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Synthesis And Characterization of Lead doped Copper nano-ferrite by sol-gel auto combustion Method

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Abstract- Future applications of ferrite nanoparticles include medicine, the development of equipment such as permanent magnets and memory storage devices, among others. Recent scientific research has shifted its focus to ferrite nanoparticles. Nanostructure powders of ferrites with chemical compositions [PbxCu1-xFe2O4] where x=0.2, 0.4, were produced through nitrate citrate autocombustion using a stoichiometric combination of their respective metal nitrates. Sintered the produced powders at 400 0C for 4 hours. X-ray diffraction (XRD) and scanning electron microscopy were used to analyse the powder's structure, shape, and ferrite formation (SEM). The X-ray image demonstrated the production of nanoparticles of ferrite with a cubic spinel structure and a cubic phase within the ferrite matrix. The Scherrer method was used to determine the average size of crystalline particles. The crystalline size gradually grows as the Pb concentration increases. From XRD patterns, the lattice parameters, X-ray density, and bond length are estimated. Scanning electron microscopy was used to characterise the surface morphology of wear.

Keywords: *PbCu nano-crystalline ferrite, XRD, SEM.*

1. INTRODUCTION

Spinel ferrites, with the general formula AFe2O4 (A = Cu, Pb, Co, Ni, Mn, or Zn), are important magnetic materials due to their distinct magnetic and electrical properties, as well as their chemical and thermal durability [1]. CuFe2O4 (copper ferrite) is a major ferrite. It is a soft magnetic n-type semiconducting material with a cubic structure that is used in a wide number of applications including heterogeneous catalysis, adsorption, sensors, and magnetic technologies [2]. The high surface-to-volume ratio of magnetic materials is an attractive property that can be attained by nanofabrication. Due to this property, their technical use should be broad, encompassing nanocomposites, nanocatalysts, nanosensors, nanoelectronics, and photonics. Lead copper ferrite (PbCuFe2O4) is a significant ferrit. It is a soft magnetic n-type semiconductor with a cubic structure that has a wide range of applications in heterogeneous catalysis, adsorption, sensors, and magnetic technologies [3-4]. The requirement for a unique gas sensor capable of operating reliably in severe environments has never been greater. These sensors are used for a variety of purposes, including monitoring traffic pollution or food quality using specially built electronic noses [5-6]. The materials' ability to detect biomolecules and gases is dependent on their microstructural qualities, which are related to their synthesis technique; the latter is crucial in terms of the chemical, structural, and physical properties of a spinel ferrite. PbxCu1-xFe2O4 is frequently synthesised utilising zinc nitrate, magnesium nitrate, and glycine as a fuel source [7]. Alternatively, several wet processes are accessible, including co-precipitation [8], microemulsions [9], oxidation approaches [10], and hydrothermal synthesis [11]. The sol-gel device and low-temperature synthesis are two of these technologies [12].

2. EXPERIMENTAL DETAILS

Nanoparticles of $Pb_xCu_{1-x}Fe_2O_4$(where x=0.2,0.4) were prepared by Sol-gel auto-combustion method using 'AR' grade Lead nitrate ,Copper nitrate, ferric nitrate and citric acid as a raw material. Citric acid is used as a fuel. The metal nitrate to citric acid is taken in the as 1:3. These raw materials were weighed according to its stoichiometric ratio and then dissolved separately in deionised water. pH is maintained 7 by adding ammonia in the solution. After. On the magnetic stirrer at 1000C with constant swirling, the solution was allowed to gel. The dried gel was allowed to burn in a self-propagating manner until it was totally consumed by fire and reduced to fluffy loose powder. Sintered the produced powder for 4 hours at 400oC. At ambient temperature, X-ray diffraction (XRD) with CuK (=1.54056 oA) was utilised to investigate the single-

phase nature and nanophase development of PbxMg1-xfe2O4 ferrite nanoparticles.

General Reaction: -

$$x(Pb(NO_3)_2,6H_2O)+1-x(Cu(NO_3)_2,6H_2O+2Fe(NO_3)_2.9H_2O+3C_6H_8O_7 \xrightarrow[100^0C \text{ for } 6 \text{ hrs}]{\triangle} Pb_xCu_{1-x}Fe_2O_4$$

3. RESULTS & SISCUSSION

X-Ray Diffraction:

Fig. 1 illustrates the XRD patterns of the PbxCu1-xFe2O4 ferrites. The average crystalline size was estimated using Scherrer's equation[13] from the broadening of the diffraction peak.

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

(1)

where, ⅄ is the wavelength of the CuKα radiation (⅄=1.54056Å), and β is the full width at half maximum in radians. The lattice parameter of the sample was determined from using this relation[13].

$$\sin^2\theta = \frac{\lambda^2}{4a^2}(h^2+k^2+l^2)$$

(2)

This formula was used to determine the X-ray density Dx of the produced sample[14].

$$Dx = \frac{ZM}{N_a a^3}$$

(3)

Where Z represents the number of molecules per unit cell (Z=8), M represents the sample's molecular weight, Na represents the Avogadro's number, and 'a' represents the lattice parameter.

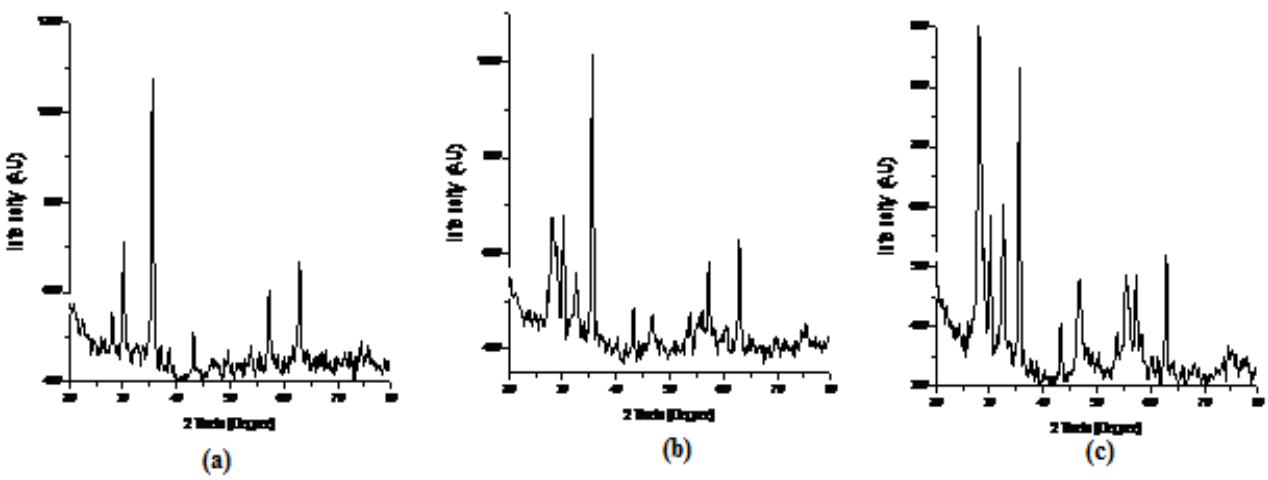
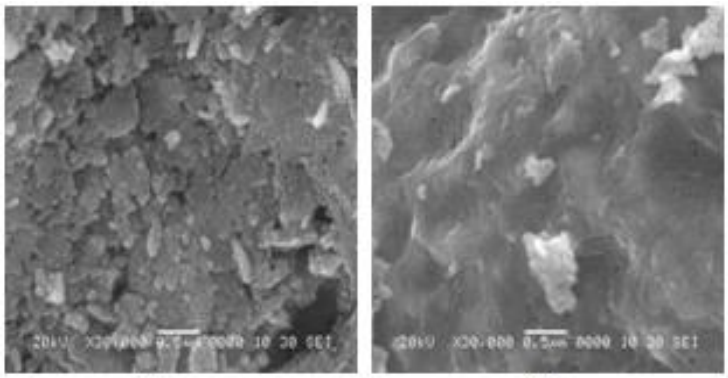


Fig-1 XRD of $Pb_xCu_{1-x}Fe_2O_4$ (a=0.2,b=0.4,c=0.6)

Sr.No	Composition x	Grain Size (nm)	Lattice Constant ^{0}A	X-Ray Density (gm/cm^3)
1	$Pb_{0.2}Cu_{0.8}Fe_2O_4$	26	8.3688	5.93
2	$Pb_{0.4}Cu_{0.6}Fe_2O_4$	24	8.3835	5.12

3	$Pb0.6Cu_{0.4}Fe_2O_4$	23	8.4071	4.32

Scanning Electron Microscopy(SEM):-



(a) (b)

Fig-2 SEM Micrograph of $Pb_xCu_{1-x}Fe_2O_4$ (a=0.2,b=0.6)

4. CONCLUTION

From above results we conclde that as the concentration of lead increases particle size found to be 26-23nm and lattice constant incereases. The lead Copper ferrite was of structure found to be body centered cubic.As concentration increases X-Ray density decreases.

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