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Physical and Optical Study of Cobalt Oxalate Single Crystals Grown by Agar-Agar Gel Method

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Abstract: **The cobalt oxalate single crystals were grown in agar-agar using gel method. In the present investigation, the cobalt oxalate single crystals were grown by single diffusion technique, such grown crystals were found in different size and colour. The physical and optical properties of cobalt oxalate crystals were characterized by different techniques such as SEM and UV-Vis spectroscopy and results are discussed.**

Index Terms: **Cobalt oxalate, Crystal growth, Optical properties, SEM and Single diffusion.**

I. Introduction

Single crystal growth is the rapid growing field in research because of increase in demand of single crystals for many applications there are various types of crystals which can be grown by gel method. It is simple and inexpensive technique. We have turned our attention towards the oxalates are having good application can be synthesized by gel method. Many research has grown the series of pure and mixed crystals to find out the new materials for various purpose (Bacchhav S. K. et al.,2014; Jhon M.V., et al.,2001; Gao P.,2008). There are various techniques for growing crystals like melt growth, Vapour growth, solution growth and etc. the gel technique attracted more attention towards it because of its simplicity and cost effectiveness. The crystals can be grown at ambient temperature.

Cobalt oxalate is quite interesting compound as they are having good application. The cobalt oxalate crystals have been grown by the single diffusion and double diffusion technique using silica gel and also studied as precursor of Co_4O_4 nano particles (Yuniar P.,2012). In the present work of investigation, the cobalt oxalate single crystals were synthesized using single diffusion technique at room temperature and their characterization by EDAX, Powder XR, FT-IR and TGA-DTA. The work has been already published by the author (Pawar H.et al.,2021; Pawar H.et al.,2021).The crystals were analyzed by various characterization techniques. The physical and optical properties were studies by Scanning electron microscope (SEM) and UV-Vis Spectroscopy.

II. Experimental

A. Crystal Growth

The growth of cobalt oxalate crystals has been carried out by single diffusion technique using gel method. The glass test tube of 25 mm diameter and 250mm length were used as crystal growth apparatus. 1% of agar gel was prepared by adding 1gm of agar powder into hot water. The solution of cobalt chloride (first reactant) and oxalic acid (second reactant) of 0.5, 1.0, 1.5 and 2.0M concentration were prepared and store in clean glassware. Cobalt chloride solution and oxalic acid solution were used as first reactant and second reactant respectively. The solution of first reactant (oxalic acid) was taken in a test tube and 2% of hot agar gel was poured along the wall. Then test tubes were kept undisturbed for setting and aging gel, after setting and aging, 1M of second reactant (cobalt chloride) solution was gently poured over set gel. The open end of test tubes was closed with cotton plug to prevent evaporation and contamination of the exposed surface by dust particles and impurities of atmosphere and were kept undisturbed. After 28 to 42 days the good quality and different morphological crystals were grown and harvest them. The figures 1 (a) with working reaction during crystal growth in test tube and (b) shows that some good quality harvested cobalt oxalate crystals.

The reaction between cobalt chloride and oxalic acid in agar – agar gel medium resulted in the growth of cobalt oxalate crystals. As grown crystals were characterized for structural, morphological, physical and optical properties. Growth of cobalt

oxalate crystals are gained by reacting the components cobalt chloride ($CoCl_2$) and oxalic acid ($H_2C_2O_4$). The expected reaction taking place in this work is as follows

$$CoCl_2 + H_2C_2O_4 \longrightarrow CoC_2O_4 + 2HCl$$

Fig. 1 (a) working reaction during crystal growth in test tube

Fig. 1 (b) Harvested crystals of cobalt oxalate

III. Results and Discussions

A. *Scanning Electron Microscopy (SEM)*

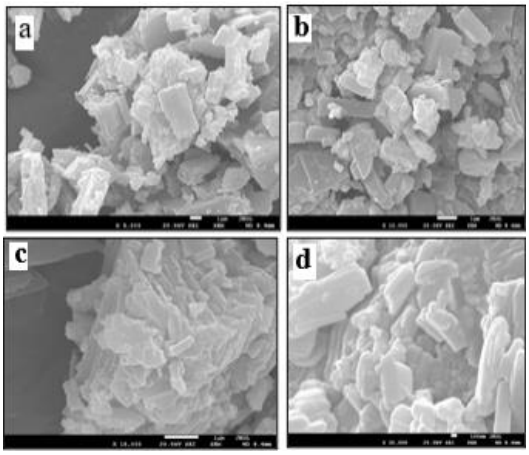


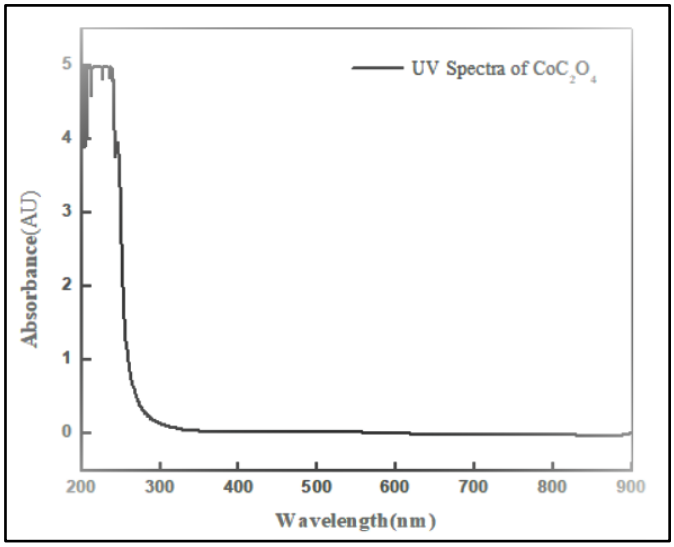
Fig. 2 (a), (b), (c) and (d) SEM images of as grown cobalt oxalate crystal

SEM images gives the information about the nature and suitability for device applications and also it is used to check the presence of imperfections. SEM analysis was carried out using JEOL, JSM 7001F scanning electron microscope. The morphology and particles size were observed by scanning electron microscopy. Fig 2(a), (b) and (c) Shows typical SEM images of the cobalt oxalate at resolution X5000, X1000, X15000 and X30000 respectively.

SEM images revealed that the growth of cobalt oxalate crystals was composed of many rectangular sheets approximately greater than 5µm in length and of the thickness more than 5µm. However, in the high magnification of samples as shown in figure 2 (c) and (d). It revealed that the rods are actually bundle of rectangular plates those are in hexagon shape, which were stacked in parallel fashion. (Usha R.et al.,2012). Figure 2 (a), (b), (c) and (d) illustrate the SEM images of same sample.

B. *UV-Vis Spectroscopy*

Absorption spectrum of cobalt oxalate crystals was obtained by a SHIMADZU UV-2450, UV- Vis spectrophotometer. Figure 5.15 shows UV-Vis absorption spectrum of cobalt oxalate crystal. The lower cutoff wavelength for CoC_2O_4 crystals was found to be 300.31 nm were shows in fig.3 form the graph the value of band gap was found 4.12 eV. The absorption coefficient is high at low wavelength and low at high wavelength. Hence it is wide transparent crystal for wide range of wavelength (300-900). The wide band gap of CoC_2O_4 crystals confirms the less absorbance in visible region (Arun K.et al., 2008; Want B.,2006; Rohit P.S..,2020). The cobalt oxalate crystal can be used for the nonlinear optoelectronic device fabricating applications. The band gap energy of Cobalt oxalate crystals is found to be 4.12 electron volt.



IV. Conclusion

The present work reports the growth and characterization of cobalt oxalate single crystals grown by single diffusion technique

using agar-agar gel as a medium of growth. Scanning electron microscopic (SEM) analysis revealed that it consists of many rectangular sheets, those are in hexagonal shape and stacked in a parallel fashion. UV-Vis studies shows that the crystals have a wide transparency window from 300nm to 900nm enables it to good candidate for second harmonic generation.

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