# ADVANCES IN MATERIALS ENGINEERING

## Volume 1

Edited By:
Zahurin Halim
Iskandar Idris Yaacob
Md Abdul Maleque

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Chapter 023

# Porous Alumina-Hydroxyapatite Composites via Protein Foaming-Consolidation Method: Effect of HA Loading on Physical Properties

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

**Abstract.** The porous alumina-hydroxyapatite (HA) composite bodies with good interconnectivity were successfully prepared via protein foaming-consolidation method. The egg yolk was used as a pore creating agent. Alumina and HA powders were mixed with yolk, starch and Darvan 821 A at an adjusted mass ratio to make slurry. 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 1,550°C for 2 h. The porous alumina-HA composites with pore size in the range of 50-500 μm with good interconnectivity were obtained. The densities and porosity were in the range of 2.15 – 2.48 g $cm^{-3}$ and 36.7 - 45.8%, respectively. The increasing HA-to-alumina mass ratio in slurries from 0.4 to 0.6 w/w increased compressive strength of sintered bodies from 2.9 to 24.2 MPa. XRD pattern result shows the presence of tricalcium phosphate (TCP) phase in the sintered bodies.

## Introduction

Ceramic materials based on alumina are widely used in the manufacture of medical implants. Today, alumina ceramics as specified by ISO 6474 are generally approved as biomaterials for use in total joint replacement because of inertness, excellent biocompatibility and high wear resistance [1,2]. However, replacement surgery is still associated with complications. For example, in total hip replacements, loosening of the acetubular or femoral components and wear debris remain problem. The problem of loosening is attributed to bioactivity of the material at the bone prosthesis interface, and the problem of wear debris is attributed to the articulating surface of the joint prosthesis [3].

Although the mechanical properties of hydroxyapatite (HA) as an implant material are not as good as those of alumina (Al), it has been reported that HA bonds to bone owing to its bioactive property. Therefore, to solve the problem of the border between alumina and bone, we developed HA coated porous alumina ceramics (HA/Al). HA/Al have high mechanical strength as well as bioactive properties [3].

Many researchers have reported on HA coating on various implants, and it is known that HA coating stimulates bone formation. Youn et al. fabricated alumina porous bodies using the polyurethane sponge and the hydroxyapatite were coated onto the porous alumina substrates. This techniques resulted porous bodies with 90-75% porosity and compressive strength of up to 6 MPa [4]. Saki et al. have developed composite ceramic bioscaffold of hydroxyapatite-alumina and silicon carbide by using an organic template which is commercial polyurethane sponge with an open