitosan for Controlled Release of Biomolecules

[1]Shin-Hee Jun, [1]Eun-Jung Lee, [2]Jun-Hyeog Jang, [3]Hae-Won Kim and [1]Hyoun-Ee Kim
[1]Department of Materials Science & Engineering, Seoul National University, Seoul, 151-744, Korea
[2]Department of Biochemistry, School of Medicine, Inha University, Incheon, 400-712, Korea
[3]Department of Biomaterials Science, School of Dentistry & Institute of Tissue Regeneration Engineering (ITREN), Dankook University, Cheonan, 330-714, Korea

Introduction:

Bioactive coating on a metallic implants has been widely applied to enhance bone ingrowth and healing behavior. Among the bioactive materials for the coating on the metallic implants, sol-gel derived silica xerogel has been found to be effective for biomolecules carriers because of its excellent bioactivity and mesoporous structure, which it enable to encapsulate the biomolecules such as drugs, proteins and growth factors [1, 2]. Because silica xerogel shows the burst effect, it was hybridized with chitosan as organic substance. The hybridization was effective not only for controlling the release rate but also for enhancing mechanical properties. Therefore, in this study, we fabricated the hybrid coatings containing biomolecules and evaluated their *in vitro* properties. As biomolecules, vancomycin and fibroblast growth factor (FGF) were tested.

Materials and Methods:

Biomecules loaded silica xerogel/chitosan hybrid coating was fabricated by sol-gel process at room-temperature. The sol-gel derived silica xerogel containing Ca and P (15, 5 wt%) synthesized and chitosan solution dissolved in 2 wt% acetic acid was mixed with different volume ratios (silica sol = 10, 30, 50, 70 vol%). After the hybrid solution was prepared, vancomycin (20 mg/ml) and fibroblast growth factor (FGFs) (100 μg/ml) as biomolecules were mixed in the hybrid sols. As a coating substrate, commercially pure Ti disc (12 mm in diameter x 1 mm) was treated 5 M NaOH solution in order to promote adhesion property. The hybrid sol containing biomolecules was spin-coated on the Ti substrates with at 3000 rpm for 1 min and then dried at 37 ℃ for 1 h in humid atmosphere. *In vitro* vancomycin and FGF release rate were examined in 2 ml phosphate buffer saline (PBS) at 37 ℃ for 30 and 7 days, respectively. The absorbance values were measured at 280 and 220 nm for vancomycin and FGF, respectively, on an UV-spectrophotometer (n=3).

Results:

The morphologies of the bioactive hybrid coatings with encapsulating biomolecules were observed by SEM. Both the vancomycin and FGFs-containing coating were crack-free and uniform surface morphologies. Figure 1 and 2 show the vancomycin and FGFs release profiles in PBS for 30 and 7 days, respectively. The release kinetics from the hybrid coatings strongly depends on the composition. The initial burst, which is presented due to the high surface area of the silica xerogel, was reduced markedly with increasing chitosan contents.

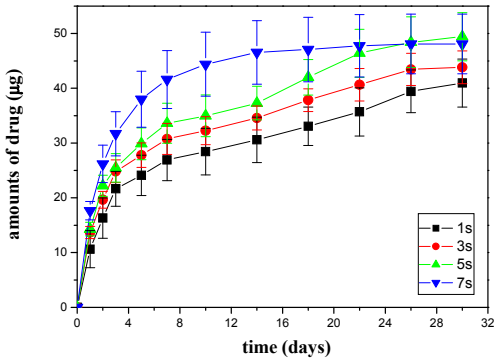

Figure. 1. Cumulative vancomycin released as a function of time (days) in PBS

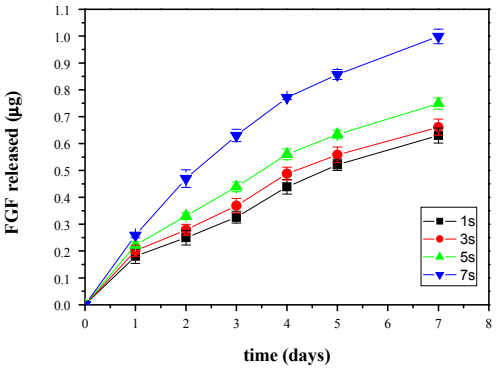

Figure. 2. Cumulative FGFs release as a function of immersion time (days) in PBS

Conclusions:

The bioactive silica xerogel/chitosan hybrid layer containing biomolecules was coated uniformly on titanium. The vancomycin and FGF were released steadily through long term period. The release rate from the coating layer was controlled by adjusting the composition of the hybrids.

Reference

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2. Aughenbaugh, W. J. Biomed. Mater. Res. 2001;57;321-326