

Effect of Annealing Temperature on Yttrium Nano Ferrite Prepared by Sol-Gel Technique

Jyoti. B. Shitole¹, Sopan M. Rathod²

^{1,2}Nano Materials & Lasers Research Laboratory, Department of Physics, Abasaheb Garware College, Karve Road, Pune - 411004, Maharashtra, India

Abstract: Yttrium nano ferrite $Y_xFe_{2-x}O_4$ (where $x=0.2$) Nanoparticles were synthesized by a simple and low cost effective method involving sol-gel auto combustion technique at low temperature. Yttrium ferrite is a typical used as garnet magnets ferrite material with a completely inverse spinel structure, has a large number of applications. The present work is to study effect of annealing temperature on yttrium nano ferrite properties of the synthesized samples. The role of the effect of different annealing temperature shows the formation of crystal phase, which was identified by X-ray diffraction method. The annealing temperature 300 °C, 500 °C, 700 °C and 900 °C show the phase formation and particle size changes with annealing temperature. We report the synthesis of nanoparticles, spinel with crystalline size is in the range of 15 to 41nm. The FTIR characterization shows the bond formation and synthesized material is ferrite.

Keywords: Sol-gel, Yttrium nano ferrite, FTIR, XRD

1. Introduction

The researchers are reported that the physical properties of Nano-particles are enhanced significantly by various techniques and synthesis process [1-3]. This method is used to obtain improved properties, more homogeneity and narrow particle distribution thereby influencing structural, electrical, magnetic [4-5] and optical properties of ferrite of Bi Y Fe_2O_4 as well as multi ferrite are reported. [6-7]. It is interesting and important to develop techniques by which the size and shape of the particles can be well controlled. In the present work we have successfully synthesized and studied the effect of Annealing Temperature on Yttrium nano-ferrite particles prepared by sol-gel Technique [8].

2. Experimental Technique

The high purity AR grade ferric nitrate ($Fe_2(NO_3)_3 \cdot 9H_2O$), Yttrium nitrate ($Y(NO_3)_3 \cdot 6H_2O$), citric acid ($C_6H_8O_7$), ammonium hydroxide solution (NH_4OH) were used to prepare $Y_{0.2}Fe_{1.8}O_4$ nanoparticles by sol-gel auto combustion synthesis technique. In this process Citric acid was used as a Fuel. These nitrates and citric acid were weighed accurately to have proper stoichiometric proportion required in the final product. The mixed solutions of all the chemicals were stirred until the homogeneous solution is obtained. During the stirring process ammonium hydroxide solution was added drop by drop to obtain pH of 7. The mixed solution was simultaneously stirred and heated to form a gel, after that auto-combustion takes place. The prepared powder was sintered at different temperature for 4 hours, and the crystalline Nano powder of sample was obtained.

3. Results and Discussion

FTIR: The figure 1 shows the FTIR of Yttrium ferrite sintered at 900 °C temperature the peak at 433.28 – 517.06 it shows the prepared sample is ferrite.

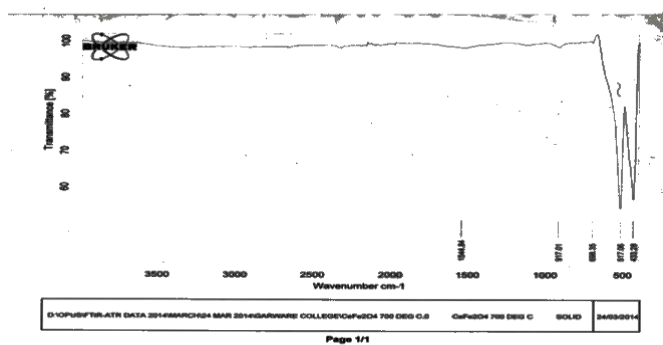


Figure 1: FTIR of yttrium ferrite

XRD ANALYSIS

XRD pattern is used to estimate the average size of very small crystallites, from the measured width of the peaks of the different pattern [10].

The interplaner distance were calculated by using Bragg's equation from the relation

$$n\lambda = 2d \sin \theta \quad [1]$$

The lattice parameter „a“ was calculated using following

$$a = d\sqrt{h^2 + k^2 + l^2} \quad [2]$$

Where ,(hkl) is the miller indices, λ is the wavelength of X-ray radiation and θ is the Bragg's angle. The results of interplane distance and lattice parameter are shown in table.

The particle size were calculated using Scherer's formula

$$t = \frac{0.9\lambda}{\beta \cos \theta} \quad [3]$$

Where, “t” is the particle size, and β is the FWHM (full width half maxima) of the peak θ .

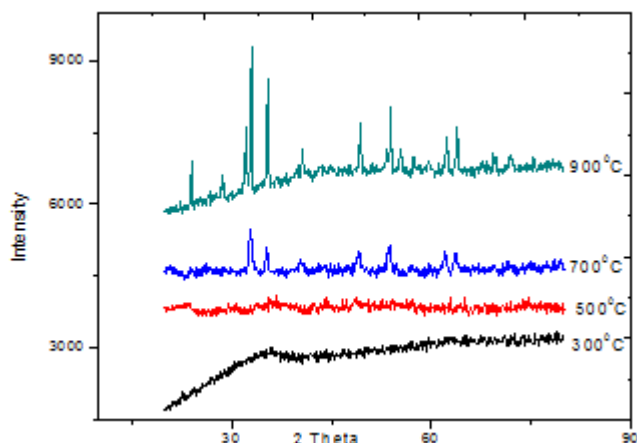


Figure 2: XRD pattern of $Y_{0.2}Fe_{1.8}O_4$

Table 1: XRD Analysis

Annealing Temperature (°C)	Average Grain Size (nm)	Lattices Constant (Å)
300	-	-
500	-	-
700	15.9650	8.1526
900	41.6814	8.2809

4. Conclusion

Yttrium nano ferrite $Y_xFe_{2-x}O_4$ (where $x = 0.2$) Nanoparticles were successfully synthesized by sol-gel auto combustion technique. The sample is subjected to different sintering temperatures. From the FTIR it is clear that the prepared sample is ferrite. From XRD it is clear that there is no crystallization of the sample at 300 °C and 500 °C. The partical size at 700 °C is 15 nm and at 900 °C is 41 nm.

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Author Profile



Dr Rathod Sopan Mansing is M. Sc. Ph. D. Physics. He is Associate Professor in P. G. & Research Department of Physics, Abasaheb Garware College, Karve, Pune, Maharashtra, India. He had done Research in Nano material Science and Lasers and its applications. He is Research Guide recognized by Savitribai Phule Pune University, Two Ph. D are awarded and four are Pushing their Ph. D. Under his Guidance. He has published more than 20 Papers in international journals.



Mrs. Jyoti Babasaheb Shitole is M.Sc. B.Ed. in Physics. She is working as junior college teacher in Abasaheb Garware College, Karve Road Pune, Maharashtra, India. She got 10th rank in Pune university and first rank in Abasaheb Garware college in M.Sc. physics.