Materials Chemistry and Physics 113 (2009) 233–238

Contents lists available at ScienceDirect

Materials Chemistry and Physics

journal homepage: www.elsevier.com/locate/matchemphys

Synthesis, characterization and studies on magnetic and electrical properties of Mg ferrite with Cr substitution

P.P. Hankare[a,*], V.T. Vader[a], N.M. Patil[a], S.D. Jadhav[a], U.B. Sankpal[a], M.R. Kadam[a], B.K. Chougule[b], N.S. Gajbhiye[c]

[a] Solid State Research Laboratory, Department of Chemistry, Shivaji University, Kolhapur 416004, Maharashtra, India
[b] Composite Material Laboratory, Department of Physics, Shivaji University, Kolhapur 416004, Maharashtra, India
[c] Department of Chemistry, Indian Institute of Technology, Kanpur 208016, Uttar Pradesh, India

ARTICLE INFO

Article history:
Received 16 March 2008
Received in revised form 29 May 2008
Accepted 8 July 2008

Keywords:
Ferrites
Synthesis
Characterization
Magnetic and electrical properties

ABSTRACT

Mixed metal oxides possessing spinel structure exhibit interesting structural, electrical, magnetic and catalytic properties. During the course of investigation, chromium substituted magnesium ferrites were synthesized by co-precipitation technique using NaOH at a pH of 9.5. Formation of spinel phase was identified using X-ray diffraction technique (CuK_α 1.54056 Å). All the compounds exhibited cubic spinel symmetry and lattice constant varied between 8.40 and 8.33 Å. They showed decreasing trend with increase in concentration of chromium. Infra-red spectral studies showed two strong bands one around 600 cm^{-1} which is attributed to the intrinsic vibrations of tetrahedral complexes and other at 400 cm^{-1} is due to octahedral one. The morphology and size of the particles was found by scanning electron microscope while element compositions by elemental dispersive X-ray spectroscopy. The various compounds of the system $MgFe_{2-x}Cr_xO_4$ were also investigated for their thermal, electronic and magnetic hysteresis studies.

1. Introduction

AB_2O_4 type of compounds with spinel structure show interesting structural, electrical and magnetic properties, which vary with the nature of the ions, their charge and site distribution amongst tetrahedral and octahedral sites [1,2]. Among various oxides, transition metal oxides with iron oxides as their main component have attracted the attention of physicists and technologist, since these are magnetic semiconductors suitable for use in microwave devices [3]. Magnesium ferrite is also a pertinent magnetic material showing inverse spinel structure for wide applications owing to its high resistivity, high Curie temperature and environmental stability. The chromium substituted magnesium ferrite requires annealing temperature of the order of 900 °C to achieve the desired proportion of the ion distribution on octahedral and tetrahedral sites [4]. This ferrite is suitable not only for fundamental studies of structural and magnetic properties but also for industrial applications. The compounds of formula $MgFe_{2-x}Cr_xO_4$ are suitable for the long wave part of high frequency range as they have very low dielectric losses [5]. At present, several chemical methods including co-precipitation, solid-state reaction, sol–gel, citrate precursor etc. have been used to prepare the $MgFe_2O_4$ [6–10].

In the present work, Cr substituted magnesium ferrites were prepared by co-precipitation method. The structural and magnetic properties of the compounds were studied, which mainly concern the experimental results due to chromium substitution on the various properties of magnesium ferrite

2. Experimental

The mixed metal oxide system $MgFe_{2-x}Cr_xO_4$ with composition $x = 0.0$, 0.5, 1.0, 1.5 and 2.0 were prepared by co-precipitation method [11,12]. It is economical for producing large quantity of small and uniform particles which is somewhat difficult in other methods such as ceramic due to the agglomeration of particles. Co-precipitation gives the compounds of good chemical homogeneity, high purity and lower sintering temperature than the ceramic. So, obviously there is a difference in the morphology and properties of compounds prepared by co-precipitation than the ceramic method. Initially, calculated amount of each chloride (AR Grade) were weighed carefully on microbalance and dissolved in doubly distilled water. The precipitation was carried out at a controlled pH of 9.0–9.5 using 10% NaOH solution. It was heated on water bath (95–100 °C) for 4 h and was oxidized by 30% H_2O_2 with constant stirring at the same temperature. The precipitate was filtered and washed with doubly distilled water in order to remove excess alkali and Cl^- ions. The compounds were dried at 110 °C in an oven and finally sintered at 900 °C for 6 h.

The powders were mixed with 2% PVA binder for granulation. The granulated powders were pressed into pellets of 1.25 cm diameter and 0.15 cm thickness under a pressure of 10 ton.

* Corresponding author. Tel.: +91 231 2609381.
E-mail addresses: p_hankare@rediffmail.com (P.P. Hankare), vtv_chem.@rediffmail.com (V.T. Vader).

0254-0584/$ – see front matter © 2008 Elsevier B.V. All rights reserved.
doi:10.1016/j.matchemphys.2008.07.066