

ADVANCES IN MATERIALS ENGINEERING

Volume 1

Edited By:
Zahurin Halim
Iskandar Idris Yaacob
Md Abdul Maleque



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Effect of Milling Time on Mechanochemically Synthesized Nanohydroxyapatite Bioceramics

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Abstract. This chapter presented nanosized hydroxyapatite (HA) powder synthesized via mechanochemical method by a dry mixture of calcium hydroxide $\text{Ca}(\text{OH})_2$ and di-ammonium hydrogen phosphate $(\text{NH}_4)_2\text{HPO}_4$ powders. The effect of mechanochemical processes on the sintered compacts properties were further investigated by prolonged milling times from 15 hours to 30 hours and 60 hours at 370 rpm respectively. Powders with uniaxially compacted at 2.5 MPa and cold pressed at 200 MPa were sintered from 1050-1350°C. The maximum hardness and density were achieved by powders milled in 60 hours with 5.31 GPa and 98.6% respectively. 1250°C is the optimum sintering temperature to produce higher density and hardness compared to other sintering temperatures.

Introduction

Hydroxyapatite (HA) is clinically used numerously in dentistry, orthopaedic and maxillofacial surgery area [1]. There are two types of HA that have been studied earlier such as in porous [2] and in dense form [3]. Development of dense HA ceramics with superior mechanical properties is possible if the starting powder is stoichiometric with better powder properties such as crystallinity, agglomeration, and morphology. Nano scale grain size in dense sintered materials is a desired parameter to enhance the mechanical and biological properties of HA-based bioceramic materials [4]. Powder properties depend on the types of synthesis method used which comprising of wet precipitation [3], sol-gel [5], hydrothermal [6] and mechanochemical [7-9].

Mechanochemical milling has been used since 1922 where the materials components are synthesized by deformation process through ball-particle, particle-wall, and particle-particle collisions [10] at a particular time, leading to the chemical reaction between particles to form new nanosize composites or powders. Mechanochemical is a simple and low cost method compared to others. Besides, it has been recently receiving attention as an alternative route in preparing materials characterized by better biocompatibility with natural bone [7-9]. Dry mechanochemical was reported to be more benefits compared to wet mechanochemical due to faster reactions without water addition and a very low level of pollution by the mill material, whereby powders obtained can be use directly without filtering and drying stage [11]. Some studies have used dry mechanochemical method in producing calcium phosphate bioceramics in various milling times [9], fluoride substituted HA [12] and nanocomposite HA [13]. Although there were a lot of investigations on milling times in mechanochemically synthesized powder [9, 14-15], but the powders conversion to dense bodies and the effect of sinterability on various milling time powders