Advanced Multifunctional Electroceramics

Edited by
Sean Li, Thiam Teck Tan and Danyang Wang

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Preface

As a relatively recent phenomenon, Electroceramics have had a profound impact on the so called "electronics revolution". Ceramic materials that have been specially formulated for specific electrical, electromagnetic and optical properties can be tailored for their use as insulators, ferroelectric materials, highly conductive ceramics, electrodes, MEMS, energy convertors, sensors and actuators, etc. The quest to push performance boundaries through further study into the fundamental aspects of electroceramics and their commercial applications is essential for the advancement of this science and technology.

The International Conference on Electroceramics (ICE) is a biennial event created to provide a platform for researchers and engineers to exchange knowledge and advances related to this emerging field of science. This series of conferences, initiated in Cambridge/Boston, with successive meetings held in Seoul, Tanzania, New Delhi, and then in Sydney, Australia from 12 - 16 December 2011.

This volume of Key Engineering Materials publishes a part of the works presented in ICE 2011. All manuscripts were peer-reviewed by two independent referees. We believe these works will bring some new insights to the development of electrocaermics. We would like to thank the indispensible support from the organizing committee members and specially thank Professor Weiguang Zhu from Nanyang Technological University, Singapore and Professor Yun Liu from Australia National University. The organizing committee would also like to acknowledge the financial supports from the sponsors.

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Synthesis and Characterization of Nano Particles of Mn-Co Ferrites for Technological Applications

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Abstract. Manganese doped cobalt nano ferrites were synthesized by co-precipitation method having general formula $Co_{1-x}Mn_xFe_2O_4$ (x =0.0-1.0). These materials are studied to analyze the structural effects on the associated materials properties. The prepared samples were heat treated at 750^0 C for two hours. Sintering effect on the structural properties was investigated. The lattice constants of samples were measured from X-rays diffraction data. The (311) peak was used to find crystallites size by the Scherrer formula. Structural morphology was observed by scanning electron microscopy. Variation with temperature in electrical resistivity (DC) and drift mobility were also investigated. The variations with frequency and composition in AC electrical properties of prepared samples were determined. The structural and electrical properties demonstrated firm association. Saturation magnetization, coercivity and remanence of the samples were discussed with the help of sharing of cations within crystals.

Introduction

Ferrite nano-particles are magnetic compounds that have been studied for the understanding of structural, electrical and magnetic properties in nano-meter regime [1]. Ferrites have major plus over normal magnets due to higher resistivity which results in lesser energy loss [2]. Many researchers have worked on manganese substituted cobalt ferrites and studied their structural and magnetic properties. In previous studies on manganese doped cobalt ferrites, it has been shown that high mechanical stability and inter related magnetic properties make them good for sensor application [3]. In the present studies, role of manganese doping on various interesting parameters $Co_{1-x}Mn_xFe_2O_4$ (where x= 0.0-1.0 with step size of 0.2) was investigated.

Synthesis procedure

Nano-particles of manganese doped cobalt ferrites were co-precipitated with nominal composition. Precursor materials were nitrates of respective chemicals. NaOH (as precipitating reagent) was mixed quickly into the metal solutions. The solution was kept stirred, until co-precipitation occurred. Pellets of different diameter (7-18mm approx.) were made using hydraulic press. The pellets were sintered at of 750 ±5˚C for 2 hours before further characterization.

Characterization Results

Structure related properties. XRD of prepared samples was done at ambient conditions. The source was CuKα (λ=1.5406 Å) radiations. Analysis of XRD data established fully the presence of spinel (FCC) structure. Lattice parameter 'a' was determined by equation [4].

$$a = d_{hkl}(h^2 + k^2 + l^2)^{1/2} \quad (1)$$

The indexed patterns of the series are given in Fig. 1. The crystallite sizes have been calculated by using Debye-Scherrer formula.

$$t = \frac{0.9\lambda}{\beta \cos\theta} \quad (2)$$

where, 'λ' represents wave length of incoming X-rays (λ=1.5406Å), θ is the Bragg's angle & β comes from peak maximum width at center at a particular θ.

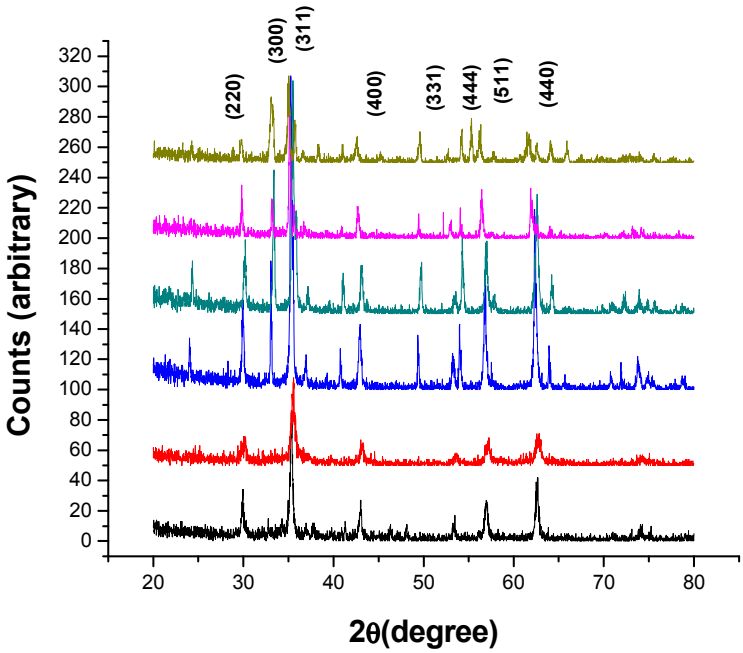

Fig. 1. XRD patterns of sintered samples of $Co_{(1-x)}Mn_xFe_2O_4$ where x= 0.0-1.0.

Scanning electron micrographs (SEM) for representative samples are shown in Fig. 2. SEM micrographs show surface morphology of the samples. Analysis of SEM showed that structures are cubic and particle sizes are approximately same.

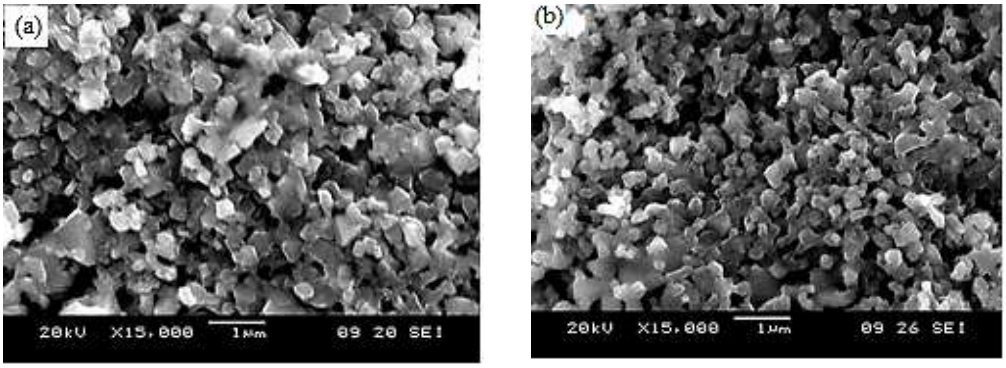

Fig. 2. SEM micrographs of $Co_{(1-x)}Mn_xFe_2O_4$ (a) x= 0.8 and (b) x=1