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Wet-chemical Synthesis and Magnetic Property Studies of Fe(III) Ion Substituted Hydroxyapatite

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1 Introduction

The objective of this study was to synthesize and characterize Fe(III) ion substituted hydroxyapatite (HA).

2 Materials and Methods

HA was prepared using a wet chemical synthesis route form $Ca(OH)_2$ and H_3PO_4 at 95 °C. Fe(III) ions were incorporated by adding a predetermined volume of aqueous solution of $FeCl_3$ of appropriate concentration to achieve 5 mol% and 10 mol% substitution. $FeCl_3$ solution was added to the reaction mixture only when the pH of the reaction mixture started to decrease to avoid precipitation of $Fe(OH)_3$. The resulting precipitate was filtered, washed three times with deionized water and dried at 60 °C in an oven. The morphology of the particles was examined in Field Emission Scanning Election Microscope (FESEM) while structural and chemical characterizations was done using powder X-ray diffraction (XRD) and Fourier Transform Infrared (FTIR). Spectroscopy, and magnetic properties were determined using Vibrating Sample Magnetometer.

3 Results

The shape of the precipitates is nearly spherical and the particle size distribution is narrow, as inferred from FESEM studies. XRD confirmed that the precipitates retained the HA structure and the Rietveld analysis indicated that the Fe(III) ions substituted at the Ca^{2+} sites in the HA lattice. The average particle size also decreased from 35 nm for pure HA to 27 nm for 10 mol% Fe substituted HA. Magnetization measurements showed only 10 mol% Fe substituted HA exhibits saturation magnetization of magnitude 0.482 emu/g with a coercivity of 12.76 G.

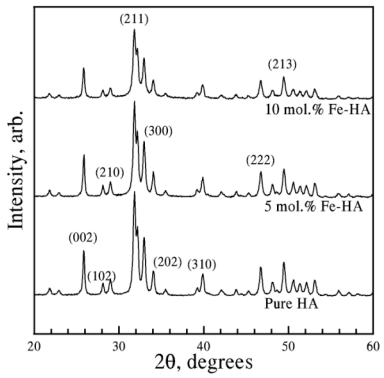

Figure 1 : X-ray diffraction pattern of the samples showing the crystal structure is apatite and that the Fe^{3+} ions present in the apatite lattice. No iron-based compounds were detected.

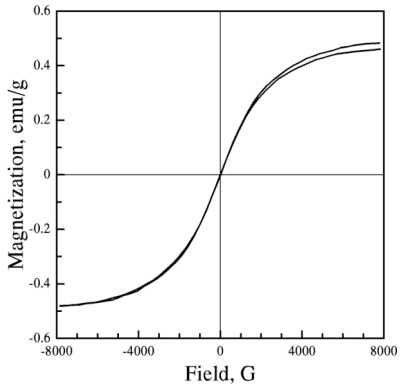

Figure 2 : M-H curves of 10 mol.% Fe substituted HA showing superparamagnetic behavior.

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4 Conclusion

High phase purity Fe(III) substituted HA was successfully synthesized through wet-chemical processing and characterized for the first time, to the authors' knowledge. The M-H magnetization curves of the synthesized, new materials appear to show superparamagnetic behaviour for the 10 mol% Fe. Thus, this material could be potentially used for a contrasting agent in magnetic resonance imaging and targeted drug delivery.