

Synthesis and Characterisation of Zinc Phosphate Nanoparticles by Precipitation Method

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Abstract—Zinc phosphate ($Zn_3(PO_4)_2$) nanoparticles were successfully prepared by precipitation method using zinc acetate and Phosphoric acid as the zinc and phosphate sources. The synthesized $Zn_3(PO_4)_2$ nanoparticles were characterized by X-ray diffraction, Scanning electron microscope and Transmission electron microscope in order to confirm the phase purity and morphology of the sample. $Zn_3(PO_4)_2$ nanoparticles exhibit monoclinic structure, which was revealed by the XRD analysis.

Keywords- Zinc phosphate, nanoparticles, precipitation method.

I. INTRODUCTION

Nanoparticles are unique in all properties and it is very much suitable for drug delivery applications [1] due to their good interaction with biological activity. Inorganic nanoparticles are comparatively good than the organic nanoparticles [2] due to their non-toxicity, stability, biocompatibility and hydrophilic. These inorganic nanoparticles have received much attraction as drug delivery due to their low toxicity [3], high cellular uptake capacity and non immunogenic response. Zinc phosphate is very well known for its multifunctional materials such as potential applications, including environmentally friendly anticorrosive pigments and dental cements due to its low solubility in water/biological environment and biocompatibility [4, 5]. In addition, the catalytic properties of zinc phosphate have been investigated in hydrocarbon conversion process, such as dehydration/ dehydrogenation of sec-butanol and methanol conversion [6, 7]

II. EXPERIMENTAL

A. Chemicals and reagents

Zinc acetate, hydrazine hydrate and ortho phosphoric acid were purchased from Qualigens. Double distilled water was used as a solvent throughout the experiment.

B. General synthesis of zinc phosphate nanoparticles

2 mmol of ortho phosphoric acid was added by drop wise to the 2 mmol of zinc acetate solution (1:1) with constant stirring. Few drops of hydrazine hydrate were added to the solution and the stirring was continued for 3 hours, white precipitate was obtained. It was filtered and washed with water several times followed by ethanol to remove organic impurities. Then the precipitate was calcined in muffle furnace for 24 h at 300 °C.

III. RESULTS AND DISCUSSION

A. Characterization methods

The crystal structure of $Zn_3(PO_4)_2$ nanoparticles was analyzed by a Rich Siefert 3000 diffractometer with Cu-K 1 radiation ($\lambda = 1.5406 \text{ \AA}$). The morphology of the materials was analyzed by SEM HITACHI SU6600 scanning electron microscopy respectively.

B. Structure and morphology

XRD patterns of the $Zn_3(PO_4)_2$ nanoparticles is shown in Figure 1, which indicates the $Zn_3(PO_4)_2$ has monoclinic phase structure. The peak positions ($2\theta = 26, 45.6$) and relative intensities obtained for the $Zn_3(PO_4)_2$ match with the JCPDS card No: 76-0518 file, identifying it as $Zn_3(PO_4)_2$ with a monoclinic structure and cell constant $a = 5.45 \text{ \AA}$. There was no characteristic peaks of impurity were observed. The average grain size of $Zn_3(PO_4)_2$ is determined using Scherrer relation and it was found to be around 15 nm.

The SEM micrograph of the $Zn_3(PO_4)_2$ calcined is shown in Figure 2. It can be seen that the particles adopt irregular morphology with different sized particle. From the image it is clear that the particles were highly agglomerated in nature. This might be due to the fact that the agglomeration may be induced during the crystal growth itself because of the small size regime which is evident from the XRD analysis

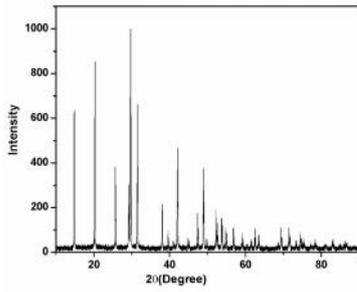


Figure 1. XRD pattern of $Zn_3(PO_4)_2$ nanoparticles

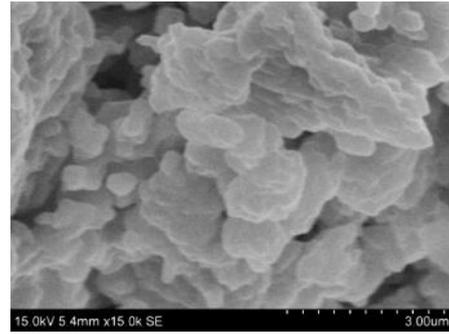


Figure 2. SEM image of $Zn_3(PO_4)_2$ nanoparticles

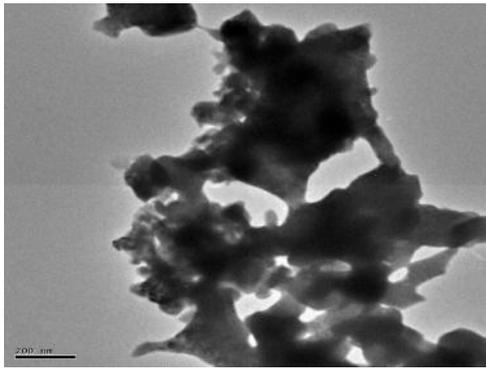


Figure 3. TEM image of $Zn_3(PO_4)_2$ nanoparticles

B. Raman and FTIR spectral analysis

Raman spectrum of zinc nanoparticles [8] was shown in the Figure 4. The P-O bond bending and stretching was obtained as the absorption peak at 372 cm^{-1} and 870 cm^{-1} . The O-H stretching broad peak was obtained in the absorption peak within $1500\text{--}1750\text{ cm}^{-1}$. FT-IR spectrum of the $Zn_3(PO_4)_2$ nanoparticles was shown in Figure 5. It shows a broad peak at 3378 cm^{-1} due to the presence of -OH stretching and a sharp peak at 1641 cm^{-1} due to water. Multiple absorption peaks from 900 cm^{-1} to 1200 cm^{-1} was due to stretching of phosphate (PO_4^{3-}) group as reported [9]. Symmetric and anti symmetric stretching of phosphate (PO_4^{3-}) were obtained at 1120 cm^{-1} and 1010 cm^{-1} .

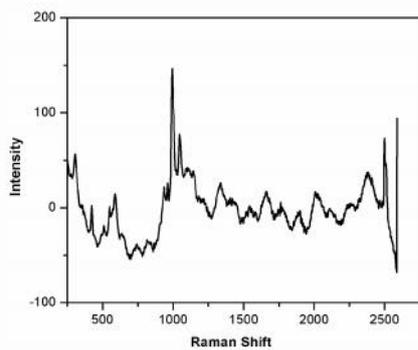


Figure 4. Raman Spectrum of $Zn_3(PO_4)_2$ nanoparticles

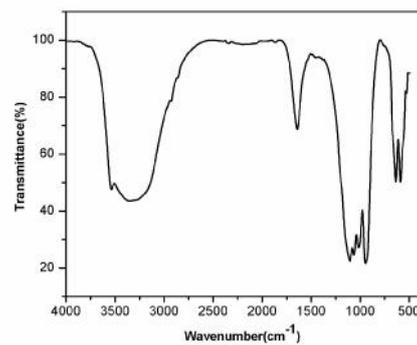


Figure 5. FTIR Spectrum of $Zn_3(PO_4)_2$ nanoparticles

IV. CONCLUSION

In conclusion, Zinc phosphate nanoparticles was synthesized by precipitation method and their morphology and optical property have been investigated by XRD, SEM, TEM, FT-IR, Raman spectroscopy techniques and CV.

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