

# Synthesis and Thermogravimetric Analysis of $\text{Li}_{0.5-0.5x}\text{Mg}_x\text{Fe}_{2.5-0.5x}\text{O}_4$

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## ABSTRACT

Mg-doped Li-ferrites with compositional formula  $\text{Li}_{0.5-0.5x}\text{Mg}_x\text{Fe}_{2.5-0.5x}\text{O}_4$  (where  $x= 0$  to 0.5) are prepared by combustion synthesis. Using the thermogravimetric data the sintering temperature is fixed to 450°C. Polyethylene glycol was used as the fuel during the combustion synthesis.

**Key words:** Mg-doped Li- ferrite, Thermogravimetric analysis, PEG, Combustion.

## INTRODUCTION

Ferrosinels have interesting structural, electrical and magnetic properties and widely used in many important applications such as microwave devices like circulators, phase shifters, memory cores, magnetic recording media, transformers, choke coils, high frequency instruments, data storage, noise filters and recording heads, owing to their high magnetic permeability's and low magnetic losses [1,2]. The properties of spinal ferrites depend upon the method of preparation, substitution of suitable cations, heat treatment, annealing conditions and pH value etc [3].

Lithium ferrites and substituted lithium ferrites have become one of the most attractive materials for microwave applications especially as a replacement of garnets. Mixed lithium ferrites have low cost, square hysteresis loop, high Curie temperature which results superior high temperature

performance are the other important properties that make them promising materials for microwave applications [4-6].

Since the number of ferric ions on A and B sites is unequal in lithium ferrite, the calculated magnetic moment is not just that of lithium ions, but is given by the difference in the magnetic moment of ions on A and B sites. Consequently, lithium ferrite possesses a higher Curie temperature than other spinel ferrites [7]. Moreover, lithium ferrite have been also promising substitutes for Ni-Cu-Zn ferrites in advanced planar ferrite devices, because of their low sintering temperature, high curie temperature and excellent electromagnetic properties at high frequency [8]. Magnesium substituted lithium ferrites have been used in many electronic devices for high frequency because of their high electrical resistivity, high Curie temperature and low cost [9].

Many researchers have reported studies on Li-Cd [10, 11], Li-Zn [12], Li-Mg [13] and Li-Ni [14] ferrites. In this present communication, we report on TGA analysis of Li-Mg Ferrites.

## METHODOLOGY

In the present investigation combustion synthesis is used and flow chart of it is shown in figure 1. Mg-doped Li- ferrite with compositional formula  $\text{Li}_{0.5-0.5x}\text{Mg}_x\text{Fe}_{2.5-0.5x}\text{O}_4$  where x values are 0, 0.1, 0.2, 0.3, 0.4 and 0.5 was prepared by combustion process [15], using high-purity analytical reagents  $\text{Li}_2\text{CO}_3$ ,  $\text{Fe}_2\text{O}_3$  and  $\text{MgO}$  as starting materials. Polyethylene glycol (PEG) acted as the fuel for the combustion process. All initial reagents are mixed for 2 hours and the fuel Polyethylene glycol (PEG) with molecular weight 6000 is added in a weight ratio 1:2 in a pestle and mortar. Using Perkin Elmer, STA 6000 Simultaneous Thermal Analyser, is used for thermogravimetric analysis. The rate of heating is maintained at 10 °C per min and the mass of solid specimen is 40 mg. The measurements are carried out in nitrogen current at the rate of 50  $\text{cm}^3$  per min. The

resulting mixtures were placed in an aluminium crucible and heated at a temperature of 420 °C for 3 h.

## RESULTS AND DISCUSSIONS

Combustion synthesis has been proved to be a simple and economic way to prepare nanoscale powders [16 - 18]. But combustion technique has some limitations viz., use of urea as fuel, and also that poly vinyl alcohol has a wide variation of molecular masses, both of these parameters may influence the combustion to undergo as a highly exothermic reaction. Hence, a new fuel which can also act as a controllable oxidant in a combustion reaction generating self-propagation is essential. In search of a suitable economic fuel, the use of polyethylene glycol (PEG) has given promising results in a single step.

Fig. 1 shows the DTA/TGA curves of  $\text{Li}_{0.5-0.5x}\text{Mg}_x\text{Fe}_{2.5-0.5x}\text{O}_4$  samples for  $x = 0.0, 0.3$  and  $0.6$ . The decomposition process consists of two regions. They are 25 - 170 °C and 170 - 480 °C. Owing to the initial breakdown of the complex and spontaneous combustion, the first weight loss of about 0.2 to 1.8 % in the region from 25 - 170 °C indicates the evaporation of absorbed water with an energy of about - 2.1 J/g to - 900 J/g. The second weight loss of about 60 to 65 % region observed between 170 - 480 °C is ascribed to dehydration of OH group in the spinel structure of some constituents such as carbonates and PEG with a heat formation of about 40 J/g to 19 kJ/g, which lead to two degradation systems involving both inter and intra-molecular transfer reaction, the oxidation of complexes. With the liberation of  $\text{H}_2\text{O}$  and  $\text{CO}_2$  providing an oxidizing environment for the combustion of the organic components [19], the spontaneous combustion is caused from the interactions of polyethylene glycol and carbonates. Above 420 °C there is no weight loss. From this study, it is seen that the DTA/TGA curve is steady, demonstrating the absolute volatility of water, organic compound, carbonates in the composites. Thus the sintering temperature is fixed to 420 °C indicating the completion of crystallization route and the immediate formation of Mg-doped lithium ferrite.

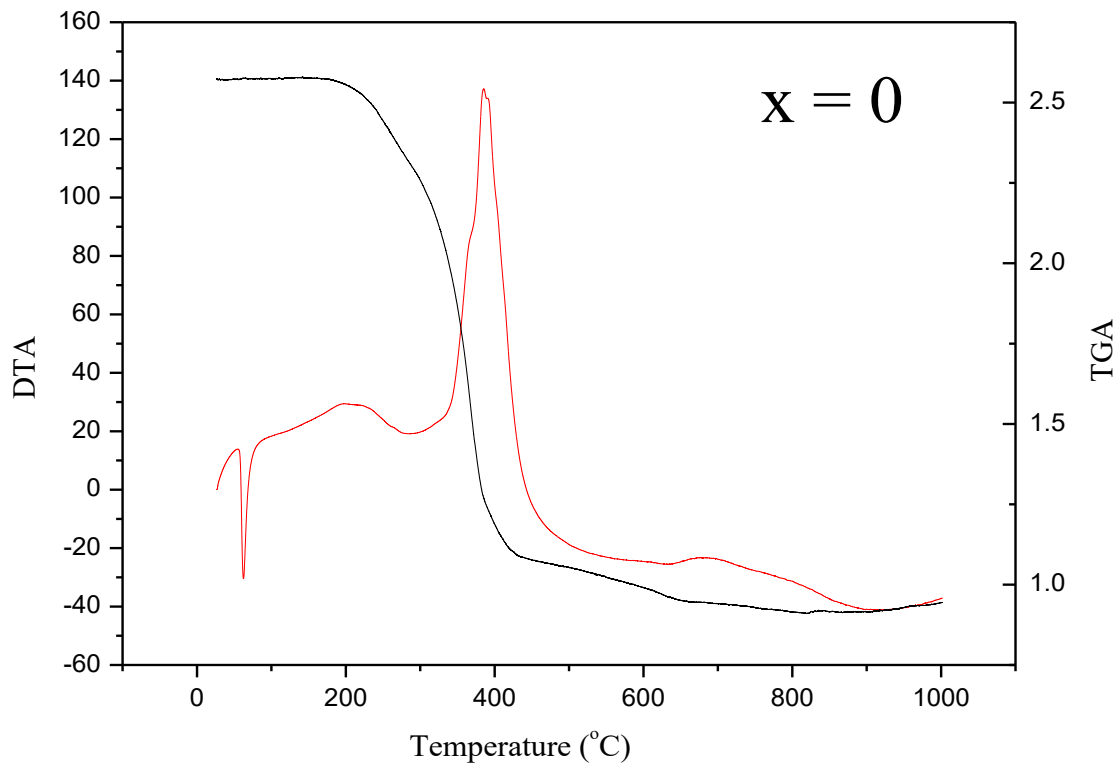


Fig. 1 (a) TGA and DSC curve for  $\text{Li}_{0.5-0.5x} \text{Mg}_x \text{Fe}_{2.5-0.5x} \text{O}_4$  samples for  $x=0$

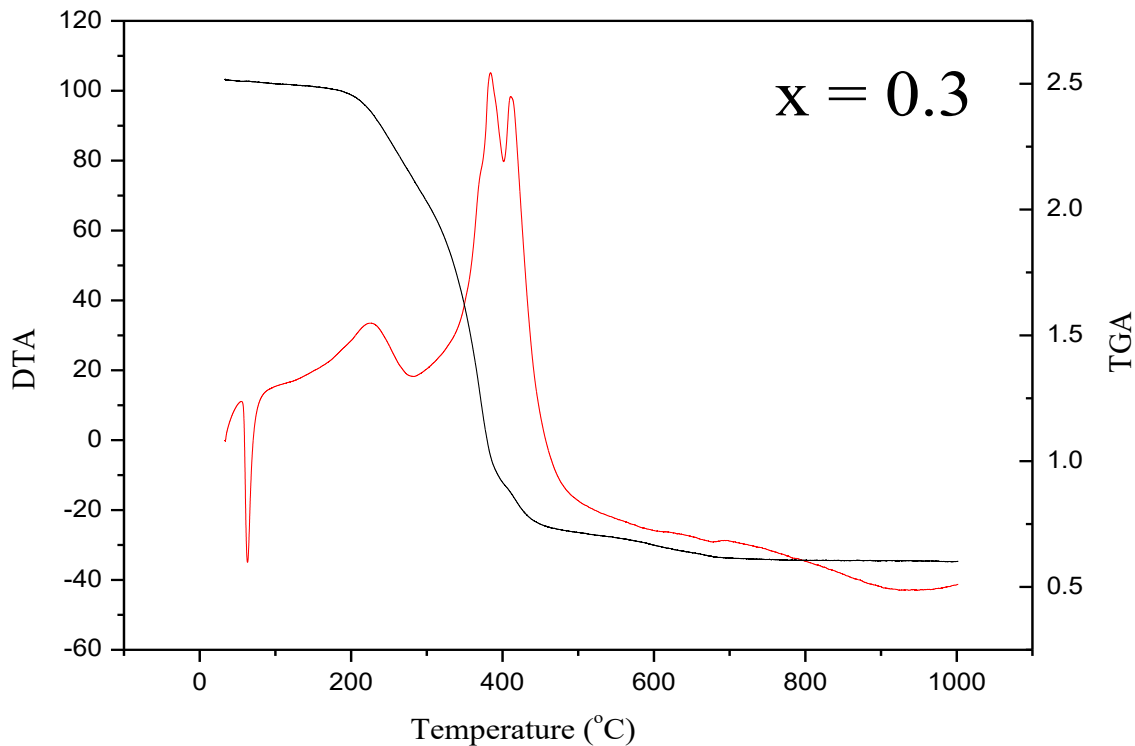


Fig. 1 (b) Showing the DTA/TGA Curve of  $\text{Li}_{0.5-0.5x} \text{Mg}_x \text{Fe}_{2.5-0.5x} \text{O}_4$  samples for  $x=0.3$

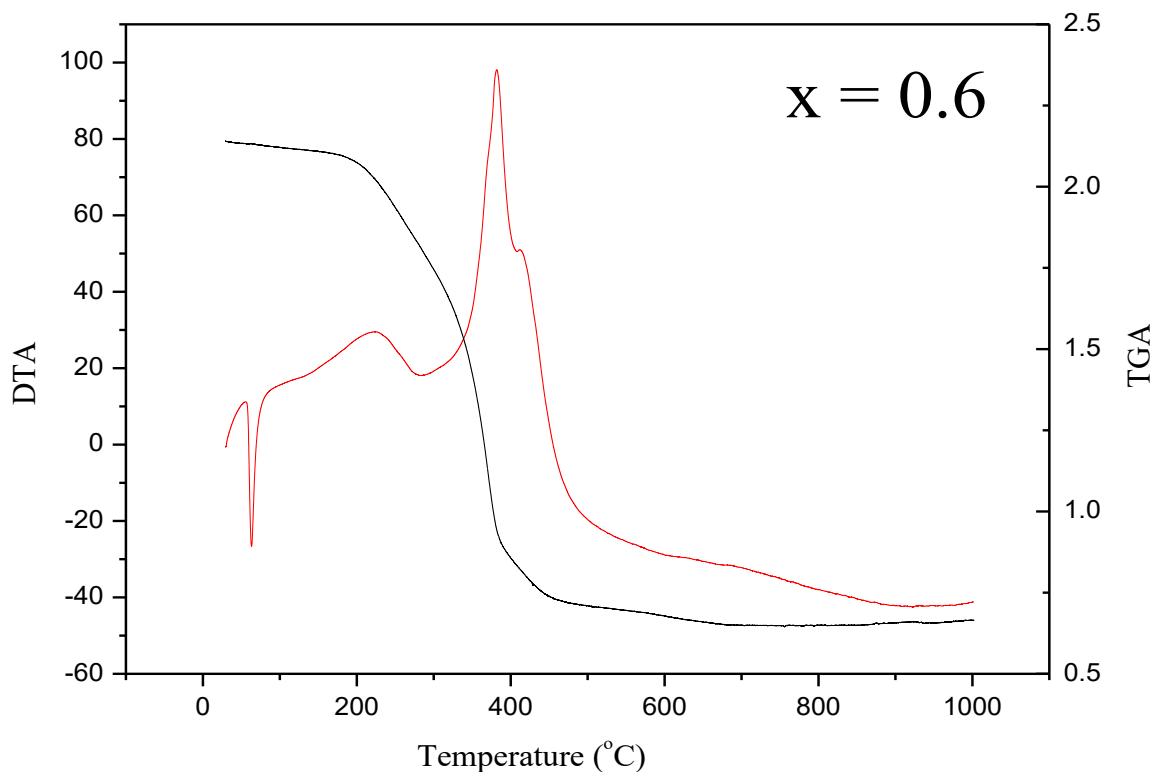


Fig. 1 (c) Showing the DTA/TGA Curve of  $\text{Li}_{0.5-0.5x}\text{Mg}_x\text{Fe}_{2.5-0.5x}\text{O}_4$  samples for  $x=0.6$

## CONCLUSION

An attempt has been made to synthesize the Mg-doped Li-ferrite at different compositions by combustion method. Using thermogravimetric data the sintering temperature was fixed to 420 °C much smaller compared to the conventional high temperature synthesis routes reported in literature.

## REFERENCES

- Goodenough JB. Magnesium and Chemical bond, Wiley, New York, 1956.
- Blasse G. Philips Res. Rep.(Netherlands) 20 (1965) 528.
- Liu C, Lan Z, Jiang X, Yu Z, Sun K, Li L, Liu P. J. Magn. Mater, 320, 2008.
- Shaik AM, Kanamadi CM, Chogale BK. Mat. Chem. Phy., 93, 2005, 548-551.
- Jadhav SA. J Magn. Mater, 224, 2001, 167-172.
- Jadhav SA. Mat. Chem. Phy., 65, 2000, 120-123.
- Fu YP. Mater. Res. Bull., 41, 2006, 809-816.
- Yue Z, Zhou J, Wang X, Gui Z, Li L. J. Eur. Ceram. Soc., 23, 2003, 189-193.
- Ravinder D, Reddy PV. J. Magn. Mater., 263, 2003, 127-133.
- Bellad SS, Pujar RB, Chougale BK. Mater. Chem. Phys., 52, 1998, 166.
- Radha K, Ravinder D. Indian J. Pure Appl. Phys., 33, 1995, 74.
- Ravinder D. J. Mater. Sci. Lett., 11, 1992, 1948.
- Purushotham Y, Reddy MB, Kishan PP, Sagar D, Reddy V. Mater. Lett., 17, 1993, 341, (North-Holland).
- Reddy PV, Reddy VD. J. Magn. Mater., 136, 1994, 279.
- Lature S, Kalashetty S and Jadhav GH. Phy. Scr., 90, 2015, 85805
- Chakrabarathi N and Maiti HL. Mater. Lett., 30, 1997, 169.
- Schafer J, Sigmand W, Roy S and Aldinger F. J. Mater. Res., 12(10), 1997, 2518.
- Yue Z, Li L, Zhou J, Zhang H and Gui Z. Mater. Sci. Eng., B64, 1999, 68.
- Guo L, Shen X, Meng X, Feng Y. J. Alloys Compd., 490, 2010, 301-306.