

Preparation of porous β -TCP scaffolds coated with sol-gel-derived SiO_2 glass

(Nagoya Institute of Technology) ○Ye Zhu, Akiko Obata, Toshihiro Kasuga

問合せ先 ; E-mail: kasuga.toshihiro@nitech.ac.jp

Introduction β -tricalcium phosphate (β -TCP) scaffolds with high porosity play an important role in the recovery of bone defects due to its excellent biocompatibility and bioresorbability. Cellular compatibility and bone formation were reported to be enhanced on porous material because macropores have a significant role in osteogenic outcomes and they have the ability of bone-formation-inducing protein adsorption. Recently, a trace amount of silicon-ion-species was reported to enhance the osteoblast proliferation¹⁾. A porous scaffold with silicon-ion-species releasability is expected to have excellent bone-forming ability. In the present work, the skeleton surface of porous β -TCP was coated with the thin layer of a sol-gel-derived SiO_2 glass, which was supposed to improve its mechanical properties and provide silicon-ion-species releasability. Hydrothermal treatment was found to be effective for joining between β -TCP and the sol-gel-derived glass.

Experimental procedure β -TCP powders were ball-milled with ethanol for 2 days. The ball-milled powders were uniaxially pressed to form a disk-shape pellet. The pellet was sintered at 1070 °C for 3 h. The resulting β -TCP pellet was autoclaved at 140 °C for 2 h. The β -TCP pellets before and after autoclaving were characterized by thin film X-ray diffractometry (TF-XRD). The porous β -TCP ceramic was prepared by heating an urethansponge after coating with slurry consisting of β -TCP powder and an aqueous solution of polyvinyl alcohol (PVA) (β -TCP powder: PVA=2 : 1 (wt ratio)). The resulting β -TCP ceramic was autoclaved at 140 °C for 2 h and characterized by Fourier-transform infrared reflection spectroscopy (FT-IRRS). The autoclaved β -TCP ceramic was dip-coated with silica-sol prepared via hydrolysis of tetraethoxysilane with a mixed solution of EtOH and HCl. The dip-coated sample was dried at 50 °C for 1 h, and then heated at 1000 °C for 1 h. The resulting sample was observed with a scanning electron microscope (SEM) incorporating energy dispersive spectrometer (EDS). The compressive strength test was carried out at a crosshead speed of 0.5 mm/min in an ambient condition.

Results and discussion Figure 1 shows the TF-XRD patterns of the β -TCP surface before and after autoclaving. The intensities of the peaks corresponding to β -TCP decrease after autoclaving. An amorphous phase was suggested to form on the surface by autoclaving. FT-IRRS results showed that hydroxyl groups form on the β -TCP surface of after autoclaving. SEM observation and EDS results showed that the surface of the autoclaved β -TCP was covered with the sol-gel-derived SiO_2 glass, while that of non-autoclaved one was not done with the layer. The sol-gel-derived SiO_2 layer is supposed to make bond with β -TCP through the amorphous layer containing a large amount of hydroxyl group. The compressive strength of the ceramic was estimated to be 240 kPa; it was about 20 times larger than that of β -TCP without the SiO_2 coating.

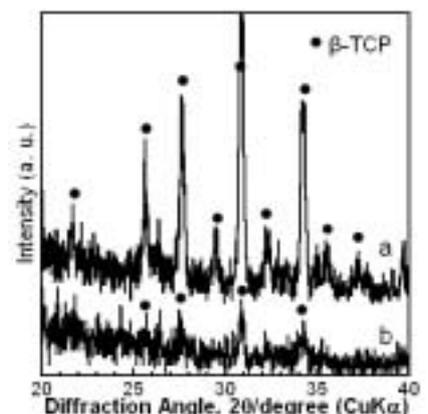


Figure 1 TF-XRD patterns of β -TCP (a) before and (b) after hydrothermal treatment

1) I.D. Xynos et al., Biochemi. Biophys. Res. Comm., 276, 461-465(2000).