International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 4, Issue 11
November 2017

Low Temperature Synthesis and Characterization of Nano Size $CuFe_2O_4$ Particles by Hydrothermal Method

T. Ramaprasad[1, 2], R. Jeevan Kumar[1*], M.Prakash[1], U. Naresh[1], D. Kothandan[3], K.Chandra Babu Naidu[4]

[1]Department of Physics, Sri Krishnadevaraya University, Anantapuramu, A.P, India.
[2]MRITS, Hyderabad, Telangana, India.
[3]Sreenivasa Institute of Technology and Management Sciences, Chittoor, A.P, India.
[4]Srinivasa Ramanujan Institute of Technology, Anantapuramu, A.P, India.

Abstract:
In the present investigation $CuFe_2O_4$ nanoparticles were synthesized by a simple hydrothermal processing in which these particles were mashed-up at 150°c for 8 hrs using NaOH solution. The purity, structural and morphological properties of newly synthesized powder has been investigated using the X-Ray powder diffraction (XRD) and Scanning Electron Microscopy (SEM). The $CuFe_2O_4$, a kind of soft magnetic materials is one of the most attracting classes of materials due to its interesting and important properties and has many technical applications, such as in catalysis, sensors and so on. The average size of composite nano particles for all samples was determined. Diameter of the samples is amalgamate in nano scale .The X-ray diffraction results have indicated that these samples are high phase purity, crystalline and inverse spinel ferrites. The SEM imaging exhibits shape of grains. These samples can be considered as promising materials for magnetic recording media and electromagnetic absorbing technological applications.
Keywords: Nanoparticles; Hydrothermal Method; Diffraction; Microscopy.

Introduction:

Soft ferrites are the candidate materials for electromagnetic applications such as transformer cores, inductors, antenna rods, filters and electromagnetic interference shielding due to their high permeability and electric constants [1, 2]. Generally, ferrites are of AB_2O_4 (where A = Cu^{2+}, ions and B = Fe^{3+} ions) cubic-spinel structured materials. Nowadays, multilayer chip inductors (MLCI) are becoming indispensable electronic components in miniature electronic products such as laptop computers, i-pads, cellular phones, and video cameras. In general, chip inductors are fabricated by arranging alternate layers of ferrites. And also electromagnetic radiation has emerged as one of the forms of pollution in atmosphere [2]. These radiations create lot of problems to human health such as immunity loss, restlessness and damage of DNA structure. In order to overcome these problems EMI shielding is necessary. Therefore, an intense research has been focused on EMI suppression materials and different ferrites and ferrite composites are investigated by hydrothermal method technique [2].

Ferrite materials have been extensively investigated for distinct electrical and magnetic properties as they are ideal candidates for the applications such as information storage devices, telecommunication devices, filters, transformers, inductors, antennas, microwave devices, gas sensors, humidity sensors, magnetic tapes, magnetic recording devices, deflection yokes and electromagnetic interference (EMI) shielding devices [2]. Present investigations focus on structural and morphological properties of $CuFe_2O_4$ synthesized using hydrothermal method.

2. Experimental Procedure

In order to synthesize $CuFe_2O_4$ nano-particles we have taken Cu $(NO_3)_2$ $6H_2O$, Fe $(NO_3)3$ $9H_2O$ (each of 99.8 % purity, Sigma Aldrich) and NaOH are taken as precursors. Calculated Stoichiometric ratio of Cupper nitrate and iron nitrates are mixed in distilled water (ml) with 1:3 (Nitrates: water) ratio. Then NaOH (gm) is added slowly to the resultant solution (ml) in 1:4 (NaOH: nitrates) ratio and the P^H = 10 is obtained to the mixture. Further, the combination fetched into a 300 ml Teflon-lined steel autoclave. Furthermore it is

International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 4, Issue 11
November 2017

deposited in a hot-air oven and reaction is made at 150˚C for 8 hr. Afterwards the solution of cupper ferrite nano-particles separated from autoclave by washed with acetone and distilled water more than six times till it reaches the P^H =7. And then dried the particles to remove water percentage at 60°C for 6 hr. Furthermore, the samples are characterized using X-ray diffractometer and Scanning Electron Microscope for structural, morphological properties respectively.

3. Results and Discussion

The diffraction pattern of copper ferrite nanoparticles was analyzed and depicted as shown in Fig.1.

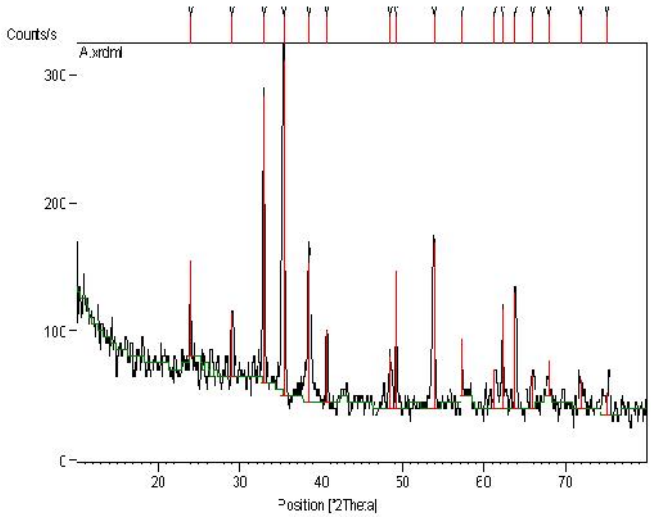

Fig.1. XRD pattern of copper ferrite nanoparticles

It can be well understood from the figure that the single phase cubic spinel structure was formed. In addition the average crystallite size was noticed to be of 52.3 nm using the Scherrer formula [3]. The intensity of nanoparticles was come down as the full width half maximum was increased than the bulk counterpart.

Fig.2 shows typical scanning electron micrographs (SEM) of ferrite. The average grain size G_a of 213.8 nm for these samples was estimated using linear intercept method [4, 5]:

$$G_a = 1{:}5L/MN$$

Where L = the total test line length, M = the magnification, and N = the total number of intercepts which the grain boundary makes with the line. Almost square shape grains were observed.

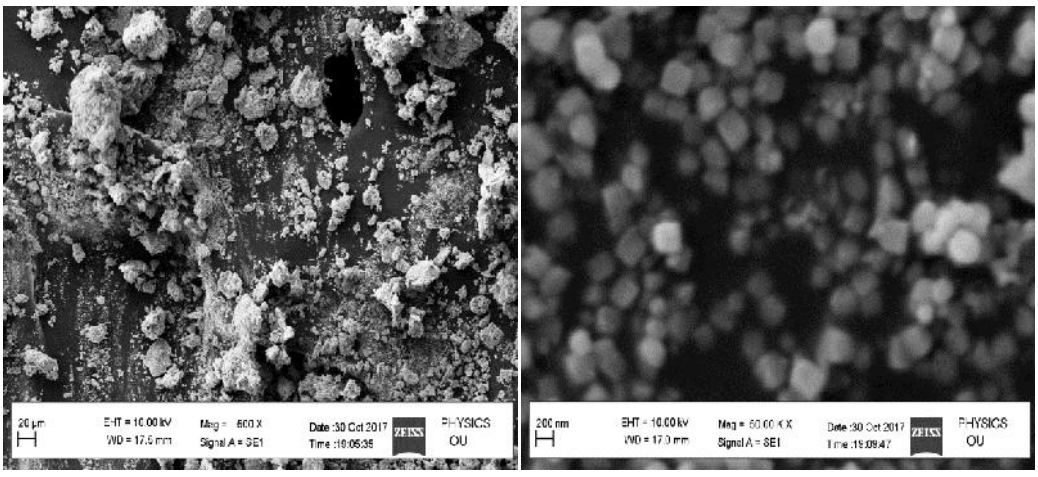

Fig.2. FESEM micrographs CF nanoparticles

From the SEM micrographs, it can be noticed that grains are not well grown. This must be due to grain boundary effect of set samples [6]. The ferrites must have melt at very low temperature than that of sintering temperature of ferrites and was expected to segregate at the boundaries of the grains opposing further grain growth of Cu ferrites. Sintering temperatures and processing times directly affect the morphology of the ferrite samples.

Conclusions:

The copper ferrite nanoparticles were synthesized via hydrothermal technique. The average crystallite size was found to be 53 nm. The morphology revealed almost square shape grains.

References:

[1] K. Chandra Babu Naidu, W. Madhuri, Microwave processed NiMg ferrite: Studies on structural and magnetic properties, Journal of Magnetism and Magnetic Materials 420 (2016) 109–116

[2] K. Chandra Babu Naidu and W. Madhuri, Microwave Processed Bulk and Nano NiMg Ferrites: A Comparative Study on X-band Electromagnetic Interference Shielding Properties, Materials Chemistry and Physics 187 (2017) 164-176

[3] M. Maddaiah, K. Chandra Babu Naidu, D. Jhansi Rani, T. Subbarao, Synthesis and Characterization of CuO-Doped $SrTiO_3$ Ceramics, Journal of Ovonic Research 11 (2015) 99-106

[4] V. N. Reddy, K. C. Babu Naidu, T. Subbarao, structural, optical and ferroelectric properties of $BaTiO_3$ ceramics, Journal of Ovonic Research 12 (2016) 185-191

[5]. Chandra Babu Naidu K., Madhuri W, Microwave assisted solid state reaction method: Investigations on electrical and magnetic properties NiMgZn ferrites, Materials Chemistry and Physics 181 (2016) 432-443

[6] K Chandra Babu Naidu and W. Madhuri, Hydrothermal synthesis of $NiFe_2O_4$ nanoparticles: structural, Morphological, optical, electrical and magnetic properties, Bulletin of Material Science 40 (2017) 417–425