Structural studies of co-spinel ferrite synthesized by an auto combustion method

Raval A.M., Panchal N.R., Jotania R.B.
Department of Physics, Gujarat University, Ahmedabad, Gujarat

Abstract -Nanocrystallite magnetic particles are attractive due to many importants applications like magnetic drug delivery, hyperthermia for cancer treatment, ferro fluids, magnetic storage data etc. Nanosized particles of cobalt ferrite have been synthesized by an auto combustion method. The citrate – nitrate solution was prepared under molar ratio of 1:1. The final product has been received by self ignition then as burnt powder was calcined at 950 ºC. The formation and phase identification of the synthesized particles were confirmed by FTIR and XRD. The particle size was investigated by a Scanning Electron Microscope.

Introduction

According to the structure, spinel ferrites are super lattices. It has tetrahedral A site and octahedral B site in AB_2O_4 crystal structure. Depending on A site and B site cations, it can exhibit ferimagnetic, antiferromagnetic and paramagnetic behavior [1].

Metal–oxide nanoparticles are currently a subject of interest because of their optical, electronic and magnetic properties, which differs from their bulk counter parts. Many of these unique properties also make them very promising candidates for a variety of applications in biomedical [2] as well as recording technology.

Among the various techniques such as chemical co-precipitation, micro emulsion, ceramic method, hydrothermal, auto combustion, etc., it is acknowledged that the combustion synthesis method has many potential advantages such as low-processing cost, energy efficiency and high production rate [3, 4].

Experimental Procedure:

The sample reported in this study was prepared by an auto–combustion method. Starting materials were cobalt nitrate, iron nitrate and citric acid. Double distilled, de-ionized water was used as the solvent in order to minimize the impurities in the final product.

The sol is prepared under molar ratio (1:1) of metal nitrates to citric acid and pH was adjusted to 7 by adding ammonia to the sol. Then the sol was heated on a hot plate with continuous stirring to evaporate the water. The sol was heated and converted to a gel and by continuous heating the gel is automatically burnt and a porous product was obtained. The as-burnt powder was then calcined at 950 ºC to get the pure phase. The phase identification of the sample was recorded by X-ray diffractometer (XRD) with CuKα radiation. The average crystallite size of powders was determined by De-Bye Scherrer formula. FTIR and XRD confirm the formation of single phase cobalt ferrite. The Particle morphology was investigated by a Scanning Electron Microscope.

Results and Discussion

Fig.1 shows FTIR of as-burnt sample as well as the sample heated at 950 ºC. The bands in the range 400-600 cm^{-1} confirm the ferrite formation.

Fig.2 shows XRD taken at room temperature for the sample calcinated at 950ºC for 4 hrs. All the peaks are index to $CoFe_2O_4$ spinel phase and no impurities are found. Average crystallite size was measured 40nm by the X-ray line broadening technique employing the

X-ray Scherrer formula [5], using the profile of (311) peak, which is also confirmed by SEM.

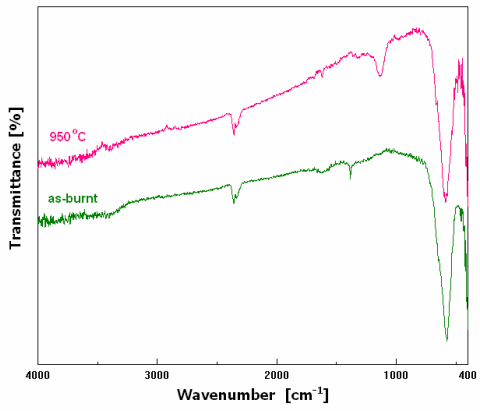

Fig. 1-FTIR

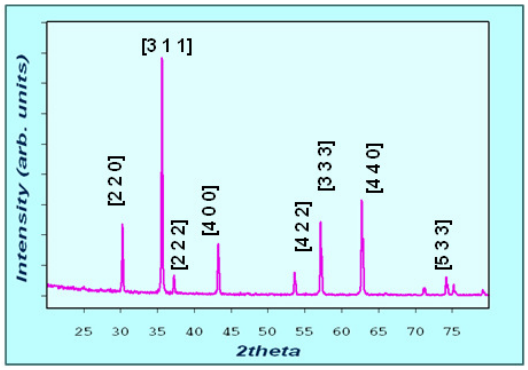

Fig. 2-XRD

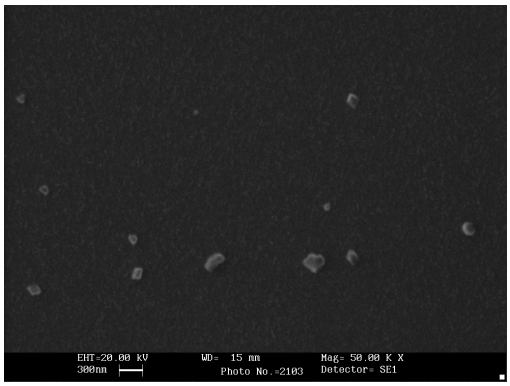

Fig. 3-SEM

Conclusion

Cobalt ferrite nanoparticles were successfully synthesized by using an auto-combustion method. The formation of ferrite is confirmed by FTIR results. The particle size calculated by De-Bye Scherrer formula for most intense peak (311) is 40nm. SEM image show nano sized, uniform and separated particles.

References

[1] A. K. M. Akhter Hussain, M. Seki, T. Kawai, H. Tobata, J. Appl. Phys. 96 (2) 2004 1273.

[2] P. Tartaj, M. D. Morles, V.V. Sabino, et al., J. phys. D 36 (2006) R 182.

[3] J. F. Crider, Ceram. Eng. Sci. Proc. 3 (1982) 519.

[4] Z. A. Munir, Am. Ceram. Soc. Bull. 67 (1988) 342.

[5] Cullity B. D., Elements of X-ray Diffraction, (Addison-Wesley, Reading, MA, 1987)