

# Investigation of Structural, Magnetic and Photocatalytic Properties of Al Substituted Cobalt Ferrites

R. P. Patil<sup>1,\*</sup>, R. S. Pandav<sup>2</sup>, A. V. Jadhav<sup>2</sup>, S. D. Jadhav<sup>3</sup>, and P. P. Hankare<sup>2,\*</sup>

<sup>1</sup>Department of Chemistry, M.H. Shinde Mahavidyalaya, Tisangi 416206, MH, India

<sup>2</sup>Department of Chemistry, Shivaji University, Kolhapur 416004, MH, India

<sup>3</sup>Department of Chemistry, Yeshwantrao Chavan Science College, Karad, MH, India

## ABSTRACT

Nanocrystalline  $\text{CoFe}_{2-x}\text{Al}_x\text{O}_4$  ( $2.0 \geq x \geq 0$ ) systems were prepared by sol–gel route. Formation of single phase cubic spinel structure for all the compositions was confirmed from their X-ray diffraction patterns. The lattice parameter shows a decreasing trend with the increase in Al content. Infrared spectra showed two main absorption bands in the range  $400\text{--}800\text{ cm}^{-1}$  arising due to tetrahedral and octahedral stretching vibrations. A room temperature magnetization result shows a ferromagnetic behavior decreases with increase in aluminum content. The enhanced photocatalytic activity is attributed to surface area of the nano catalyst. The detailed results of structural and magnetic have been discussed so as to bring out the role of aluminum substitution in cobalt ferrite.

**KEYWORDS:** Sol–Gel Chemistry, TGA-DTA, X-ray Diffraction, Infrared Spectroscopy, Magnetic Properties.

## 1. INTRODUCTION

Ferrites are spinels with the formula  $\text{AB}_2\text{O}_4$ , where A and B represents various metal cations, usually including iron. Spinel ferrites usually adopt a crystal consisting of cubic close-packed oxides with A cations occupying one eighth of the tetrahedral holes and B cations occupying half of the octahedral holes that is, the inverse spinel structure.<sup>1,2</sup> Ferrite cores are used in electronic inductors, transformers, electromagnets, magnetic recording tapes, component of radar-absorbing materials or coatings used in stealth aircraft and in the absorption tiles lining the rooms used for electromagnetic compatibility measurements.<sup>3–5</sup>

The applicability of these materials mainly depends upon their various physico-chemical properties. Their structural, electrical, magnetic, catalytic and gas sensing activity were examined for dependence on their oxidation state, active centers, surface area and smaller uniform sized grains, which crucially depend on the process of synthesis, heat treatment and location of cations over tetrahedral ( $T_d$ ) and octahedral ( $O_h$ ) sites.

Various physical and chemical methods like mechanical milling, inert gas condensation, hydrothermal reaction, oxidative precipitation, sol–gel synthesis and reverse

micelle technique are employed for the preparation of nanoferrites.<sup>6–13</sup> The sol–gel method is used to speed up the synthesis of complex materials. It is a simple process, a significant saving in time and energy consumption over the traditional methods. Small crystalline size of the resultants may have an important influence on the particles of the materials prepared. This method is employed to obtain improved powder characteristics, more homogeneity and have a narrow particle size, thereby influencing structural, electrical, and magnetic properties of spinel ferrites.

A large number of organic pollutants are now days introduced into the water systems from various sources such as industrial effluents, agricultural runoff and chemical spills. Their toxicity, stability towards natural decomposition and persistence in the environment has been the cause of much concern to societies and regulation authorities around the world. Dyes, phenols, pesticides, fertilizers, detergents, and other chemical products are disposed off directly into the environment, without being treated, controlled or uncontrolled and without an effective treatment strategy. Color removal from the textile wastewater has become an issue of interest during the last few years because of the toxicity of the dyes and more often the colored wastewater from the textile industries also decreases the transparency of the receiving waters. Therefore, photocatalytic activity of the system was studied by using hazardous methyl blue in presence of ultra-violet light with fixed wavelength.

\*Authors to whom correspondence should be addressed.

Email: [raj\\_rbm\\_raj@yahoo.co.in](mailto:raj_rbm_raj@yahoo.co.in)

Received: xx Xxxx xxxx

Accepted: xx Xxxx xxxx