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Investigation of structural and magnetic properties of nanocrystalline manganese substituted lithium ferrites

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ABSTRACT

Nanocrystalline manganese substituted lithium ferrites $Li_{0.5}Fe_{2.5-x}Mn_xO_4$ ($2.5 \leq x \geq 0$) were prepared by sol–gel auto-combustion method. X-ray diffraction patterns revealed that as the concentration of manganese increased, the cubic phase changed to tetragonal. Magnetic properties were measured by hysteresis loop tracer technique. All the compositions indicated ferrimagnetic nature. The surface morphology of all the samples was studied by using scanning and transmission electron microscopy. The substitution of manganese ions in the lattice affected the structural as well as magnetic properties of spinels.

1. Introduction

Ferrospinels have interesting structural and magnetic properties and are widely used in many important components such as microwave devices, memory cores, magnetic recording media, transformers, choke coils, high frequency instruments, data storage, noise filters and recording heads, owing to their high magnetic permeabilities and low magnetic losses [1,2]. These properties are dependent on the nature of ions and their charge distribution among tetrahedral and octahedral sites. In spinels, the oxygen ions form a cubic close packed array, in which the A site cations occupy one-eighth of the tetrahedral sites and the B site cations are distributed over one half of the octahedral positions. The modifications of the structural and magnetic properties of ferrites are due to substitution of different ions and have been studied by various workers [3–8].

Here, we report the substitution of manganese in lithium ferrite and its effect on structural and magnetic properties.

2. Experimental details

Polycrystalline samples having the general formula, $Li_{0.5}Fe_{2.5-x}Mn_xO_4$ ($0.0 \leq x \leq 2.5$) were synthesized by sol–gel auto-combustion method. High purity AR grade ferric nitrate, manganese nitrate, lithium nitrate and citric acid were used for synthesis. The metal nitrate solutions were mixed in the required stoichiometric ratios in distilled water. The pH of the solution was maintained between 9 and 9.5 using ammonia solution. The solution mixture was slowly heated around 373 K with constant stirring to a obtain fluppy mass. The precursor powder was sintered at 973 K for 8 hrs then mixed with 2% polyvinyl alcohol as a binder and uniaxially pressed at a pressure of 8 ton/cm^2 to form the pellets.

The phase formation of the samples was confirmed by X-ray diffraction studies using Philips PW-1710 X-ray diffractometer with Cu$K\alpha$ radiation ($\lambda = 1.54056$ Å). The surface morphology and size of sintered powders were studied by scanning electron microscopy (SEM: Model JEOL-JSM6360). A Philips 200 CX transmission electron microscope (TEM) was used to find the particle size by suspending the samples in isopropyl alcohol. The FTIR spectra were recorded using Perkin Elmer FTIR in KBr pellets. Magnetic properties were studied using Hysteresis loop tracer (Magneta B–H loops tracer) at a maximum applied field of 2.5 KOe.

3. Results and discussion

3.1. X-ray diffraction

X-ray diffraction patterns of the Mn-substituted lithium ferrite samples are shown in Fig. 1. From Table 1, it is noted that, the

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