Microwave Processing of Amorphous Magnesium-Calcium Phosphate

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Statement of Purpose: In this presentation, we report microwave sintering of magnesium-calcium phosphates with predominantly amorphous phases and calcium phosphate and magnesium phosphate. Different Mg:Ca ratios on densification, microstructure evolution and mechanical properties were studied. The sintered amorphous materials of calcium-magnesium phosphate was solid solutions of β-tricalcium phosphate doped with magnesium with a chemical formula of $Ca_{(3-x)}Mg_x(PO_4)_2$.

Methods: The amorphous magnesium-calcium phosphate (aMCP), MgP and aHA powders were prepared according to a precipitation method from ethanol medium which previously published by our group. Table 1 represents the composition of the powders. Powders were pressed to form compacted pellets prior to heat treatment via microwave. 1 g of each powder sample was put into a 1 cm diameter cylindrical steel die and pressed using a uniaxial hydraulic press at 10 ksi for 3 min. The compacted pellets were sintered in a semi-industrial grade microwave sintering samples were heated at 1150 °C for about 20 minutes, after which they were allowed to cool to room temperature [1-2].

#	Mg Mmole	Ca Mmole	P Mmole	Mg:Ca	(Mg+Ca): P
H6	22.5	22.5	22.5	1	2
H7	15	30	22.5	0.5	2
H8	30	15	22.5	2	2
H9	45	-	28	-	1.63
H10	-	45	28	-	1.63

Table 1 composition of powders

Results:

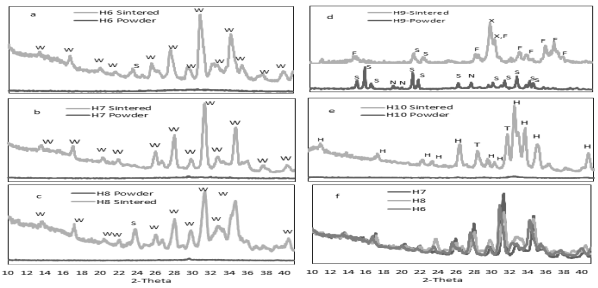

Fig 1 (a-c) X-ray pattern of β-T(Ca, Mg) P). Peaks w represent Whitlockite, peaks S represent Standfieldit. (d) X-ray pattern of sintered MgP, peaks S represents Struvite, peaks with N represent Newberiyte, peaks F with represent Trimagnesium Bis(phosphate(v)), Peaks with X represents (e) X-ray pattern of HA/β-TCP, Peaks H represent HA and peaks T represent β-TCP. (f) Shift of peak positions of the β-T ((Ca, Mg) P) due to the substitution of Mg^{2+}.

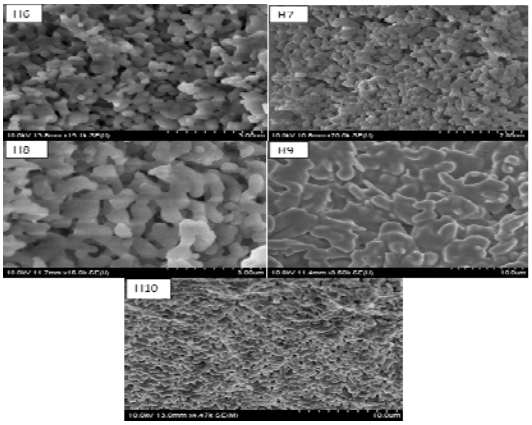

Fig 2 Microstructural evolution of β-T(Ca, Mg) P)(H6, H7, H8), HA/β-T(Ca, P) (H10) with an average size of 2.7 µm and MgP sintered (H9) with average particle size of 8.5µm when sintered at 1150°C .

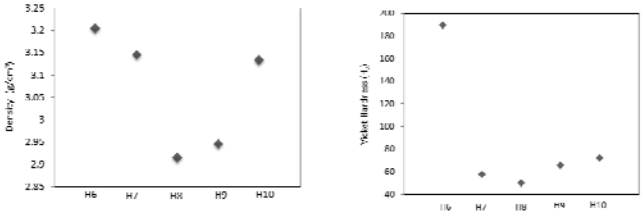

Fig 3 (left) Density variation of β-T(Ca, Mg)P) with different Mg content (H6, H7, H8) , HA/TCP (H10) and MgP (H9) when sintered at 1150°C. (right) Average Vicker hardness variation of β-T(Ca, Mg) P) with different Mg content (H6, H7, H8), HA/TCP (H10) and MgP (H9)

Conclusion: The amorphous magnesium-calcium phosphate transferred into nano crystalline β-TCP upon microwave sintering method The results indicate that initial Mg:Ca ratio control the magnesium substitution amount in β–TCP structure. Increasing magnesium substitution up to a certain amount into the TCP lattice improved mechanical properties and the densification process while accelerating the sintering kinetics for all Mg ratios

References

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