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Synthesis and Characterization of Nanostructured Hydroxyapatite using Sol-gel Method

S.Boopathi, A.Ruban Kumar*

School of Advanced Sciences, VIT University, Vellore-632014, Tamil Nadu, India.

***Corres.author: arubankumarvit@gmail.com**

Abstract: Hydroxyapatite (HAP) is effectively used as a bio-implant material because it closely resembles bone apatite and exhibits good biocompatibility. HAP powder has been prepared via sol-gel procedure using calcium nitrate tetra hydrate and di-ammonium hydrogen phosphate as the precursors for calcium and phosphorus, respectively. Double distilled water was used as a diluting media for HA sol preparation and ammonia was used to adjust the pH. Synthesised HAP was characterized by X-ray Diffraction (XRD), Scanning electron microscopy (SEM) and Fourier Transform Infrared Spectroscopy (FT-IR) to reveals that phase content, morphology and types of bond present within it (Ca/P=1.67).
Keywords: Hydroxyapatite, calcium and phosphate, biomedical applications, nanoparticles.

1. Introduction

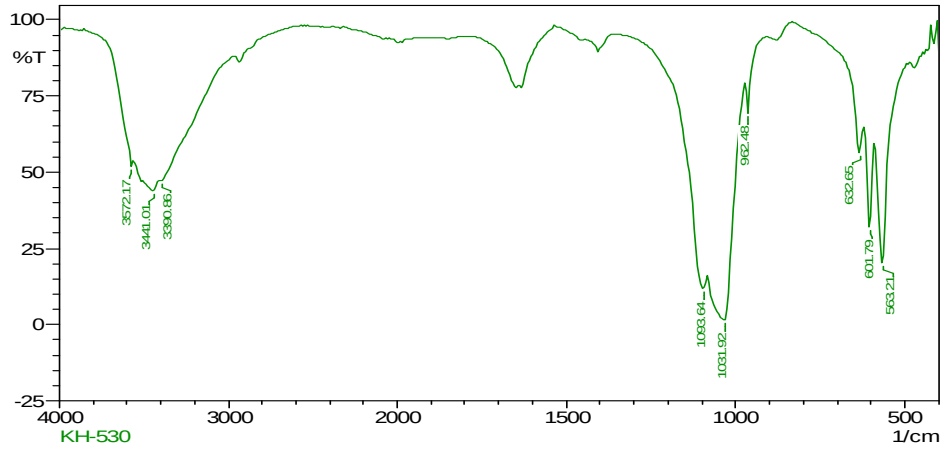
Hydroxyapatiteis widely used in clinical applications because of its excellent biocompatibility and bioactivity such as an important material, including bone repair and coatings for metallic implants[1]. It is main inorganic constituent of bones in humans, and has chemical formula ($Ca_{10}(PO_4)_6(OH)_2$[2]. Moreover, its additional prominence target for drug delivery, such as antibiotics, Scaffolds of growth factors and implantable materials [3].Nanostructured HAP particles can be prepared by variety of technique and most of reported in chemical precipitation. Application of HAP is biomedical field such as tissue engineering, dental implants and used in bioreactors.

Experimental procedure

HAP was synthesized by sol-gel method. In this method two different chemical reagents 1M calcium nitrate tetra hydrate and 0.67 M of di ammonium hydrogen phosphate dissolved in 500 mL of double distilled water in separate beaker and rapidly added to a solution containing di-ammonium hydrogen phosphate under stirring at a 75°C. The final product was stirred for 12 hours and the pH values of calcium and phosphate mixture solution was adjusted to 10 using NH_3 solution. Then, obtained gel was allowed cool and washed with double distilled water and ethanol. Finally, HAP gel washes and filtered and dried at 85°C for 8 hours.

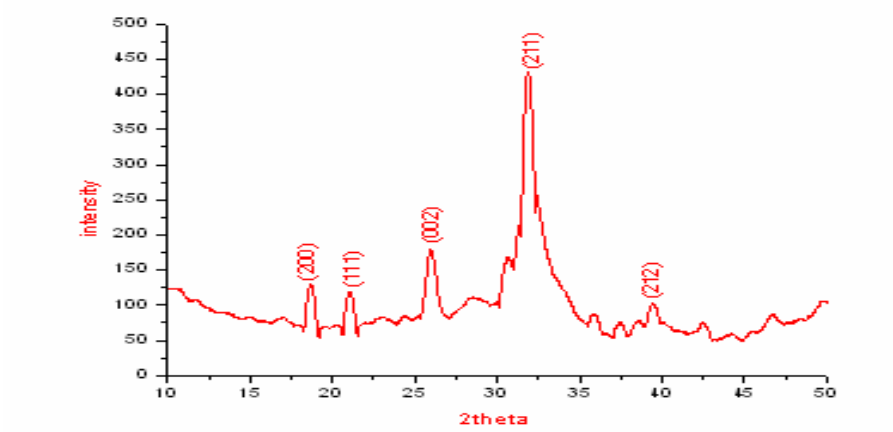
Results and Discussion

2.1 FTIR and XRD analysis



a) FTIR spectrum of HAP

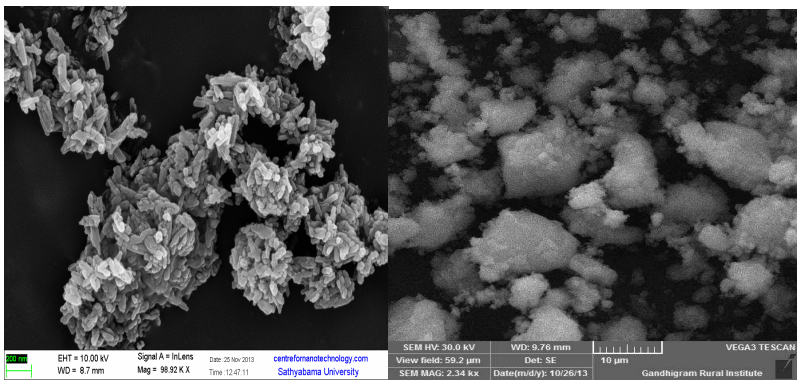
The FTIR spectrum of the synthesized HAP is shown in the fig (a). The peak at 3572 and 3441cm^{-1} shown the (O-H) group present in the synthesized HAP at 1093 and 1031 cm^{-1} we can find out the stretching modes of PO_4^{3-} and bending vibration modes. The common vibrational modes of PO_4^{3-} are observed in low intensity at 632 and 601 cm^{-1}.



b) XRD pattern of HAP

The diffraction pattern of as synthesized HAP powder is shown in the fig (b). It reveals that the synthesized powder has the crystal structure of pure HAP and matching with IC DD standard for HAP (JCPDS: 09-0432) with no secondary phases. The broad peak are having small particle size 31 to 65 nm.

2.2 SEM-EDAX analysis



c) SEM images of HAP

Morphological results from SEM investigation are shown in fig (c). It shows the presence of HAP nano crystals in rod-like structure with pores between. The average sizes of the rods are measured and they are in the range of 31 to 65 nm respectively.

2.3 Conclusion

The present study shows that nano structure hydroxyapatite can be synthesized by sol-gel method at low temperature. The XRD, FTIR and SEM study proves that the synthesized materials are pure, highly crystalline and rod- likes structure. This rod- like structure creates the pores in the middle and helps for the circulation of physiological fluids when it is coated on the implant materials.

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