Synthesis of Copper Ferrite Nanoparticle using Co-Precipitation Method

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Abstract- *Ferrite based magnetic nanoparticles have generated unique identity among researchers because of its wide applications from biomedical to industrial range. Copper ferrite nanoparticles are one among those with great potential in the application of technological field. $CuFe_2O_4$ NPs were synthesised using chemical co-precipitation method. The synthesised sample were studied using powder X-ray diffraction (XRD). Scherrer analysis and WH-Plot were used to study the size and lattice strain of the synthesised sample. The Crystallite size of the sample were calculated as 16.79nm in range.*

Keywords**:** Copper Ferrite, Chemical Co-Precipitation, Nanoparticles, XRD, WH Plot

Introduction:

An exponential interest on nanoparticle from researchers and scientists has been waved freshly, not only because of its smaller size and structure but also due to its significant advantages over technology and applications [1]. In the range of Nano scale, nanoparticles exhibit several unique and incomparable chemical, physical and biological properties than the particles in the range of higher scales [2]. Among the ferrite based nanoparticles copper ferrite have the most wide applications due to its potential. These magnetic copper ferrite nanoparticle materials are very low in cost and also stable under various conditions. Based on the crystallite structure and physical properties of these ferrite based nanoparticles they are classified into several groups such as Hexaferrite, Orthoferrite, Garnet and Spinel ferrites [3]. These nanoparticles can be used as a sensor at room temperature to indicate the presence of ammonia gas [4]. Spinel ferrite nanoparticles are also used in the magnetic storage devices [5].

Experimental:

Materials and Method:

The Copper Ferrite ($CuFe_2O_4$) nanopartricles were synthesised by using Co-Precipitation method. The precursors used for the synthesis was Copper Chloride ($CuCl_2$) and Ferric chloride ($FeCl_3$). Under a stoichiometric quantity the precursors were blended using distilled water in Magnetic stirrer. A constant temperature of 80^0C was maintained and then the

precipitating agent was introduced drop by drop till the pH of the solution reaches 12. At this stage a brown slurry precipitate was formed which was washed for about several times till the pH level reaches 7. Then the precipitate was dried to obtain powder form. Finally, the synthesised precipitate was annealed at 1000^0C for about 5hrs. Again the sample was crushed using motar and pestle to obtain fine particles. [6]

Characterisation:

The X-Ray diffraction pattern was analysed using PAN alytical 3040 X'pert-Prodiffractometer and the wavelength of the instrument used was about 1.5406Å. The continuous scanning of the particle was carried out in θ-2θ mode under copper target. The range of 2θ is about10^0-80^0. The microstrain of the particles were analysed by comparing XRD data with Williamson-Hall plot method.

Result and Discussion:

XRD Analysis:

The 1000^0C annealed $CuFe_2O_4$ nanoparticles was studied using X-Ray Diffractometer and the obtained graph is shown in Fig.1. The peaks show good agreement with JCPDS file no34-0425. From the Results obtained it is confirmed that the desired ferrite sample was synthesised and the crystallite size was calculated using Schirrer formula.

$$D = k\,\lambda / \boldsymbol{\beta}\cos\theta$$

Where K is the shape factor, **β** is the Full width at half maximum of peak, λ denotes the X-Ray wavelength of the instrument used and θ is the angle of diffraction in radians [7].

The crystallite size was found to be 16.79 nm and also they exhibit tetragonal structure.

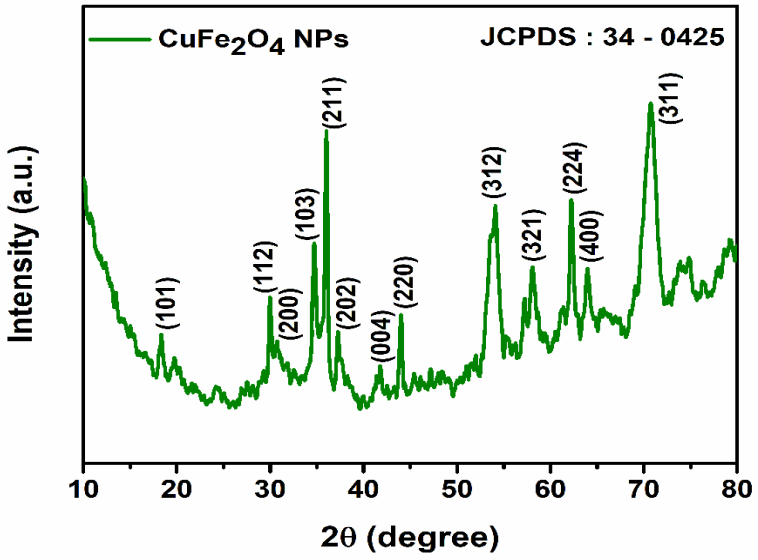

Fig: 1 XRD pattern of annealed $CuFe_2O_4$ nanoparticle

Williamson-Hall plot:

To understand more about the microstructure of the lattice such as particle size and microstrain W-H plot is used [8]. In the plot X-axis represents 4sinθ and Y-axis denotes βCosθ.

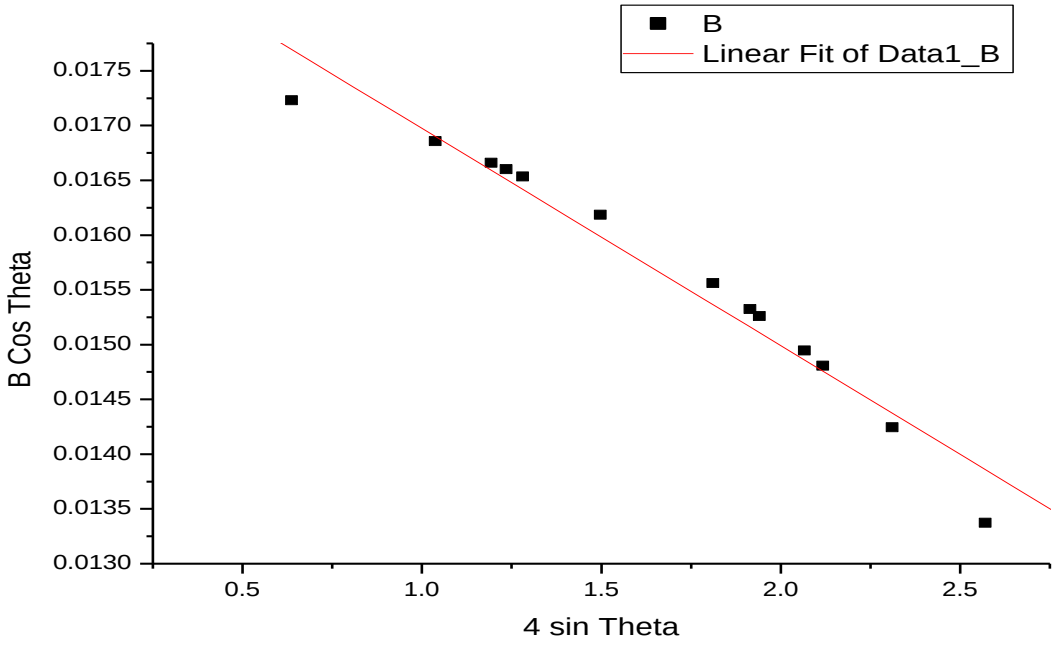

Fig:2 Williamson-Hall plot for $CuFe_2O_4$ Nanoparticles

Conclusion:

Copper Ferrite ($CuFe_2O_4$) Nanoparticles is successfully synthesised using simple co-precipitation method. X-Ray Diffractometer is used to characterise the crystallite structure of the synthesised nanoparticles. By this the crystallite size is found to be 16.79nm. The synthesised sample exhibit tetragonal structure. Using Williamson-Hall plot the microstrain of the synthesized nanoparticles was found to be 0.97942×10^{-3}.

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