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SYNTHESIS AND STRUCTURAL PROPERTIES OF ZINC FERRITE

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Abstract-
Powdered spinel zinc ferrite powder sample was synthesized by using sol-gel method. Structure of spinel zinc ferrite was confirmed by using X-ray diffraction. Average crystalline size and lattice parameter of powdered sample is calculated using X- ray diffraction.
Keywords – Zinc ferrite, X-ray diffraction

Introduction

Ferrite nanoparticles are a large group of magnetic particles have drawn a lot of attention of many researchers due to its extensive uses in variety of disciplines from biomedical to industry. Ferrite nanoparticles are particularly used for biomedical applications due to its physiochemical properties like surface functionalization feasibility, high surface to volume ratio [1]. properties like strong magnetic anisotropy, high coercivity at room temperature, moderate saturation magnetization, good mechanical hardness, chemical stability & high resistivity makes the family of ferrites is promising material for various industrial purpose such as sensors, memory devices, refrigeration, quality filter circuit, high frequency transformers, wide band transformers, high frequency electronic circuitry, microwave applications, multilayer chip conductor [2]–[4].

Spinel ferrites have face centered cubic structure and characterized by MFe_2O_4 formula where M denotes the divalent metal ions like Zn, Cu, Al. Spinel ferrites can have normal spinel structure, inverse spinel structure or mixed spinel structure. In spinel structure, all metal ions occupy tetrahedral sites, whereas all Fe^{+3} occupy octahedral sites. In inverse structure, all metal ions occupy octahedral site while Fe^{+3} ions are distributed over both tetrahedral & octahedral sites [5]. Among family of ferrites, zinc ferrite ($ZnFe_2O_4$) having normal spinel structure is imperative due its wide applications in data recording media, adsorption, sensors, photo catalyst, lithium ion batteries, magnetic resonance imaging (MRI), biomedical applications [6]–[8] as it shows low saturation magnetization, high resistivity properties. For synthesis of zinc ferrite, many methods like co precipitation[9], hydrothermal [10], combustion [11], ball milling [12] , sol gel [13] are used.

In this paper, we reported synthesis of zinc ferrite using sol gel method & structural properties of zinc ferrite are determined using X-ray diffraction.

Materials & methods

Materials

For synthesis of zinc ferrite analytical grade zinc nitrate ($Zn(NO_3)_3.6H_2O$), & ferric nitrates ($Fe(NO_3)_3.9H_2O$), reagents are used without further purification. Double distilled water is used throughout the synthesis & citric acid is used as reducing agent.

Method

For preparation of zinc ferrite, separate solutions of zinc nitrate & ferric nitrate are prepared in stoichiometric amount in double distilled water. These solutions were mixed into beaker & beaker is kept for constant stirring with heating at 150°C. Citric acid is added into beaker as a reducing agent. After 3 hours, solution is converted into viscous gel due to evaporation. Then, the gel was heated

to 250°C to self -sustaining combustion to produce burned brownish zinc ferrite fluffy powder. This burned fluffy brownish powder is kept for annealing in furnace for 900°C for 4 hours & used for further characterization.

Results and Discussion

Structural properties

X-ray diffraction (XRD) pattern of zinc ferrite powder is shown in figure 1. From X-ray diffraction pattern, phase, crystalline size and lattice parameter of the powdered sample is obtained. The XRD pattern shows spinel structure having Fd3m space group having peaks due to (111), (200), (311), (222), (400), (422), (511) planes that fit with JCPDS card no.82-1049. Average crystalline size is calculated using Debye-Scherer formula $D = \frac{0.9\lambda}{\beta cos\theta}$ where λ is the wavelength of X-ray radiation, β is full width half maxima for most intense peak, θ -Bragg's angle for the most intense peak. Lattice parameter is calculated by using formula $a = d_{hkl}\sqrt{h^2 + k^2 + l^2}$, where d_{hkl} is inter-planner spacing & hkl are Miller indices. Using given formula calculated value of lattice constant & average crystalline size are 8.48 °A and 27.12 nm.

Conclusion

In the present paper, zinc ferrite is synthesized using sol-gel method & spinel structure of zinc ferrite is confirmed by using X-ray diffraction. From X-ray diffraction, calculated values of lattice constant and average crystalline size were found out to be 8.48 °A and 27.12 nm.

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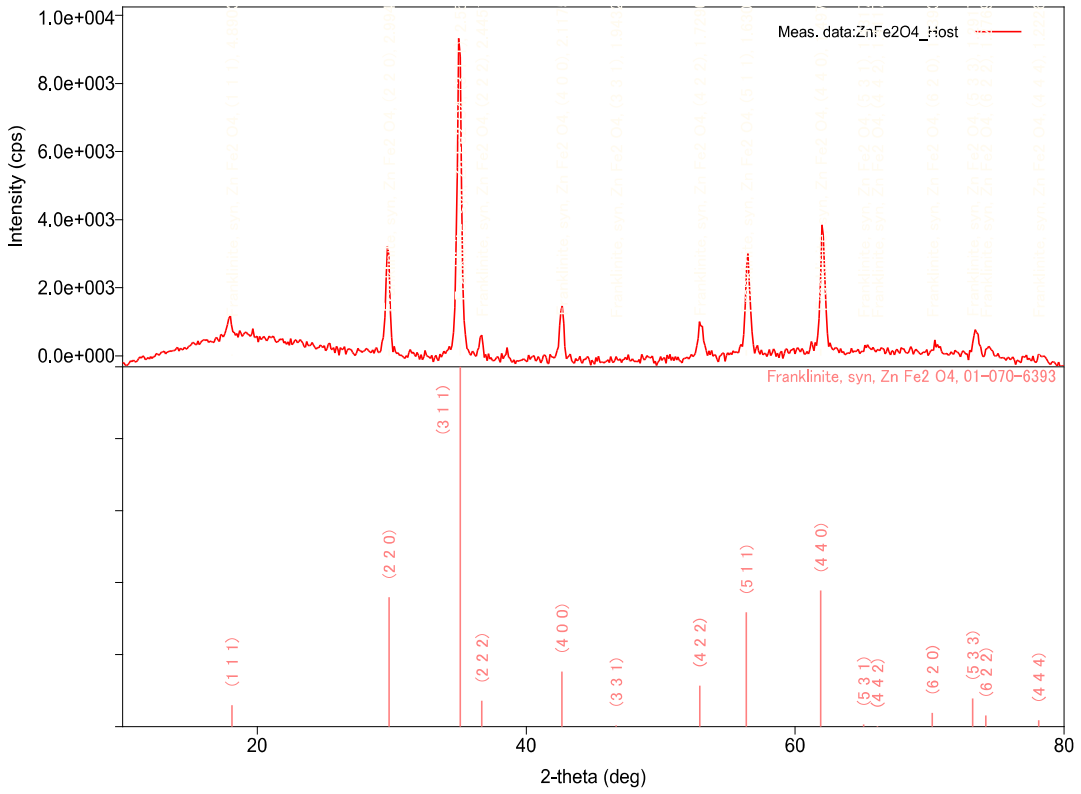

Fgure 1