UNIVERSITI TEKNOLOGI MARA

THE INFLUENCE OF ZINC INCORPORATION ON THE PHYSICOCHEMICAL PROPERTIES OF ZINC DOPED CALCIUM PHOSPHATE

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

Calcium phosphate ceramics have generated growing interest in biomedical applications because of the biocompatibility properties. However, calcium phosphate ceramics are not identical enough compared to the mineral components of human bone and teeth. It is observed that bone consists of various substituted ions. Thus, ionic substitutions have been proposed to mimic the bone chemical composition. Ionic substitution can alter the chemical and physical characteristics of calcium phosphate ceramics. In addition, having hydroxyapatite and β-tricalcium phosphate as biphasic mixture is favourable for biomedical applications such as bone defect repair. In this study, several zinc concentrations (0, 5, 10 and 15 mol%) were substituted and the characteristics such as phase composition, crystallinity (the fraction of completely crystallised phase), crystallite size (single crystal size), lattice parameters and particle size of the as-synthesized samples were evaluated. The result shows with increased zinc content, the XRD peaks were broadening, the lattice parameters were decreased, the crystallite size and crystallinity of the as-synthesized samples were also decreased. Then, based on thermogravimetric analysis, the as-synthesized samples were calcined at several calcination temperatures (600, 700, 800, 900, 1000 °C) to identify the suitable biphasic mixture ratio. In calcination process, hydroxyapatite phase in all samples was stable at 600 °C and started to decompose into β-tricalcium phosphate at 700 °C. Calcination temperature at 700°C was chosen as pre-sintering temperature since hydroxyapatite phase was the dominant phase for zinc substituted calcium phosphate ceramics. The effects of sintering temperatures from 900 to 1100 °C on the samples in terms of phase stability, physical and mechanical properties were determined. The sintered samples showed an increase in β-tricalcium phosphate phase in all samples and formation of α-tricalcium phosphate phase in sintering temperature of 1100 °C. An increase in density was observed in all samples as sintering temperature increased. 5 mol% zinc substituted showed the highest density value of 2.94 g/cm^3 at the sintering temperature of 1000 °C while the compressive strength was found to be higher at 112 MPa and the hardness value at 2.0 GPa. The hardness value and compressive strength decreased with further increase in zinc content at the same sintering temperature. This study demonstrated that the properties of calcium phosphate can be tailored by ionic substitution and affected the calcination and sintering behaviour process.

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CHAPTER ONE
INTRODUCTION

In this chapter, it covers the background of the study, problem statement and research objectives that give the framework for this thesis. Then, the scope of this study is discussed and followed by the significance of this study and lastly the thesis outline.

1.1 BACKGROUND OF THE RESEARCH

Bone is a complex living tissue known as hard tissue which has a sophisticated structure. The bones and skeleton system serve an important role in protecting vital organs and also provide support and movement. Bone consists of inorganic minerals, organic soft composite organised together by a structural framework. Bone is made up of 69 wt% of biomineral constituents in protein matrix, 22 wt% of organic constituents and 8 wt% of water [1, 2]. There are two types of bone structures known as a cortical and cancellous bone. Cortical bone also known as compact bone which forms the outer shell of most bones while cancellous bone known as spongy bone which fills the interior of the bone as shown in Figure 1.1.

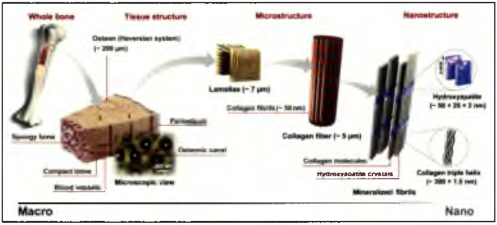

Figure 1.1 : The typical bone structure categorise at different length scales [3]

Bone is vulnerable to fractures due to damage and deteriorating diseases which is frequently related to ageing. Thus, there has always been a need, for the repair of