ADVANCES IN MATERIALS ENGINEERING

Volume 1

Edited By:
Zahurin Halim
Iskandar Idris Yaacob
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Chapter 021

The Influence of Hydroxyapatite Loading on Protein Foaming-Consolidation Porous Alumina Sintered at 1300°C

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Keywords: Porous alumina, hydroxyapatite, composites, protein foaming-consolidaion.

Abstract. The aim of this work is to investigate the effect of hydroxyapatite (HA) on physical properties of porous alumina bodies fabricated through protein foaming-consolidation method using egg yolk as a pore creating agent. Hydrothermal derived HA powder was used as bioactive ceramic. Alumina and HA powders were mixed with yolk, starch and darvan 821 A at an adjusted mass ratio to make slurry. HA-to-alumina mass ratio were in the range of 0.0 to 0.8 w/w. The slurries were cast into cylindrical shaped molds and then dried for foaming and consolidation process. Subsequently, the dried bodies were burned at 600°C for 1 h, followed by sintering at temperatures of 1,300°C for 2 h. The porous alumina-HA composites with pore size in the range of 50-500 μm and densities of 2.7 – 2.9 g cm^{-3} were obtained. Porosity of bodies decreased from 35.9 to 31.7% when HA-to-alumina mass ratio increased from 0.0 to 0.8 w/w. Compressive strength of sintered body was 0.8 MPa at 35.9% porosity and 2.9 MPa at 31.7% porosity. X Ray Diffractometer (XRD) pattern showed the intensity of tricalcium phosphate (TCP) phase in bodies increased with HA loadings.

Introduction

Calcium phosphate ceramics have received much attention as potential bone graft substitute because of their biocompatibility, bioactivity and osteoconduction characteristics. The most widely used calcium phosphate-based bioceramics in bone replacement is hydroxyapatite (HA, $Ca_{10}(PO_4)_6(OH)_2$) [1]. HA also has excellent biocompatibility with hard tissues and high osteoconductivity and bioactivity despite its low degradation rate, mechanical strength and osteoconductive potential [2]. Porous HA exhibits strong bonding to the bone because the porosity and bioactivity allows the in-growth of bone tissue to achieve full integration with the living bones. Thus porous HA have been applied in many applications such as for cell loading, drug releasing agents, chromatography analysis and most extensively, for hard tissue scaffolds [3]. Porous HA has low mechanical properties, therefore normally porous HA implants cannot be heavy loaded and are used to fill only small bone defects. This is due to larger pores, strength of the implant decreases significantly [4]. The porous HA are usually very brittle and prone to fracture upon sudden impact, particularly during the healing stage. Therefore, it is desirable to develop scaffold implant materials with both reliable mechanical properties and porous structures, similar or superior to natural bones [5]. To improve the mechanical strength while maintaining the bioactivity of the scaffold, porous alumina-HA have been shown to have higher strength than the HA porous implant and exhibited a similar bioactivity and osteoconductivity property to the HA porous implant [4].