Synthesis and Characterization of lithium ferrite

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Abstract

$Li_{0.5}Fe_{2.5}O_4$ ferrites were successfully prepared by using sol-gel process. The resulting nanosample has been characterized by using XRD and SEM techniques. The X-Ray diffraction (XRD) analysis studies clearly suggest the formation of single phase nanomaterials. The SEM analysis indicates the formation of uniform and fine grains like morphology in mixed-metal oxides. The results of combustion synthesis elucidate that the fuel to oxidizer ratio is the most effective factor for the formation and surface morphology of mixed-metal oxides.

***Keywords**:* Sol-gel Chemistry, XRD, SEM

1. Introduction

Mixed-metal oxides have attracted tremendous attention due to their potential applications in biomedical, catalytic, separation, chemical sensing, fuel cell, capacitor, micro-fabrication, tribological, resonant coupling, and high flux gas transport. Because its consists of materials with small dimensions, remarkable properties, and great application potential. It is well known that the sol–gel method synthesis has been proved to be one of the most effective routes to realize the low temperature sintering of ferrites. However, properties of these ferrite materials are also very sensitive to the starting materials that are used for the composition, method of preparation, the preparation conditions, such as calcining temperature, soaking time, etc [1].

In our previous research work, $Li_{0.5}Fe_{2.5}O_4$ is an inverse spinel ferrite in which Li^+ ions occupies the octahedral (B sites) and Fe^{3+} occupies the tetrahedral (A sites) of the spinel lattice[2-4]. Lithium and substituted lithium ferrites are useful for microwave devices such as isolators, circulars, gyrators, phase shifters, cathode materials and memory cores owing to their high Curie temperature, high resistivity, low eddy current losses, high saturation magnetization and hysteresis loop properties, which offer performance advantage over other spinel structures [5-9]. Due to various applications our research group studied the structural, electrical and magnetic properties of chromium and Manganese substituted Li-ferrites synthesized by the sol-gel method. In present work, we report the synthesis of $Li_{0.5}Fe_{2.5}O_4$ system by sol-gel method and their structural properties have been investigated by XRD and SEM studies.

2. Experimental technique

Polycrystalline sample having the general formula, $Li_{0.5}Fe_{2.5}O_4$ was synthesized by sol-gel method. The Lithium nitrate, Iron nitrate and Citric acid 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 373K with constant stirring to obtain a fluffy mass. This precursor powder was sintered at 973 K for 8 h. The sintered powders were granulated using 2 % polyvinyl alcohol as a binder and were uniaxially pressed at a pressure of 8 ton /cm^2 to form pellets. These pellets were gradually heated to about 773K to remove out the binder material.

The phase formation of the samples was confirmed by X-ray diffraction studies using Philips PW-1710 X-ray diffractometer with CrKα radiation (λ=2.2897Å). The surface morphology and average grain size of the ferrite sample were studied by using Scanning Electron Microscopy technique (Model JEOL-JSM 6360).

3. Results and discussion

3.1 X-ray diffraction studies

Fig.1. illustrates the x-ray diffraction patterns of lithium ferrites sample. The diffraction patterns indicate that the samples have cubic spinel crystal structure for all samples. The values of lattice parameter'a'calculated was found to be 8.30. From the X-ray diffraction peaks, average particle size was estimated using Scherrer's formula.

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

where 0.9 is the Scherrer's constant (k), **λ** is the X-ray wavelength corresponding to CrKα, β denotes the full-width at half-maximum of the peak and θ is the Bragg angle. The crystallite size was found to be in the range of 20-30 nm. The X-ray density (dx) was calculated using the relation,

$$dx = 8M/Na^3$$

Where, N= Avagadros number (6.023 x 10^{23} atom/mole)

M=Molecular weight

a = Lattice constant

3.2 Scanning electron micrograph

Figure 2(a-e) depicts scanning electron micrograph (SEM) of $Li_{0.5}Fe_{2.5}O_4$. It is evident from these micrographs that all the synthesized samples are uniform and homogenous grains with size ranging from 0.1 to 0.5μm.

Conclusions

Lithium ferrite was synthesized by sol-gel method. The system shows single phase cubic in nature. The X-Ray diffraction (XRD) analysis studies clearly suggest the formation of single phase nanomaterials. The ferrospinels synthesized by autocombustion method were in homogenous and uniform grain size.

References

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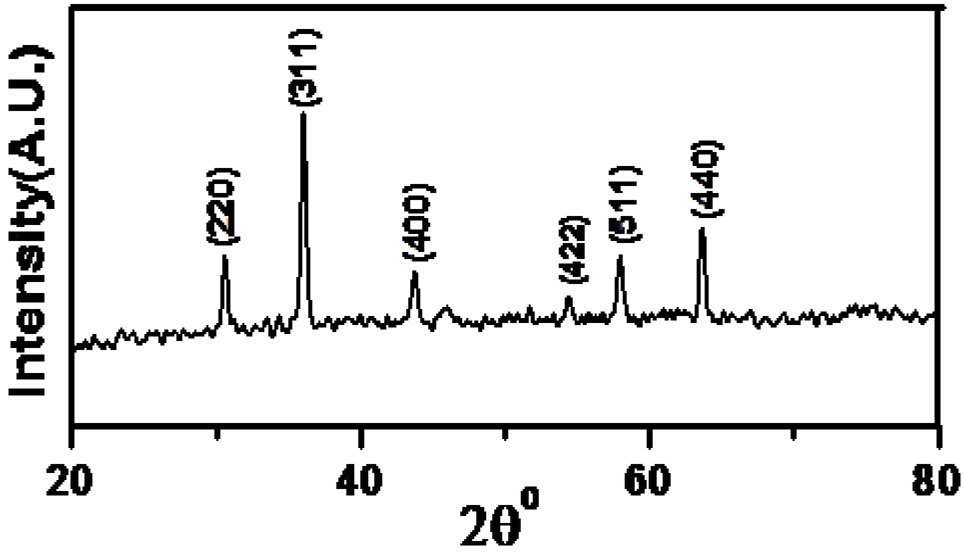

Fig.1.XRD pattern of Lithium ferrite

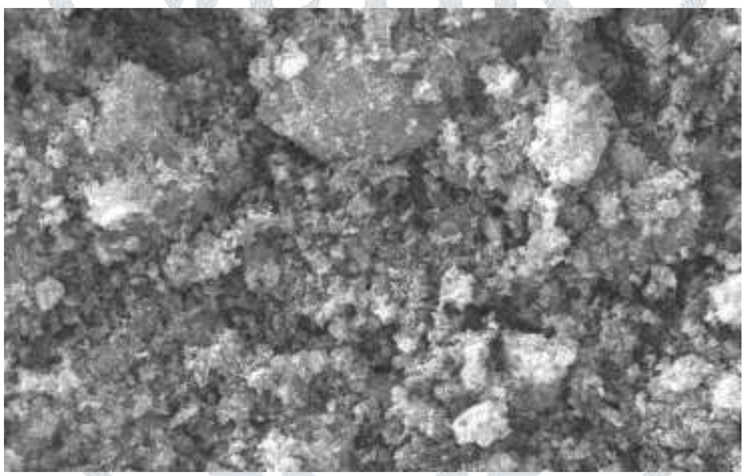

Fig.2.SEM images of Lithium ferrite