A Comprehensive Review of Different Synthesis Processes Involved for the Preparation of Magnesium Ferrite

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Abstract- **An effort was made to study the different synthesis process involved in magnesium ferrite. The approaches of research of spinel ferrites show a very significant role in defining the chemical, magnetic, & structural properties. In direction to accomplish these indistinct properties, the size & morphology of MgFe2O4 have been calculated by using numerous synthetic methods i. e co precipitation, sol–gel, mechanochemical, combustion, microwave hydrothermal & polymerization method.**

Keywords— Ferrite; Synthesis; Magnesium Ferrite; Doping

I. INTRODUCTION

Magnesium ferrite ($Mg^{2+}Fe^{3+}O_4$) is significant magnetic oxide with cubic construction of n - spinel type. The magnesium ferrite is a magnetic quantifiable but Mg^{2+} ions doesn't have magnetic characteristics and the distribution phenomenon of Mg^{2+} ions be contingent on the synthesis temperature which directly affect some magnetic properties. The annealing progression is the important parameter which affects the magnetic possessions such as saturation & transition temperature. The growing interest in potential spinel ferrite materials with improved electromagnetic properties at higher frequencies from the magnetic, electrical, & microwave fields. The magnetic, structural, dielectrical, & electrical possessions of ferrites depend on the technique of grounding, intensity of doping, chemical configuration, annealing temperature & time [1]. $MgFe_2O_4$ is a soft ferromagnetic, n-type semiconducting material with a wide range of applications in high-density data storage devices, magnetic resonance imaging, sensors, heterogeneous catalysis, drug transport, and other fields. [2-8].

The research of spinel ferrites participates an important part in shaping the chemical, magnetic & structural properties. The size and shape of $MgFe_2O_4$ have been studied utilizing a variety of synthetic processes, including co precipitation [9], sol–gel [10], mechanochemical processing [11], combustion method [12], microwave hydrothermal technique [13], and polymerization approach [14]. A numeral of raw ingredients can be applied in the research of ferrites; these include oxides, carbonates, oxalates, and nitrates. The previous three compounds decay to oxides on heat conduct and are therefore furnished with a temperature nearby that at which solid-state reactions originate. The homogenous material of fine quality is attained by this process. In aim of this research is to understand the different synthesis methods. The objective of the present study is to compare the different synthesis method used by different researcher.

II. LITERATURE REVIEW

Roberto Koferstein et. al [15] has taken Mg $(NO_3)_2.6H_2O$ & Fe $(NO_3)_3.9H_2O$ & transferred in 15 ml water & 2 g soluble starch were further poured & thoroughly mixed on a heating dish for 15 minutes at NTP. Afterwards temperature increases to about 120–140 ºC, stirred & fired until it turned into an extremely viscous red gel.

Carlos Otero Arean et. al [16] has taken $MgFe_xGa_{2-x}O_4$ and $ZnFe_xGa_{2-x}O_4$ where x is equal to 0, 0.4, 0.8**,** 1.2, 1.6 and 2 were ready by solid-state reaction technique in the form of polycrystalline at 947 & 1000 ºC of parent oxides. MgO, Fe203, & Ga_20_3 were taken in the first case, while ZnO, Fe_20_3, & Ga_20_3 were taken in the second case, and then poured in the required quantities. The nominal purity of this oxide was greater than 99.95%.

C. Doroftei et.al [17] combines sol-gel technique & self-combustion for desired samples synthesis. In comparison to traditional ceramic technology, this method yields ultra-fine, homogeneous, & repeatable ferrite dusts by using liquid solutions of metal nitrates salts. The sample configuration is $Mg_{1-x}Sn_xFe_{2-y}Mo_yO_4$, where (x = 0 & 0.1) & (y = 0 & 0.02).

M. Bagheri et .al [18] prepared the spinel ferrite quantifiable by simply adding up the precursor nitrate mixture of magnesium & iron in C_2H_5OH & then dehydrated at different temperatures. The single phase $MgFe_2O_4$ was found at 900ºC.

K. K. Bamzei et.al [19, 20] has taken rare earth $MgDy_x Fe_{2-x}O_4$, where x is equal to 0, 0.01, 0.03, 0.05, and0.07 and were ready by the solid-state reaction technique. The magnesium oxide, Fe_2O_3 & Dy_2O_3 have been poured in stoichiometric proportion. The temperature maintain in the muffle furnace was 800 ºC for 2h followed by annealing at 1200 ºC / 2hrs with heating rate 4 ºC/min.

M. J. Iqbal et.al [21] The polyethyleneglycol aided microemulsion approach produces nanosized Mg_{1-}xCoxCrxFe2-xO_4 (where x = 0 - 0.5). In well-defined quantities, liquidified solutions of correct compositions are mixed with liquid solutions of polyethyleneglycol. After the precipitates have progressed, they are heated for two hours at 300ºC. The ingredients were finally annealed at 850ºC for 8 hrs to attain the pure spinel segment.

S. F. Monsour et al. [22] used the co-precipitation method to generate $Mn_{1-x}Mg_xFe_2O_4$ (x = 0.0, 0.1, 0.2, & 0.25) with nano-size, in which raw materials of $Fe(NO_3)_2.9H_2O$, $Mn(NO_3)_2.4H_2O$, & $Mg(NO_3)_2.6H_2O$ were well mixed in their respective stoichiometry. Under rigorous stirring sodium hydroxide solution was dropped to become the precipitate. The pH was monitored during the adding of NaOH. The ingredient was stirred till pH shifted to 11–12. The precipitate hence cleaned by using double DI water numerous times to eliminate NaCl.

R. Megha et al. [23] used an auto-combustion approach to make magnesium ferrite particles, which had previously been documented in the literature. To make a homogeneous solution, stoichiometric amounts of magnesium nitrate, ferric nitrate, & urea were put into DI water. To start the self-propagating exothermic reaction, the contents were placed in a silica crucible & heated to 300 °C using a muffle furnace until the solution ignited, releasing gaseous products and finally forming a frothy powder of ferrite nanoparticles.

C. Murugesan et. al [24] prepared Mg-Ferrite nanoparticles using sol–gel route. Analytical grade magnesium nitrate, citric acid & ferric nitrate as precursor. The needed amount of precursors were poured individually into 25 ml double DI water, & the resulting solutions were properly combined and magnetically agitated to achieve a homogeneous liquid. Ammonium hydroxide was used to neutralise the pH of the solution. The materials were then held at 85°C to create an extremely viscous dry gel, which was then heated on a hot plate until it self-ignited.

The pre-materials were ball-milled in the correct mole proportions, dried, & pre-sintered twice in open environment for 24 hours at 1200°C, being ground after each heating, according to R. Nathans et al. [25]. The powders were hard-pressed into discs for the final heat treatment, which included a 24 h soaking session at 1400° C, followed by a 5 h holding phase at the required temperature, & finally 5 h quenching in water.

A. A. Pandit et al. [26] used the ceramic approach to manufacture samples with the general formula $Mg_{1+x}Mn_xFe_{2-2x}O_4$ for 0 = x = 0.9 in 0.1-step ratios. AR grade oxides Fe_2O_3, MgO, & MnO_2 were used as a pre-material. These oxides were thoroughly combined in stoichiometric proportions, wet ground for four hours, & presintered for 12 hours at 900 °C.

J. Shah et al. [27,28] used a mechanical ball mill to grind analytical grade $MgCO_3$ and Fe_2O_3 in a 1:1 proportion using zirconium balls. The different type of sample was obtained by mixing 0.1% and 0.3 mol% (Pr_6O_{11}) in precursor respectively which in turn was grinded for 2 h. All the 3 samples were presintered at 850ºC in open atmosphere for 8 h. These presintered powder was converted into pellet of rectangular size (15mm×3mm×2mm) which was again followed by annealing at 1000ºC in open atmosphere for 4 h.

CONCLUSION

The materials synthesis lies at the pillar of modern-day science and the growth of mankind is governed by synthesis of new advance materials. In inorganic material synthesis, high temperature combination routes are the oldest & the most practiced synthesis routes which are easily amenable to scaling up. One needs to choose proper reactants, reaction temperature, reaction duration, atmosphere, reaction crucibles. Solid state high temperature combination yields thermodynamically stable product with preserved stoichiometry of the reactants. There a wide variation to high temperature solid state synthesis available which may reduce the reaction and duration by yielding a well homogenized reaction precursor.

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