# Structural Properties of Spinel $Coal_2O_4$ Nano-Catalysts Synthesized from Plant Extract using Green Synthesis Technique

**Govindaswamy Padmapriyaa, Pandian Paulrajb, Ayyar Manikandan**

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***Abstract: Spinel CoAl2O4 nanoparticles were synthesized via Aloe vera plant extract microwave heating method. Aloe vera plant extract-assisted combustion method makes straightforward synthesis, which is alternative process of preparation of spinel nanoparticles. The harmonized spinel CoAl2O4 nanoparticles was successfully characterized by powder XRD pattern, FT-IR, EDX analysis, HR-SEM analysis, and VSM techniques. XRD, FT-IR and EDS results established the development of spinel and single cubic phase CoAl2O4 nanocrystals. The formation of spherical shaped nanoparticles was affirmed by HR-SEM technique. VSM measurements revealed that CoAl2O4 sample have superparamagnetic behavior.***

***Keywords: Spinel CoAl2O4; Nanoparticles; Aloe vera extract; Magnetic properties;***

## I. INTRODUCTION

Recently, nanostructured spinel type materials are attractive in materials science and nanotechnology, for the reason that of their novel physical, chemical and catalytic activities than that of their same bulkiness materials [1-5]. Among the various spinel materials, cobalt aluminate (CoAl2O4), has gained much attention in interdisciplinary areas due to their high mechanical strength, and chemical stability [6-8]. Various synthesis routes have been used to prepare the spinel type nanomaterials [8-10]. But the methods have some disadvantageous such as costly equipments and materials and difficult synthetic procedures. Recently, a facile microwave combustion method (MCM) has been used. In this route, the nanomaterials are synthesized at lower temperatures and also enough low cost with good controlled size of the products [10-19].

The present work focused on the synthesis of spinel CoAl2O4 nanoparticles by using green method on extract from Aloe vera microwave combustion method. Aloe vera is a permanent juicy belonging to the Liliaceal family [20-27]. To our knowledge, no literature is available on the synthesis of CoAl2O4 nanostructures by Aloe vera plant extract microwave heating method. Nevertheless, Aloe vera plant extracts using as the reducing agent by microwave heating method. Moreover, spinel CoAl2O4 nanomaterials are non-toxic, inexpensive, comparatively higher surface area and the properties formulate them proper for use as inexpensively feasible nano-catalysts [28-35].

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## II. EXPERIMENTAL

### A. *Materials*

Nitrates of Cobalt and Aluminum plant extract used for this synthesis and Millipore water was used to whole of this preparation. Aloe vera-extract separated from 5 g piece was liquefied in 20 ml water after systematic washing and allowed to stir half an hour. which is known as Aloe vera plant extract [20-26]. Nitrates of cobalt, and aluminum dissolved in the plant extract under stirring 1 h and then placed inside the micro oven for heating 10 mins. The obtained powders were labeled as CoAl2O4 after completion of the reaction.

### B. *Characterization*

Analysis of spinel CoAl2O4 nano-crystals were carry out using a Rigaku Ultima XRD (λ = 1.5418 Å). FT-IR for functional groups and its morphology achieved with a Joel JSM 6360 HR-SEM analysis. Magnetic properties carried out 3900 model VSM.

## III. RESULTS AND DISCUSSION

The structure, crystallite size, phase formation of the powders were established by analyze the XRD pattern. Fig. 1 shows the XRD of spinel CoAl2O4 nanoparticle. The peaks of 31.13, 36.84, 38.64, 44.53, 49.14, 55.73, 59.43, 65.53, 74.25 and 77.52° can be absolutely indexed as fcc spinel CoAl2O4 (JCPDS card no. 38-0814).

The crystallite size measured using Scherrer's Eq. (1),

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The calculated crystallite size is 18.35 nm.

A wide-ranging band appeared in the expanse 3220-3440 cm-1 showed the vibrations of H2O (Fig. 2). A band at around 1630 cm-1 was assigned by H-O-H vibration. The band at 2357 cm-1 is due to the CO2 vibration. The M-O stretching bands in the range 550-850 cm-1 were connected to the Al-O and Co-O-Al [14, 15].

Fig. 3 shows HR-SEM image of CoAl2O4 sample. HR-SEM image clearly shows the agglomerated particle-like nano-crystals. From the results, it is assumed the microwave

heating process, the microwaves are involved for nucleation and formed the final products with narrow size range of particles within few minutes.

Elemental and phase purity was confirmed by EDX spectral analysis. Fig. 4 shows the EDX spectra of CoAl2O4. EDX results showed that the peaks of Co, Al and O elements and there is no other secondary peak, which established the pure product formation.

The magnetization of CoAl2O4 nanoparticle was analyzed through external field between ±10 kOe by VSM at RT. The curve is shown in Fig. 5. From M-H curve, we can infer that a soft magnetic nature of CoAl2O4 material and also indicate superparamagnetism at ±15 kOe. The obtained results show that the value of Ms is 1.45× 10-4 emu/g. However, it is noted that lower Ms, Hc and Mr values confirmed the CoAl2O4 nanoparticles have soft nature of superparamagnetism [16-22].

## IV. CONCLUSIONS

Spinel CoAl2O4 nano-catalysts were prepared by a easy microwave heating route using Aloe vera plant extract. The results of the prepared sample have a spinel. The manifestation of wide-ranging band between 550 and 850 cm-1 exposed the arrangement of Al-O and Co-O-Al bonds appeared. SEM image showed the construction of well residential particle with nano grains. VSM studies revealed that CoAl2O4 showed superparamagnetism.

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