UNIVERSITI TEKNOLOGI MARA

THE EFFECT OF ZIRCONIA CONTENT IN HAP-ZIRCONIA FEEDSTOCK USING PALM STEARIN BINDER SYSTEM

NURUL JANNAH BINTI ABD LATIFF

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ABSTRACT

The purpose of this study is to investigate the performance of feedstock containing HAp-ZrO_2 bioceramic powder with palm stearin (PS) based binder system. Formerly, the stability of the HAp-ZrO_2 reinforcement involving the method and improvement on their mechanical strength has been reported widely by the researchers. However, the study on the effect of ZrO_2 composition on HAp-ZrO_2 feedstock is scarcely testified. Therefore, in this investigation, the feedstock was varied with three different weight percentage composition; 90-10, 80-20 and 70-30 of the HAp-ZrO_2 and the optimum powder loading of 60 vol % was remained for each composition. Different weight composition of HAp-ZrO_2 resulted in different characteristics of the as-mixed powder similarly in their mixing behaviour. Therefore, the performance of HAp-ZrO_2 composite powder is studied through the particle size distribution, pycnometer density and X-ray diffraction (XRD). Then, the influence of ZrO_2 percentage content in the feedstock also is observed via the rheological study. The rheological response of MIM feedstock by means of a capillary rheometer is essential to be carried out in order to examine the viscosity and flow behaviour index of the feedstock. From the analysis, the increasing content of ZrO_2 up until 20wt% resulted in homogenous mixing of both HAp and ZrO_2 powder. However, the 30wt% ZrO_2 content in the feedstock is indeed affecting the mixing behaviour of the as-mixed powder as its XRD patterns showed the evident differences in the peak present. In term of rheological study, the 70-30wt% of HAp-ZrO_2 is deemed unfit for MIM processes based on the too high viscosity and too low of *n* value. On the other hand, both 10wt% and 20wt% of ZrO_2 content in the HAp-ZrO_2 feedstock exhibit a pseudoplastic properties which were favourable for MIM processes.

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INTRODUCTION

1.1 BACKGROUND OF STUDY

In recent decades, the human desired to enhance the living standards as well as longevity has prompted a massive advancement of area associated to life science. As the result, the researcher throughout the world have been keen on investigating the bioceramics and their clinical applications. This is due to the impressive ability of bioceramics which can be used inside the human body without refusal to replace several diseased or impaired part of the musculoskeletal system (Vasconcelos, C., 2012).

One of the well-known bioceramic material is hydroxyapatite (HAp), $Ca_{10}(PO_4)_6(OH)_2$. HAp has been intensely used as implant material such as bone replacement due to its resemblance in natural bone material with the composition of 70% in human body. Possessing the unique bioactivity characteristics such as good biocompatibility, osseoconductivity and bioaffinity with living tissues, HAp stimulates speedy bone growth besides provides strong interfacial fixation for orthopaedic and dental applications (Subuki et al., 2014). Yet, the major drawback of HAp is having the inferior mechanical properties such as high fragility, low strength and low fracture toughness. This disadvantages results in the limitation of usage in load-bearing applications. Therefore, the improvement of the mechanical properties of metal-ceramic is needed to be done by incorporating the metallic materials. Due to this, the reinforcement of zirconia (ZrO_2) to the HAp matrix in the form of particles, platelets, fibers or nanoparticles has gather much interest.

According to the research, ZrO_2 has been found to have a good biocompatibility coupled with the tendency to boost the mechanical properties of HAp. Owing to the martensitic transformation of tetragonal↔monoclinic ZrO_2 (T↔M), zirconia-based