COPPER FERRITE THIN FILM FABRICATED USING THE DOCTOR BLADE METHOD: SYNTHESIS AND CHARACTERIZATION

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ABSTRACT

Copper ferrite thin film has been prepared by using doctor blade method and it finds as application dye-sensitized solar cell, which is a third generation photovoltaic device that holds significant promise for the inexpensive conversion of solar energy. For the fabrication of the thin film, $CuFe_2O_4$ nanoparticles synthesized via green route using egg white is used. The Structural characteristics of synthesized thin film was studied by X-ray diffraction analysis, Fourier transform infrared spectrum was recorded to investigate the presence of the chemical substances in synthesized Copper ferrite thin film.

KEYWORDS: *thin film, doctor blade technique, ferrite, nano, XRD, FTIR, green.*

1.Introduction

Due to their high electrical resistivity and excellent magnetic properties, spinel ferrites are excellent candidates for modern technological applications. Copper ferrite nanoparticles (NPs) are used in biomedicine (drug delivery [1], magnetic resonance imaging [2], magnetic cell separation, and DNA extraction [3]). They also have various technological applications such as energy storage devices [4], magnetic storage media [5], and spintronic and electromagnetic devices [6,7]. Furthermore, ferrites have been used as catalysts for the photocatalytic degradation of organic matter [8, 9, 10], oxidation of dimethyl ether [11] and mercury [12], and reduction of 4-nitrophenol [13]. The spinel structure of ferrites provides additional sites for the catalytic reaction, leading to an increase in the efficiency of photocatalytic decomposition [14,15].

Doctor blade coating is the most widely employed solution processing technique for large-area thin film fabrication at low cost. Doctor blade coating is a technique used to form films with well-defined thicknesses. The technique works by placing a sharp blade at fixed distance from the surface that needs to be covered. The coating solution is then placed in front of the blade and the blade is moved across in-line with the surface, creating a wet film. The technique should ideally have solution losses of about 5%; however, practically, it takes time for optimal conditions to be found [16].

A dye-sensitized solar cell is a low-cost solar cell belonging to the group of thin film solar cells [17]. The DSSC has a number of attractive features; it is simple to make using conventional roll-printing techniques, is semi-flexible and semi-transparent which offers a variety of uses not applicable to glass-based systems, and most of the materials used are low-cost. Although its conversion efficiency is less than the best thin-film cells, in theory its price/performance ratio should

be good enough to allow them to compete with fossil fuel electrical generation by achieving grid parity. Commercial applications, which were held up due to chemical stability problems, had been forecast in the European Union Photovoltaic Roadmap to significantly contribute to renewable electricity generation by 2020 [18, 19].

2.Experimental details

The doctor blade technique to adopted in the fabrication of $CuFe_2O_4$ thin film in the present work. The $CuFe_2O_4$ nanoparticles required for the fabrication is synthesized via green synthesis route adopting solution combustion methods using egg white as fuel [20 -23]. In order to prepare the thin film, 1.494g of $CuFe_2O_4$ nanoparticles were mixed with 8.3ml of liquid ethanol and 15 ml f distilled water and the mixer was stirred for 20 minutes. Then the precursor has been sonicated for 30 minutes, The pH level was optimized to 3 by adding nitric acid drop by drop. Using the glass road, the sample in the paste form is spread uniformly throughout to the conducting side of the glass slide doesn't leaving any spots of the slide uncovered. Now the same process is repeated for three times and the thin film was annealed at 500ºC furnace for 1 hour. After the completion of the above procedure the prepared thin film were characterized using XRD and FTIR.

3. Results and Discussion

3.1. XRD Analysis

The fabricated copper ferrite thin film were calcinated at 500º C for one hour and subjected to XRD analysis. The XRD pattern of the samples is shown in Fig. 1. They exhibits typical reflections planes (2 2 0), (3 1 1), (4 0 0), (4 0 0), (5 1 1) and (4 4 0) that are indications of the presence of the cubic spinel structure [24]. These diffraction lines provide clear evidence on the formation of copper ferrite system. All the diffraction peaks matches well with the reported values (JCPDS file No:25-0283).

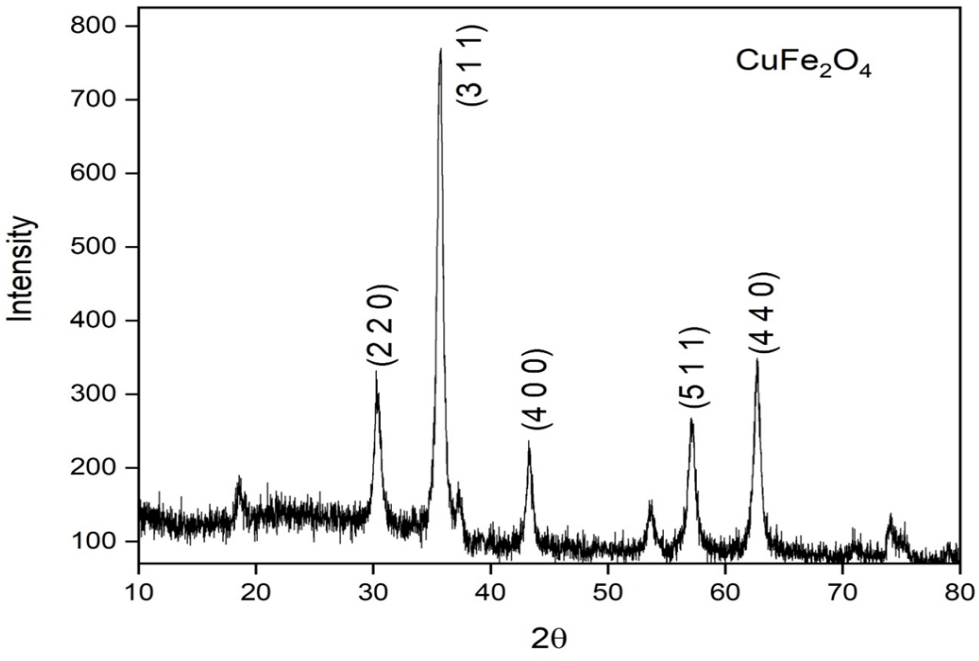

Fig. 1. XRD pattern $CuFe_2O_4$ thin film

Comparison of standard and observed 2θ values for $CuFe_2O_4$ nanoparticles

JCPDS 2θ (degree)	h k l	Experimental 2θ (degree)
30.168	220	30.408
35.641	311	37.335
43.038	400	43.340
57.052	511	57.135
62.775	440	62.704

3.2. FTIR Analysis

FTIR analysis of copper ferrite nanoparticles

The FTIR spectra of copper ferrite thin film were analyzed in two ranges of the absorption bands, 4000 – 1000 cm^{-1} and 1000 – 400 cm^{-1} and shown in Fig. 2. In the range of 4000-1000 cm^{-1}, vibrations of CO_3^{2-}, NO^{3-} and moisture were observed. The intensive broad band at around 3400 cm^{-1} and the less intensive band at around 1630 cm^{-1} are due to O-H stretching vibration interacting through H bonds. Traces of adsorbed or atmospheric CO_2 are evidenced by the very small absorption peak around 2340 cm^{-1}. The υ (C=O) stretching vibration of the carboxylate group (CO_2^{2-}) is observed around 1390 cm^{-1} and the band at around 1100 cm^{-1} corresponds to nitrate ion traces. In the range of 1000 – 400 cm^{-1}, two main metal – oxygen bands at around 560 and 450 cm^{-1} were observed in the spectra of copper and zinc substituted spinel ferrite nanoparticles. The band at around 560 cm^{-1} corresponds to intrinsic stretching vibrations of the metal at the tetrahedral site (Fe - O), whereas the band at around 420 cm^{-1} is assigned to octahedral – metal stretching (Zn/Cu - O). [25 -27]

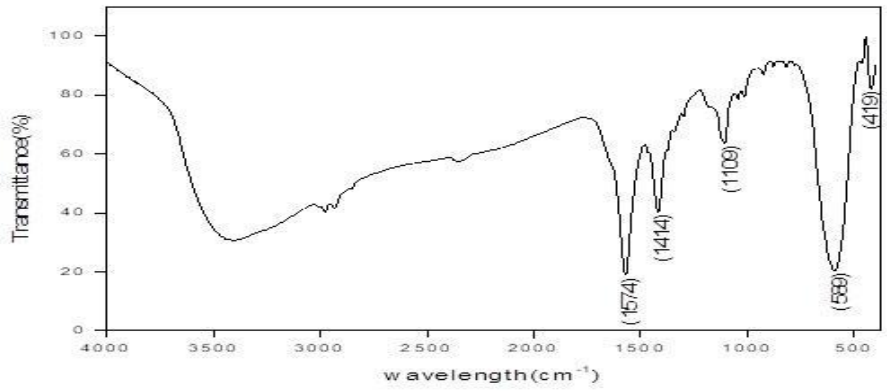

Fig. 2. FTIR pattern $CuFe_2O_4$ nanoparticles

3.Conclusion

Copper ferrite thin film has been prepared using doctor blade method. The synthesized thin film was characterized by powder XRD and FTIR techniques. The synthesized $CuFe_2O_4$ thin film was confirmed as copper ferrite system from the XRD analysis. The crystal structure of the copper ferrite thin film is found to be face centred cubic structure, from comparing XRD data with standard JCPDS file no. 25-0283. From the FTIR data, the organic and inorganic compounds and bands of them are found. The fabricated $CuFe_2O_4$ thin film can be used as sensors and for energy storage purposes.

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