

Optical properties of Cobalt Ferrite Thin Films Prepared by Spray Pyrolysis method

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ABSTRACT

Magnesium doped Cobalt ferrite thin films ($\text{Co}_{1-x}\text{Mg}_x\text{Fe}_2\text{O}_4$ for $0.0 \leq x \leq 1.0$) were grown using spray pyrolysis method. The grown thin films were annealed at 500°C for 4 h and further used for the investigation of these thin films were done and their structural, optical properties are studied. The structural characterizations with the help of the X-ray diffraction pattern of the prepared samples shown the formation of single-phase cubic spinel structure of the films. The band gap of the films was measured by UV-VIS spectrophotometer. It is observed that, the energy band gap decreases from 2.83 eV to 2.37 eV as increase in magnesium substitution. The Photoluminescence study showed the characteristic near-band-edge emission of presently investigated films samples at around 710 nm. The contact angle measurements revealed the hydrophilic nature of all the thin films under investigation.

Keywords: X-ray diffraction, Thin Films, ferrite material, spray pyrolysis, spectrophotometer.

1. INTRODUCTION

Among all the metal oxides, the ferrites with iron oxide and metal oxide as their main components are of considerable interest to the scientist and technologist owing to their combined electrical and magnetic properties [1]. Ferrites are grouped into three classes namely spinel ferrite, garnets and hexagonal ferrites depending on their crystal structure. Among these types of ferrites, spinel type ferrites are unique class of ferrites having potential applications in various fields [2, 3]. Spinel ferrites with general formula MFe_2O_4 (where M can any of the divalent metallic ions) possess two interstitial sites namely tetrahedral (A) and octahedral [B] site. Spinel ferrite possess the remarkable properties like high electrical resistivity, low eddy current, low dielectric losses, high saturation magnetizations etc. [4]. The important electrical and magnetic properties of spinel ferrites are depends on their composition, distributions of cations over available sites and microstructure, which in turn are sensitive to the preparation techniques and preparative parameters [5]. Because of the remarkable properties, spinel ferrites have the applications in the field of magnetic data storage, gas sensors, high frequency devices etc. Recently, nanosized spinel ferrites have been of much importance from application point of view. The smaller size (nanometer dimension) and high surface to volume ratio of the nanocrystalline spinel ferrite makes them useful in medical, environmental, water purification etc. field [6, 7].

In this research article, Magnesium substituted cobalt ferrite thin films have been deposited and grown onto glass substrates by spray pyrolysis technique with an aim to investigate their optical, photoluminescence, surface wettability properties. The as deposited thin films were annealed at 500°C for 4 h in an ambient atmosphere and further characterized by X-ray diffraction (XRD), UV-VIS spectrophotometer, photoluminescence (PL), contact angle measurements, etc. properties was studied and the results are presented in this work

2. MATERIALS AND METHODS

Magnesium substituted cobalt ferrite thin films with chemical formula $\text{Co}_{1-x}\text{Mg}_x\text{Fe}_2\text{O}_4$ (where $x = 0.0$ to 1.0 , in step of 0.2) were grown on cleaned glass substrates using the low-cost spray pyrolysis method. The basic principle of spray pyrolysis technique is that, when droplets of spray solution through spray gun with moderate pressure reach to the hot substrate, due to the pyrolytic decomposition of