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DEVELOPMENT OF HA/TI COMPOSITE FOR BIOMEDICAL APPLICATION VIA POWDER INJECTION MOLDING

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ABSTRACT

Hydroxyapatite (HA, $Ca_{10}(PO_4)_6(OH)_2$) has excellent biocompatibility, however it has poor in mechanical properties. HA combines with titanium alloy is one way that can be performed to get a superior material. The aim of this study was to develop HA/Ti6Al4V composite with 10wt% HA using PIM. HA/Ti6Al4V composite was successfully prepared by \palm stearin and polyethylene as binder system. The physical, mechanical and biocompatibility properties of sintered parts were investigated. The results show Young's modulus (37.39-45.32 GPa), flexural strength (75.04-119.39) and hardness properties (2.22-2,28GPa) properties tend to increase with increasing sintering temperature. In vitro and cytotoxicity test show the growth of Ca-P as indicator for biocompatibility properties and also did not demonstrate a cytotoxic effect during the condition of this study.

1.0 Introduction

The PIM process typically consists of four stages: mixing, injecting, debinding, and sintering (1). HA has a chemical structure similarity with human bones. However, it is not recommended for heavy loading application due poor performance in mechanical properties. HA with other metal via powder injection molding is one of options to obtain superior material for implant.

2.0 Materials and Method

10 wt %, HA and 90 wt % Ti6Al4V powder in spherical shape were used in this work using particle size 5 µm and 25 µm, respectively. Binder system for both of powder was palm stearin and polyethylene with composition 60 wt % and 40 wt %, respectively. Brabinder mixing machine was used to mix powder and binder with mixing temperature 150^{o}C and mixing speed 30 rpm. The binder system was removed from green part through thermal debinding under argon flow, and sintering was performed under vacuum condition. The mechanical properties of the sintered HA/Ti6Al4V composite were analyzed using INSTRON 5567, an Instron universal test machine based on MPIF standard 15. SEM was used to study the surface morphology. Simulated body fluid and cytotoxicity test was performed to analysis biocompatibility properties.

3.0 Results and Discussion

Fig 1 shows, Young's modulus, flexural strength and hardness tend to increase with increasing sintering temperature. Maximum value of mechanical properties was achieved at sintering temperature 1300^{o}C. The increase in weight occurred in the sintered sample during immersion in SBF solution as an indication of precipitation of Ca-P phase on the sample (2).

Fig 2, shows the morphological change in the sintered part during immersion process. The nucleation and growth of Ca-P phase occur on the surface of sintered part (3). After eight week, the morphology of the sintered part displayed a Ca-P phase layer with plate-like crystal. Based on cytotoxicity test, HA/Ti6Al4V did not demonstrate a cytotoxic effect.

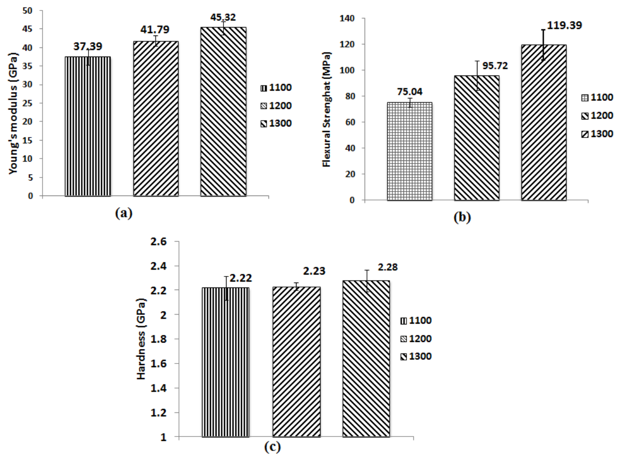

Fig.1. Effect sintering temperature on mechanical properties of HA/Ti6Al4V composite.

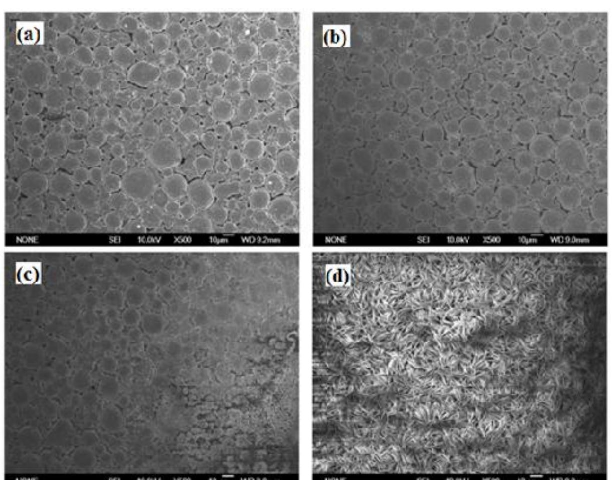

Fig 2. Morphological changes of the sintered part of HA/Ti6Al4V during immersion in SBF solution after (a) 1, (b) 3, (c) 6, and (d) 8 weeks.

4.0 Conclusion

In summary, HA/Ti6Al4V composite with a 90 wt% Ti6Al4V and 10 wt% HA was fabricated successfully via PIM. Based on *in vitro* test using SBF, HA/Ti6Al4V composite showed induces nucleation and growth of Ca–P phase on the surface of the Ti particles (4). In addition, the HA phases decomposed and formed a secondary phase, which still endowed for increasing the biocompatibility of the Ti6Al4V.

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