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Synthesis and characterization of Nickel Copper Ferrite

Y L N Murthy[*1], I V Kasi Viswanath[1], T. Kondala Rao[2], Rajendra singh[3]

[1]Department of Organic Chemistry, Andhra University Visakhapatnam,India.
[2]Government degree college for Men, Srikakulam,India.
[3]DRDO HQ, DRDO Bhavan, New Delhi,India.

Corres.author: murthyyln@yahoo.co.in

Abstract: Nano size nickel copper ferrite powders ($NiCuFe_2O_4$) have been prepared by a prepared by Co precipitation method. The resulting powders were characterized by X-ray diffraction (XRD), Scanning electron microscope (SEM).The result showed nanosize nickel copper ferrite(35.65nm). The powders showed extensive XRD line broadening and sizes of crystals observed from the XRD line broadening was35.65 nm, in coprecipitation method at the temperature 1000^o C.
Keywords: Nanosize, Co precipitation method, Nickel copper ferrite.

1. Introduction

Nano material ferrites have applications in making cores of audio frequency and high frequency transformers ,coils(inductors),chokes, permanent magnets, magneto-optical displays, microwave absorbers, wave guides in the GHZ region and chlorine gas sensors [1.] , high density information storage[2], color imaging[3], bioprocess[4], medical diagnosis[5], electromagnetic wave absorption,[6] etc. Multi layer chip indicator(MLCI) has recently been developed as one of the key surface mountingdevices[7,8]. Magnetic particles with sizes in the nanometer scale are now of interest because of their many technological applications and unique magnetic properties which differ considerably from those of bulk materials. Below a critical size, magnetic particles become single domain in contrast with the usual multi domain structure of the bulk magnetic materials exhibiting unique phenomena such as super paramagnetic and quantum tunneling of the magnetization. Magnetic nano particle systems exhibiting super paramagnetic behavior, display little or no remanence and coercivity while keeping a very high saturation magnetization. They have potential application in biomedicine[9] magnetic drug delivery and cell-sorting systems[10,11,12]. It is well known that low temperature sintering ferrites can be achieved by using ultra fine particles powders synthesized via wet chemical method. Several chemical methods for the preparation of ferrite powders such as MnZn and NiZn ferrites have been developed[13-15]

As more and more attentions have been devoted to the nano-sized magnetic materials for their unique properties compared to their bulk counterparts, the scientific interest on nano-sized nickel copper ferrite is on the rising. Various methods, such as co precipitation [16]citrate precursor techniques[17] have been developed to fabricate nickel copper ferrite nano particles. However, the irregularity of particle morphology and the agglomeration of particles still remain the main problem. In our laboratory work on (Mn-Zn and Ni-Zn) ferries by two different methods viz, co-precipitation method and ball milling method[18] and Ni-Zn feerrites by co-precipitation method[19] and sol gel method[20], Ni- Cu and NiCuZn ferrites by citrate gel precursor method were taken up & the materials were characterized[21] . In this paper we report the synthesis of nickel copper ferrite adopting co precipitation method sintering at 1000^{o}C.

2. Experimental

The polycrystalline $NiCuFe_2O_4$ was synthesized by the Co precipitation method, High purity nickel nitrate, copper nitrate, iron(III) nitrate are taken as starting materials. Each starting material was weighed separately and suitable quantity of deionised water was added to

make them 0.5 M solution and were mixed thoroughly so that , all these cationic solutions for dissolution .The NaOH solution is prepared in sufficient quantity at 0.2 M concentration and heated 60^{o}C , poured into the cationic solution in a thin flow while maintaining the stirring and heating till the precipitation occurs .Heating of the precipitate in its alkaline condition is continued to a soaking temperature 100^{o}C for 30 min in order to complete the reaction. Stirring was maintained further for 6 hours for ageing and precipitated particles are washed and filtered 6 times drying them at 60^{o}C for 48 hrs. The co precipitated ferrite agglomerates were grinded for few min using agate mortar and pestle to have very fine particles, these particles were heated 1000^{o}C for 4 hours and nano ferrite particles are formed.
The nano material was characterized by XRD and SEM which were recorded at IGCAR,kalapkkam.(fig1 & fig2)

3. Results and discussion

The NiCu ferrite sintering was carried out at 1000^{o}C for 4 hours.X Ray diffraction studies were carried out & Fig1 presents the pattern. XRD patterns shows that a single phase Ni-Cu ferrite with spinel structure . The broad peaks in the XRD patterns indicate a fine particle nature of the particles. The particle size of ferrite sample was caliculated using Scherrer's formula :

$$D = \frac{0.9\lambda}{\beta \cos\theta}$$

Where D is the average grain size, λ=1.514 ^{o}A(X-ray wave length) and β is the width of the diffraction peak at half maximum for thr the diffraction angle 2θ.

The size of the NiCu ferrite particle is 35.65nm was calculated by using above formula.
Scanning electron microscope(SEM) studies carried out on the sample sintered 1000^{0} C and presented in Fig 2. At 1000^{0}C the lump size was determined from micrograph and was found to be about 500nm. Through the micrograph, we can observe the formation of soft agglomerates with irregular morphology constituted the quite fine particles. The study of SEM micrographs reveals less number of pores with smaller lump size.

4. Conclusions

The Coprecipitation method is convenient for the synthesis of nano sized Ni-Cu ferrites. X-ray diffraction pattern confirm that the synthesis of fully crystalline Ni-Cu ferrite nano particles at high temperatures.

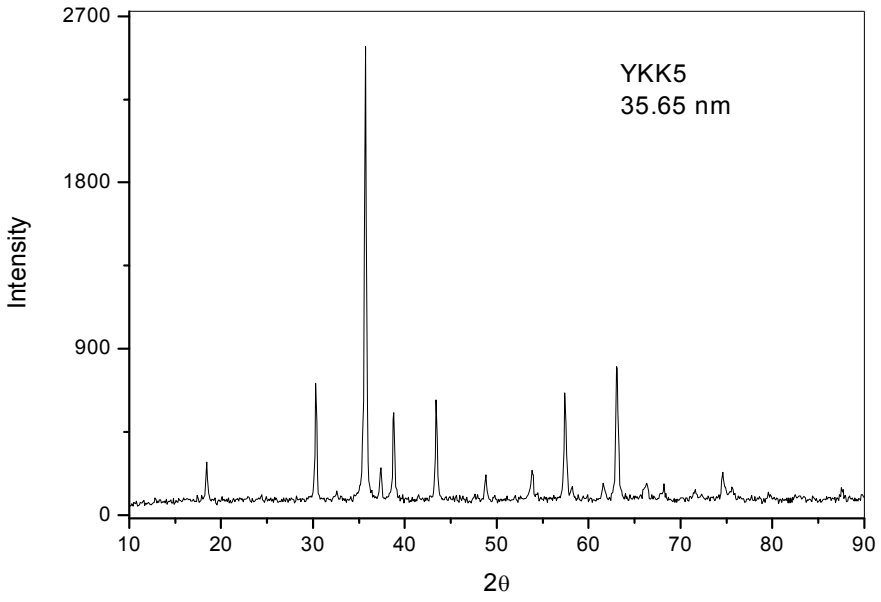

Fig 1: XRD Pattern of $NiCuFe_2O_4$ at 1000^{0}C

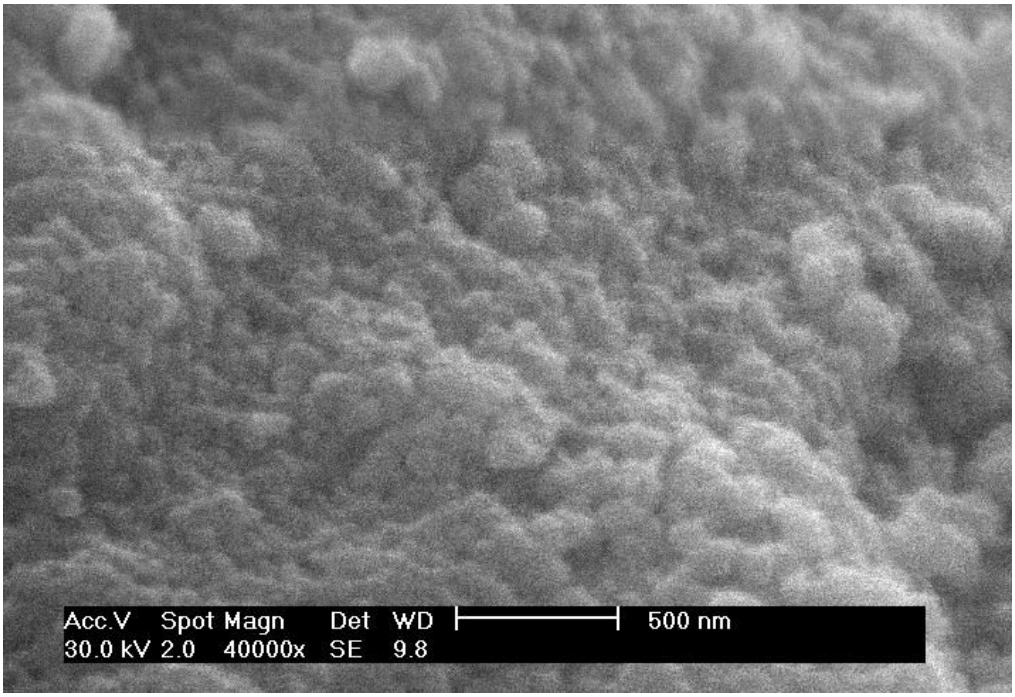

Fig 2. Sem image of $NiCuFe_2O_4$ at 1000^0 C

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