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Synthesis and Microstructure Characterization of Lithium Substituted Magnesium Ferrite Synthesized by Solid State Reaction Method

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ABSTRACT

Nano-crystalline lithium substituted magnesium ferrite was synthesized by solid state reaction method. Iron oxide , magnesium carbonate and lithium carbonate are used as raw materials to prepare circular pellets of size 35 mm diameter are subjected to X- ray diffraction (XRD) to calculate average nano – crystalline size using Debye - Scherrer's formula. X-ray diffraction patterns of the synthesized ferrite particles in the samples are cubic spinel ferrite. The morphological analysis is performed using scanning electron microscope (SEM). SEM images show that particle size range was between 170 to 250 nm.

Keywords : Lithium substituted magnesium ferrite, XRD, SEM

I. INTRODUCTION

The materials named as nano crystalline spinel ferrites have been the subject of detailed research for their potential applications in various fields. They are used in wide technological applications like microwave devices, noise filters, heterogeneous catalysis , adsorption, sensors, cancer treatment, operating devices, read/ write heads for high speed digital tapes, non resonant devices, radio frequency circuits, rod antennas and transformer cores due to their interesting electrical, magnetic, chemical properties and their thermal stability [1-6]. $(M_{1-x}Fe_x)[M_xFe_{2-x}]O_4$ is the general formula for spinel ferrites [7-8]. Here M is the divalent atom like Mg, Zn, Mn, Fe, Ni, Co or mixture of these and X is the degree of inversion. Formula for normal spinel magnesium ferrite is $MgFe_2O_4$ and has cubic structure. It is soft magnetic n-type semiconducting material. There are various types of methods to synthesize magnesium ferrites like citric acid combustion method, hydrothermal method, sol gel auto combustion method, thermolysis, self propagating, micro emulsion, wet chemical co-precipitation and solid state reaction method. Out of these, solid state reaction method is one of the best method because of the advantages like cost effective, simple preparation and uniform particle size[9-14].

In this work lithium substituted magnesium ferrite is prepared by solid state reaction method. The composition, structure and thermal properties are characterized by XRD (X-Ray Diffraction) and SEM (Scanning Electron Microscope).

II. EXPERIMENTAL

Highly pure precursors Li_2CO_3, $MgCO_3$ and Fe_2O_3 were taken in different molar ratios to synthesize different samples A, B and C of ferrite with general formula $Li_xMg_{1-x}Fe_2O_4$, where X=0.3 - 0.5. To prepare the sample , the precursor powders were mixed and grinded for 2h 30min in pestle and mortar to get fine and uniform powder. This fine powder obtained was calcined at a temperature of 800°C for 10h in air. In this calcined powder PVA (Polyvinyl Alcohol) was

added and grinded for 30min and circular pellets of size 35mm diameter and thickness 1mm were prepared by hydraulic press. These pellets were sintered at 1000°C for 6h 30min. Pellets obtained after sintering were analyzed by SEM (Scanning Electron Microscope) at an accelerating voltage of 10kV and by XRD (X-Ray Diffraction). Samples are labeled as Sample A, Sample B and sample C.

III. RESULTS AND DISCUSSION

XRD

XRD patterns of various samples are as shown below in figures 1, 2 and 3. By comparing with the standard powder diffraction pattern (JCPDS Card No. 17-464), it was obtained that the major planes correspond to (2,0,0), (3,1,1), (2,2,2), (4,0,0), (4,2,2) and (5,1,1) were matching. This confirmed the presence of lithium substituted magnesium ferrite. The average particle size was calculated using Scherrer's formula

$D = 0.91\lambda/\beta\cos\theta$

Where, λ= wavelength of X-ray radiation

B= full width of half maximum

Θ= angle of diffraction

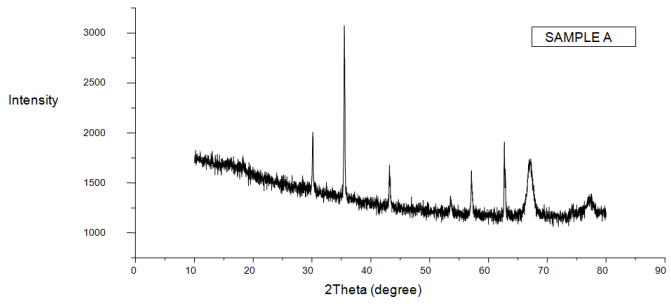

Figure 1: XRD curve of Sample A

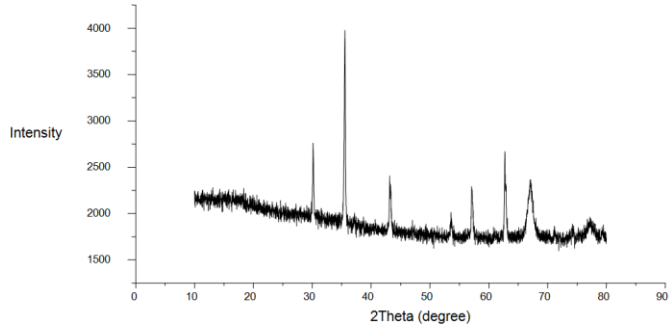

Figure 2: XRD curve for Sample B

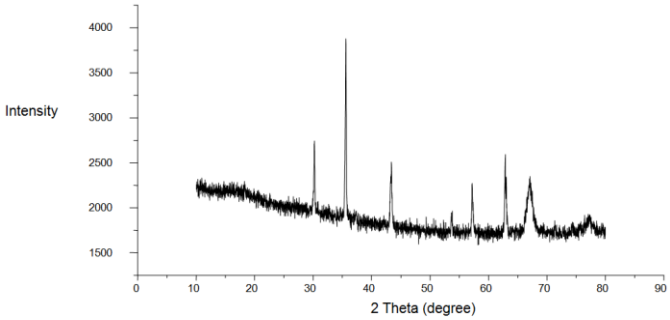

Figure 3: XRD curve for Sample C

SEM (Scanning Electron Microscope)

The scanning electron microscope photo micrographs give the information about the topology and size of particles of synthesized pellets. The SEM images of samples were obtained by EV018 Zeiss installed at SAIF, AIIMS New Delhi equipped with 35mm photography system digital imaging. The images show that the synthesized ferrite particles are cubical and agglomerated. The SEM micrographs of various samples of lithium substituted magnesium ferrite show that the particle sizes are 170 to 250 nm. This is bigger than crystallite size obtained from XRD using Scherrer's formula.

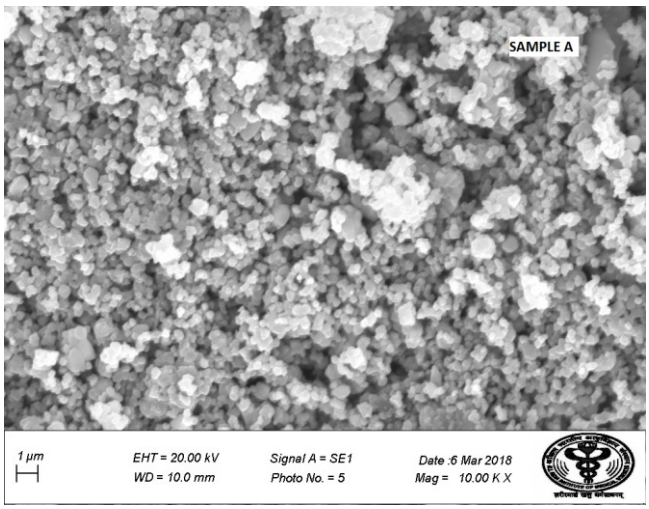

Figure 4: SEM image of Sample A

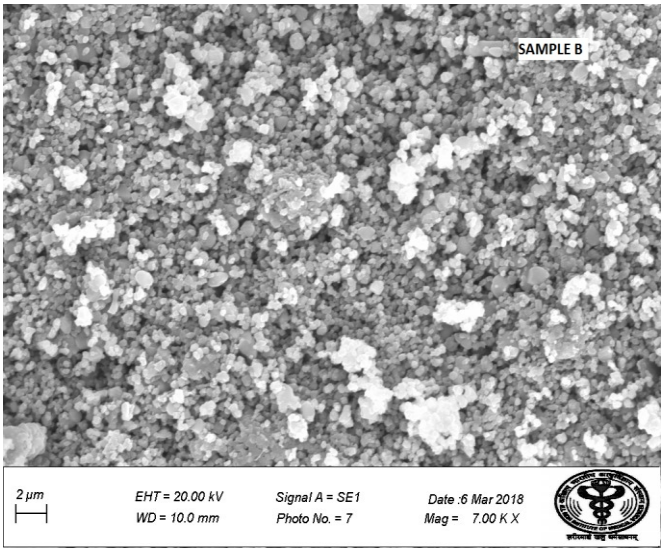

Figure 5: SEM image of Sample B

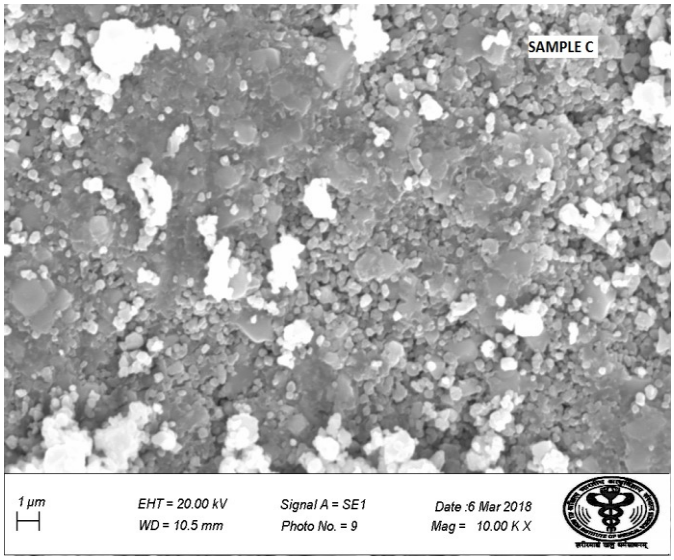

Figure 6: SEM image of Sample C

IV. CONCLUSION

The solid state reaction method is well suited for the synthesis of lithium substituted magnesium ferrite pellets with nano size particles ranging from 170 to 250 nm size. The X-Ray diffraction confirms the purity of the samples. SEM images reveal that nano-particles have cubical shape. The synthesized lithium substituted magnesium ferrite can be used in different areas like hydroelectric cell, sensing equipment, and adsorption processes.

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