UNIVERSITI TEKNOLOGI MARA

EFFECT OF PALM STEARIN AS SINGLE BASED BINDER ON PROPERTIES OF CERAMIC INJECTION MOLDED OF HYDROXYAPATITE FOR SCAFFOLD APPLICATIONS

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ABSTRACT

Palm stearin (PSr) or known as vegetable fat has been introduced in injection moulding processes which has great potential as an alternative binder in a binder system.This study presents the processing of Hydroxyapatite (Caio(P04)6(OH)2) mixed with 100 vol.% of single based binder palm stearin (PSr) using CIM. The main objective of the research was to determine the optimum formulation of powder-binder mixture via mixing torque and rheological analysis. The process generally started with the selected commercial HAp powder and the binder in correct proportions. From the CPVP test, the critical loading was 70.64%, thus the formulation was formulated below 2-5 vol.% critical loadings. Four different volume fractions of the powder were investigated: 62, 64, 66, and 68 vol.%. During the rheological test, the feedstock containing the mixture and the binder exhibited pseudoplastic properties, which was lower than 200 Pa.s with function of shear rate.The injection moulding process was successfully carried out in the injection temperature range of 65°C to 70°C which corresponded to 300 kPa to 400 kPa injection pressure being applied and followed the ASTM CI424-10. Compared to other previous research, the temperature used was slightly higher than 130°C due to the absence of a backbone binder. The moulded dumbell shape was completely debound and sintered in one complete cycle using a single furnace with the presence of wieking media to remove the PSr binder. Next, the sample was subsequently sintered at three different temperatures of 900°C, 1000°C and 1100°C to allow diffusion of the particles. Besides that, the DSC result showed the melting point of the PSr binder was at 62°C, thus the mixing temperature was applied slightly higher at 70°C which allowed for homogenous mixing. The shrinkage result showed that higher formulation (68 vol.%) resulted in - lower shrinkage properties; higher sintering temperature contributed to higher shrinkage properties. This was due to the higher powder loading which meant smaller compact volume shrinkage and easier dimension tolerance control,which is very important for complex injection molded parts. Next, the pore size of the as-sintered sample was measured using a micrometric instrument. The porosity result obtained showed that higher volume fraction of the powder loading resulted in higher porosity; 62 vol.% resulted in about 38% porosity and 68 vol.% resulted in about 41% porosity respectively. The porous structure shown in SEM images was highly interconnected; thus it promoted better bone tissue ingrowth for implant application. The XRD result obtained showed the TCP formation was at 1100°C thus decreasing the compressive strength of HAp.

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