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Characterization of Manganese Nitrate Hydrate Synthesized with Dopant Zinc Nitrate Hydrate Using the Co-Precipitation Method

R. V. Kotalkar[1], Dr. L. V. Thakre[2]

[1]Department of Physics and Research Center Dayanand Science College Latur

[2]Associate professor Department of Physics Dayanand Science College Latur

Abstract: ***This study reports $Mn_{1-x}zn_xFe_20_4$ synthesized by co - precipitation method with doping composition as x=0.0, 0.08 named as k1 sample k3samples. The synthesized powder form material was characterized by X - ray diffraction analysis SEM EDX. The lattice parameter, FWHM value, crystalline size, and volume of the nanocrystalline material were calculated by using X - ray diffraction analysis. SEM Scanning Electron micrograph indicates the morphology of material with micro and nanometer range.***

Keywords: X - ray Diffraction, ferrite nanoparticles, co - precipitation method, synthesis

1. Introduction

Ferrite materials are technically and technologically more appealing. The different experiments and applications of this material in the scientific fields made it attractive to world scientists. Advanced fields like Telecommunication system, Industry, Modern Technology, Electronics, and Electrical Engineering field, computing, Spintronics, Information Technology, Biomedical, and Biotechnology is fragmentary without ferrite materials. [1] In the past few decades, physicists and chemists have been impatient about ferrite materials and ferrite nanoparticles. Much research is going on worldwide to study different methods of synthesis, structural, morphological properties, electrical properties, and magnetic properties. [2]

2. Experimental techniques of Manganese nitrate hydrate

This paper reports the co - precipitation method as it is advantageous and economical. [3, 4]

2.1 Synthesis Method

Chosen chemicals with AR grade as Manganese (ll) nitrate hydrate (**$M_nN_20_6.\ H_20$**) (98%, Aldrich) with molecular cas no.15710 - 66 - 4, ferric nitrate **$Fe\ (N0_3)_3\ 9H_20$** (99.99 % merk) with Zinc nitrate (ll) hydrate **($H_2N_20_7Zn$)** (Aldrich 99.99%) with molecular weighed with the digital weighing machine, [5] samples are made stoichiometric molar amounts dissolving in de - ionized water with the constant stirring process for 10 - 20 min on a magnetic stirrer (1MLH) then on SILAR Equipment (magnetic stirrer 2MLH) with constant magnetic stirring when the temperature of the solution reaches 92 ^{0} C then 2M Na0H solution which acts as precipitation agent added drop by drop in the complex sample solution. [6] After adding Na0H solution, carefully PH Of the solution was noted by using a digital PH meter around 13 - 14, the color of the solution changed was coffee color. [7] The precipitate was washed 7 - 8 times by using Whatman filter paper and De - ionized water and PH changed it is 8 - 9. The remaining solution precipitate was kept for drying at room temperature and then dried at 160^o C in a vacuum oven for 6 - 7 hrs., ground to obtain powder form calcined at 800^{o}C temperature for 7 hrs in the furnace. [8]

2.2 Characterization Techniques

Structural characterization of Manganese nitrate hydrate **was done by using x - ray Diffraction (XRD) analysis** k - Beta filter start 10 stop 85 scanning mode 2θ scanning type continues scanning type x - ray - 40kv/40mA Div - slit - 1.0mm Div. H - L Slit 1.0mm.

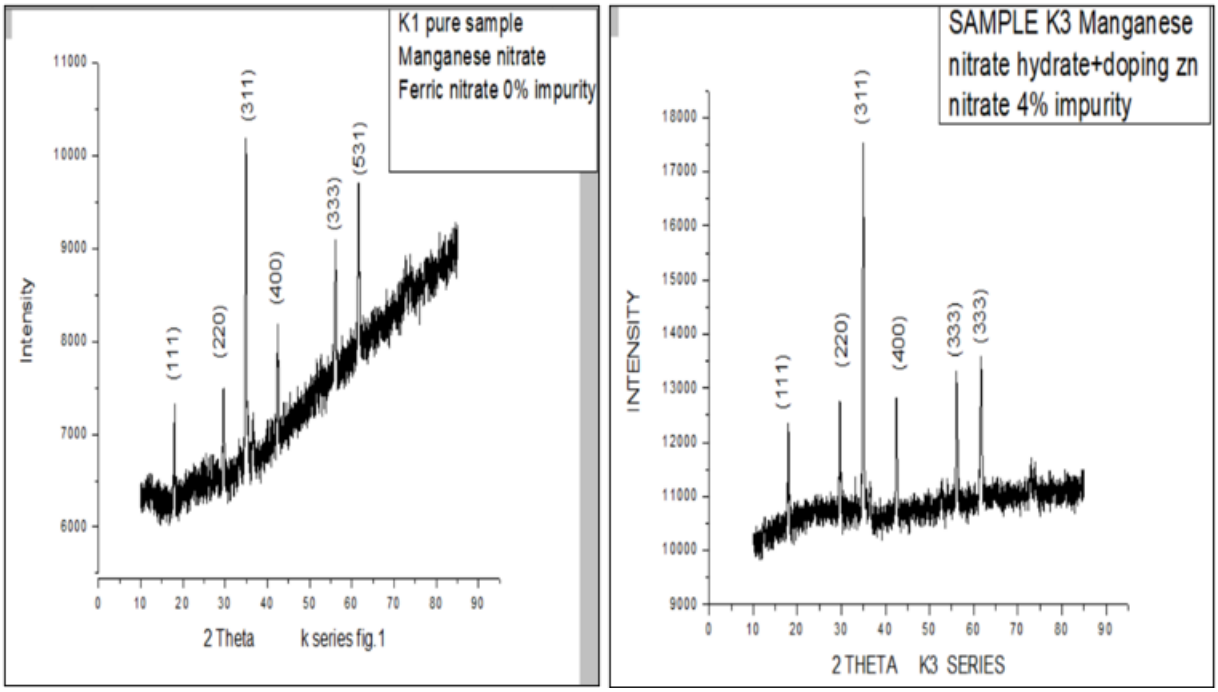

Figure 1: XRD pattern for K1and K3 series

The XRD pattern of the given sample shows the following peaks as (311), (400), (333), and (531) for the k1 series. For k3 series as (311), (220), (400), (333) The lattice constant can be calculated from Bragg's formula as below

The lattice constant can be calculated from Bragg's formula as below [9]

$A=dhkl\ \sqrt{h^2+k^2+l^2}$

Peak broadening can be calculated by using the Scherrer formula below [10, 11, 12]

$D=0.9\lambda/\beta\cos\theta$

Table 1: Data analysis from XRD peak graph for k1 samples

.	D - spacing value A. U	Lattice parameter	FWHM Value	THETA RADIAN	FWHM RADIAN	Crystalline size	volume
	4.9196	8.47	0.1574	0.1573	0.027	320.76	611.31
	3.013554	8.4852	0.3149	0.2586	0.00549	97.52	610.94
Average		8.4776	0.2362	0.2079	0.0162	209.14	611.28

Table 2: Data analysis from XRD peak graph for k3 samples [17, 18]

.	D - spacing value A. U	Lattice parameter	FWHM Value	THETA RADIAN	FWHM RADIAN	Crystalline size	volume
	4.91965	8.487	0.1574	0.1573	0.0247	320.76	611.3116
	2.56616	8.49	0.2165	0.3049	0.003779	120.30	611.96
Average		8.4885	0.18695	0.2311	0.014238	220.53	611.6358

2.3 SEM EDX - (Scanning Electron Microscopy Energy - Dispersive X - ray spectroscopy)

This technique is available for elemental analysis. [13] Elemental compositional can be determined by using SEM EDX. It is used to determine homogeneity and its elemental compositions. SEM EDX is a very simple process for data analysis. The particle size observed was 1mm after the addition of an impurity size reduced up to 500µm [14, 15, 16]

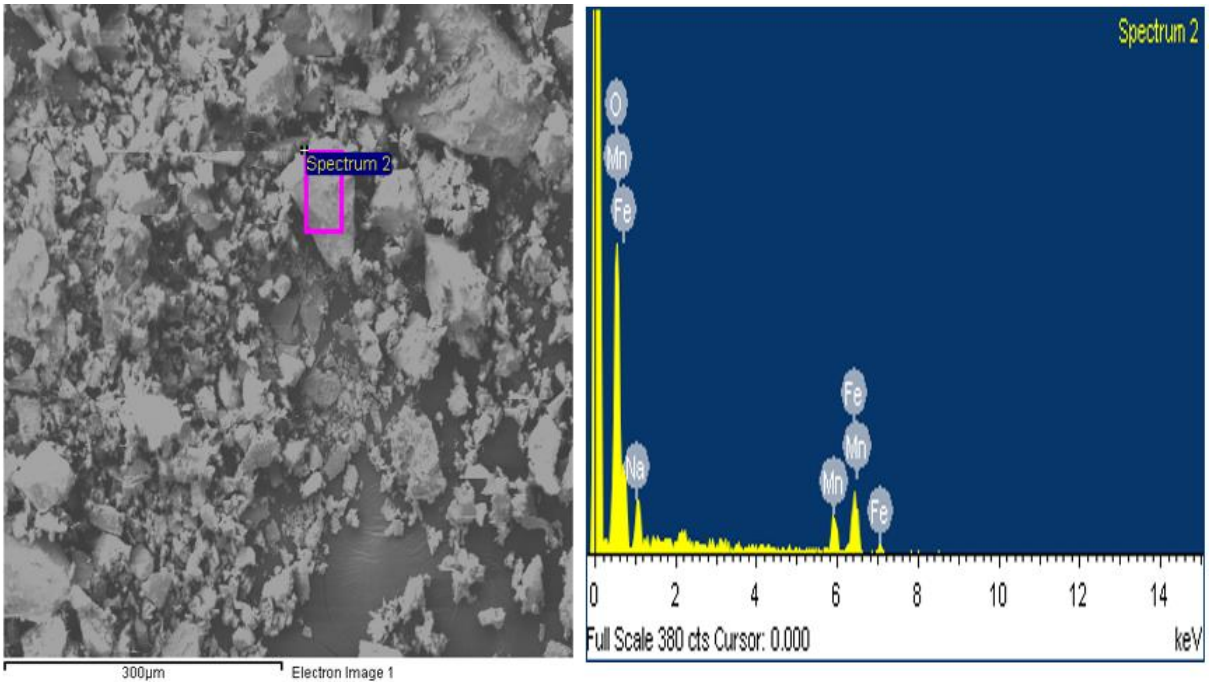

Table 3: Morphology of k1 series

Element	Weight %	Atomic %
Oxygen	28.37	33.91
Manganese	4.63	3.85
Iron	41.20	14.12

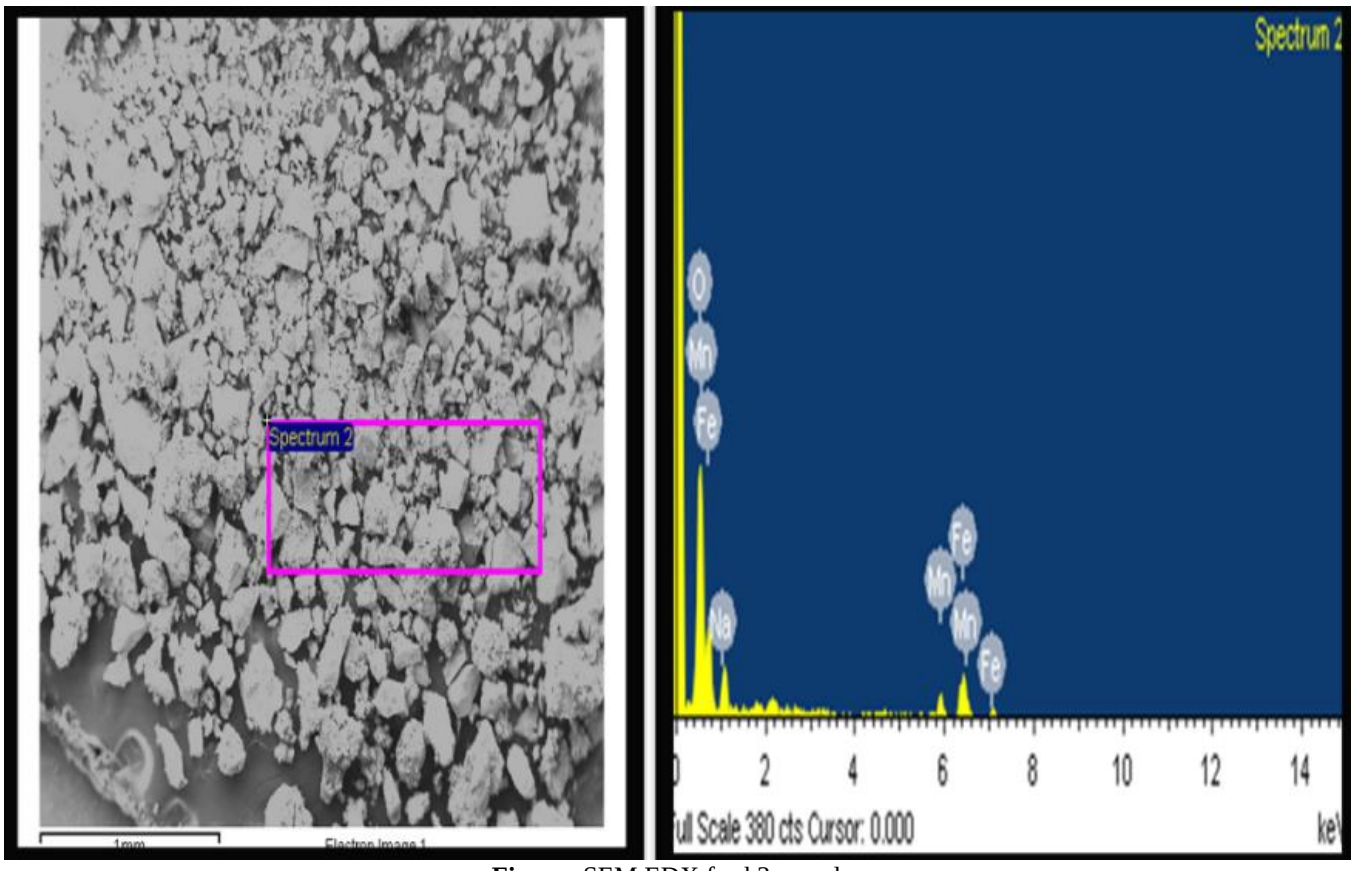

Figure: SEM EDX for k3 samples

Element	Weight%	Atomic%
O K	34.97	62.03
Na K	6.72	8.30
Mn L	4.32	2.23
Fe L	53.99	27.44

3. Conclusion

1) Manganese nitrate Hydrate synthesized effectively synthesized by using the CO - precipitation technique.

2) Using Scherrer's formula, the average value of crystalline size and volume can be estimated from an XRD graph. [19, 20]
3) Using the enlarged higher angle diffraction peak, the crystalline size and volume of ferrite nanoparticles can be determined
4) The SEM EDX morphology and grain size of the pure and doped material, the crystalline size can be easily evaluated and values could be derived.

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