Temperature Effect on Biomimetic Ca-P Coating Formation

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Statement of Purpose: Biomimetic calcium-phosphate coatings have been prepared by soaking metal implants/substrates into a simulated body fluid (SBF) [1]. Research has demonstrated that the biomimetic calcium phosphate coating can promote direct bone apposition [2]. However, the extremely long coating process (i.e. 7-28 days) makes this coating technique less cost-effective. Many studies are aimed to develop a better understanding of the coating technique so as to expedite the coating process without compromising the coating quality [3,4]. In this study, we studied the effect of temperature on the biomimetic calcium phosphate coating formation.

Methods: The SBF solution was prepared based on the procedure published by Kim *et al* [5], except that the Ca^{2+} and HPO_4^{2-} concentrations were 7.5 mM and 4.5 mM, respectively. Commercially available titanium discs were used as the substrates in this study. These discs were sandblasted, gritted and acid etched. They were thoroughly washed with de-ionized water before immersed in the SBF solution. The formation of the coating was carried out at three different temperatures: 20, 40 and 60ºC. After soaked at each temperature for 24 h, the discs were removed from the solution, gently washed and dried at 60ºC in an oven for overnight. The coatings were characterized using X-ray diffraction (XRD) and Fourier transform infra-red (FTIR) to determine the composition of the coating. Environmental electron scanning microscope (ESEM) was also used to examine the surface morphology of the coating.

Results/Discussion: Homogenous Ca-P coatings with a reasonable thickness between 5-30 µm were formed on the surfaces of titanium discs under all three operating temperatures within 24 h soaking in SBF. Fig. 1 shows the XRD patterns of the Ca-P coatings formed at different

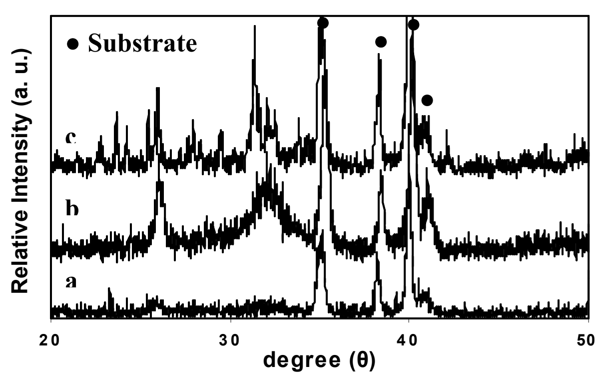

Fig. 1. XRD patterns of Ca-P Coatings formed at a) 20ºC, b) 40ºC and c) 60ºC.

temperatures. At 20ºC, except for the sharp peaks attributed to the titanium substrate, a "glass bulge" with no sharp peaks discernable was observed (Fig. 1a), suggesting that the Ca-P formed was an amorphous material. As the soaking temperature increased to 40ºC, a slight bulge in combination with some peaks were observed (Fig. 1b), indicating a poorly crystallized Ca-P coating was formed. The crystallinity of the coating improved with the increase of the temperature. At 60ºC, a relatively crystallized Ca-P coating was formed (Fig. 1c).

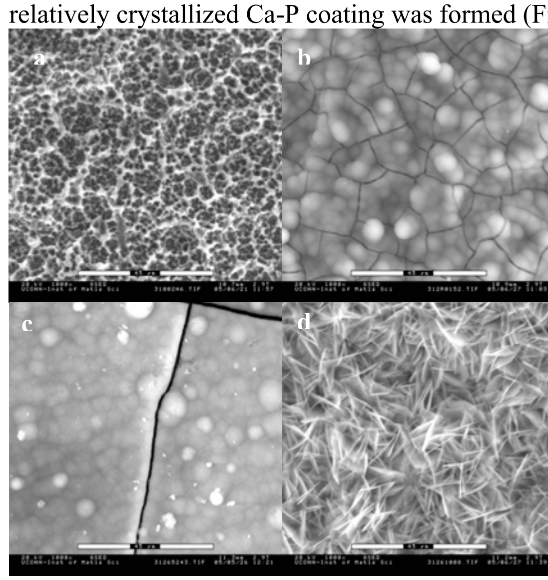

Fig. 2. ESEM images of (a) the titanium disc, and Ca-P coating formed at (b) 20ºC, (c) 40ºC and d) at 60ºC, respectively.

The surface morphology of the coating also varied substantially with the coating temperature. Figure 2 shows the ESEM images of the titanium disc before and after Ca-P coating at 20, 40, and 60ºC, respectively. It has been observed that the Ca-P coatings were uniformly deposited on the surface of the titanium discs. At a relatively low soaking temperature, such as 20ºC, the coating illustrated a dense feature (shown in Figure 2a). When the temperature was increased, the coating became more and more porous and rougher. At 60°C, a porous Ca-P coating with large Ca-P crystals was observed, as shown in Figure2c.

Conclusions: A new, promising biomimetic coating method has been developed to apply Ca-P coating on titanium substrates. A significantly shorter deposition time was required to achieve a homogenous coating with reasonable thickness. The coating crystallinity and morphology can be tailored to be suitable for different biomedical applications.

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