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Synthesis of Nanocrystalline Spinel Ferrite (MFe_2O_4, M = Zn and Mg) by Solution Combustion Method: Influence of Fuel to Oxidizer Ratio

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Abstract: Fuel to oxidizer ratio is a critical parameter that determines the properties of nanocrystalline ferrites prepared by solution combustion method. In this study, the influence of fuel to oxidizer ratio on the purity of phase and physical properties of Zinc and Magnesium ferrite nanoparticles prepared by solution combustion method using glycine as fuel is reported. PXRD and FTIR studies on the samples prepared under fuel lean and fuel rich conditions show that there is a gradual variation in the impurity phase as the F/O ratio is varied. Magnetic studies using VSM and Mössbauer spectroscopy show that a reducing environment is created during the combustion process, which influences the magnetic properties of the samples. Mössbauer studies also show that cation redistribution between the tetrahedral and octahedral sites of the as prepared samples also is an important factor which determines the magnetic properties.

Keywords: Oxide; Solution Combustion; Magnetic Properties; Mössbauer spectroscopy.

1. Introduction

Nanocrystalline spinel ferrites (MFe_2O_4) with tailored properties for various technological applications can be synthesized by a number of low cost chemical method [1,2]. Solution combustion is a relatively new and simple method which yields high purity samples depending upon the preparation conditions [3,4]. In this method, solutions of stoichiometirc quantities of metal nitrates are mixed with a fuel such as glycine and are heated with continuous strirring till direct combustion takes place to yield nanocrystalline powder of the ferrite. These samples can be used without further heat treatments. In general, the common synthesis methods such as coprecipitation, solid state reaction, microemulsion etc require high temperature heat treatment for the formation of pure spinel phase formation [5–8]. Glycine is one of the most extensively used fuels [9–13]. However, the physical properties of ferrites prepared by this method are critically dependent on the preparation condition and the fuel to oxidizer (F/O) ratio among other parameters. The F/O ratio influences the purity, crystallite size, morphology, porosity and carbon