Effect on Composition on Antibacterial Properties of Hydroxyapatite/TiO₂ Composite Coating Deposited by Suspension Plasma Spray

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Introduction
The surface of implants is coated with Hydroxyapatite (HAp) which can promote Osseointegration. However, such the surface is sometimes exposed to bacterial infection and then the application of photocatalyst to achieve antimicrobial properties has been investigated⁴. Titania can exhibit photocatalytic property under visible light. However, the effects of composition of HAp/Titania, particularly TiO₂ phases, particularly Ti₃O₇ and Ti₄O₇ phases have been applied by Suspension Plasma Spray (SPS) method, on antibacterial property has not been revealed yet.

Experimental Procedure
HAp and TiO₂ powders were used as feedstocks to prepare coating of four different compositions. The coated layer was deposited on pure titanium by SPS method. XRD measurement (Rigaku, Japan) was also conducted using CuKα radiation (45KV, 200mA) to analysis the crystallographic structure. RAMAN spectroscopy was also conducted to identify the phase of the coating.

Result and Discussion
Fig. 1 shows the phase distribution of the SPS coating by XRD. HAp coating has sharp peak from HAp at 2θ = 32° with higher crystallinity. SPS could decompose Ti₂O₃ into TiO₂ & Magneli phases, particularly Ti₅O₇ and Ti₆O₇ phases were detected by Rietveld analysis. Table 1 demonstrated that the quantity of Magneli phase was increased corresponding to the weight percentage of TiO₂ feedstocks. Fig. 2 shows the phase identification of the SPS coating by Raman. Note that peak intensities of HAp, Rutile & Anatase phase has been substituted using the reference intensity value, obtained from unheated raw powder. Coating with 20 wt.% TiO₂ only showed rutile phase. Last two composite coating with higher amount of TiO₂ exhibited peak from Anatase and Magneli phases which mainly contained due to suppressed thermal decomposition. The vibrational frequency at 210, 240, 247, 265, 605 and 615 cm⁻¹ were attributed to Magneli phases. Both XRD quantitative analysis and Raman results certified that Magneli phases can be increased by nominal composition of TiO₂ which can enhance the antibacterial property due its visible light sensitive photocatalytic performance. The antibacterial evaluation will be shown in the presentation.

Conclusion
Novel SPS successfully could produce composite coating of HAp with TiO₂ containing Magneli phase, which can be potentially applied for antibacterial coating.

Table 1: Phase composition of SPS coatings

<table>
<thead>
<tr>
<th>Coating Type</th>
<th>Weight ratio of Crystal Phase [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>HAp100: TiO₂ 0</td>
<td>100</td>
</tr>
<tr>
<td>HAp80: TiO₂ 20</td>
<td>65</td>
</tr>
<tr>
<td>HAp60: TiO₂ 40</td>
<td>52</td>
</tr>
<tr>
<td>HAp50: TiO₂ 50</td>
<td>49</td>
</tr>
</tbody>
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References.