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Growth and characterization of strontium doped cadmium tartrate crystal by gel method

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ABSTRACT

This paper presents the growth and characterization of Strontium Doped Cadmium Tartrate Crystal grown by Gel method. The structural properties are investigated by XRD and SEM. The optical parameters were studied by UV-VIS. The fictional group is investigated by using the FTIR spectrum. The elemental composition is determined by EDAX analysis. The XRD analysis reveals that the grown samples are polycrystalline and tetragonal in phase. The SEM images show the platy structure. The optical band gap is estimated as 5.63eV.

Keywords: XRD, SEM, EDAX, FTIR, UV-VIS.

INTRODUCTION

The sodium potassium tartrate and many others can be used in fabrications of ferroelectric applications [1-2]. The impact of single crystal, is clearly visible in industries like semiconductors, optics etc. This type of crystal inventions of LASER and the field of the nonlinear optical properties and the practical implementations was possible with the applications of nonlinear optical crystal [3]. Now a day great attention has been devoted the growth and characterization of doped tartrate crystal with the aim of identifying new materials for practical purposes [4, 5].The effect of doping on various purpose of crystal are of great interest from solid state science as well as technological point of view. The crystal of cadmium tartrate grown in silica gel medium in doped with Barium, strontium, Lithium, Calcium have already been reported[6]. The growth of strontium doped Cadmium tartrate crystal by Gel technique yet had not been reported. These crystals were characterized by XRD, FT-IR confirmation of proper formation of crystals.

MATERIALS AND METHODS

Most of the tartrate compounds are insoluble in water and decompose before melting. Hence, such type of compounds cannot be grown by either slow evaporation or melt technique. But can be grown by solution gel method. A single diffusion method (Henish 1973) was employed to grow pure and strontium doped Cadmium tartrate crystal in the gel method [8]. The AR grade (Loba) chemicals were used for the present work. The crystallization apparatus employed was Borosilicate glass tubes (25mm diameter and 200mm length). Gel was prepared by mixing sodium meta silicate solution of appropriate specific gravity and one molar solution of tartaric acid so that the desired pH of the mixture could be obtained. The specific gravity and pH were varied between 1.02 gm/cc to 1.05 gm/cc and 4 to 5 respectively. After mixing the solution was allowed to set for about 48 hours. Over

the set Gel, one molar cadmium chloride solution was gently poured with the help of a pipette, so as to allow the solution to fall steadily along the walls of the tube without disturbing the gel surface The supernatant ions (Sr^{++} and Cd^{++}) slowly diffuse into the gel medium where it reacts with inner reactant. The open end of the test tube was closed with cotton to avoid dust from the entering into the glass tube. The solution was faint milky and transparent, initially, but with lapse of time its color slightly change. The test tubes were kept undisturbed at room temperature. To grow doped crystal, an aqueous solution of strontium chloride of varying concentration 0.2- 1.0 M was mixed with the top solution. After one month the crystal was taken out from the test tube and cleaned for the further characterization[9]. The best quality crystals were grown for 5.2 pH as shown in fig-1.

Figure 1a-b Strontium Doped Cadmium Tartrate Crystal grown by Gel method

RESULTS AND DISCUSSION

3.1 XRD Analysis

The crystal structure of the sample compound was studied by X-ray diffractometry, for 2θ was recorded within the range of 20º-80º. The scanning rate was maintained at 2º/min. The figure 1 shows the XRD pattern of the SrCT crystal. XRD pattern shows very sharp peaks having high intensity which leads to good crystalline perfection of the SrCT crystal.

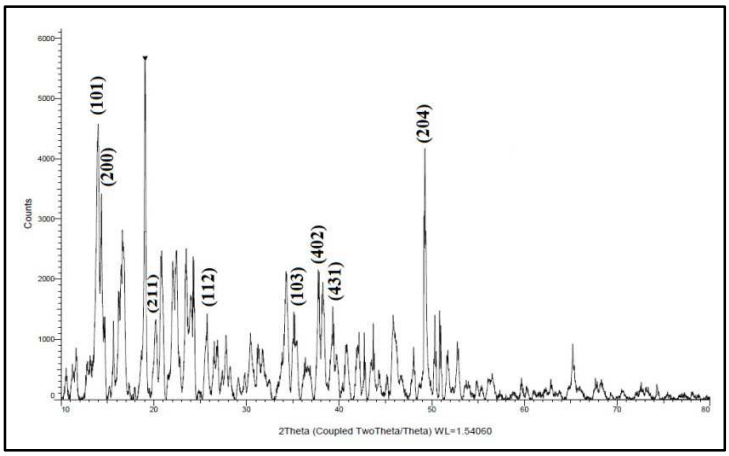


Figure 1 XRD pattern of SrCT crystal

The crystal structure of grown samples was found to be polycrystalline in nature and tetragonal ($\alpha=\beta=\gamma=90^0$) in shape. All the hkl planes of corresponding 2θ are compared with JCPDS card No: 65-1628 and indexed in table 1. Percentage of crystalinity is very good, it is 89.6%. The grain size was 6.021nm calculated by using the following formula:

$D = 0.9\lambda/\beta\cos\theta$

Where β is full width at half maximum (FWHM=0.232), λ is the wavelength of X-ray diffraction angle and θ is the diffraction angle.

The lattice parameters a, b, c and v was found to be 12.02, 12.02, 7.69, and 72.46 respectively.

Table 1 XRD data SCT crystal

From present work				From JCPDS file			
2θ	Observed d-value	Intensity	h k l values	2θ	standard d-value	Intensity	h k l values
13.961	6.33818	4439	101	13.659	6.33815	269	101
14.626	6.05268	1342	200	14.726	6.05261	254	200
20.200	4.39251	1320	211	20.138	4.39255	7	211
25.712	3.46201	1059	112	25.404	3.46200	15	112
35.370	2.53566	963	103	35.789	2.53562	265	103
37.783	2.37913	1781	402	37.972	2.37813	214	402
39.330	2.28903	1388	431	39.232	2.28803	999	431
49.557	1.83795	653	204	49.755	1.83785	12	204

3.2 Scanning Electron Microscopy (SEM)

The surface morphology can be done by using SEM. In the present work powdered sample of SrCT crystals was examine by using SEM technique at the UDCT, NMU Jalgaon.

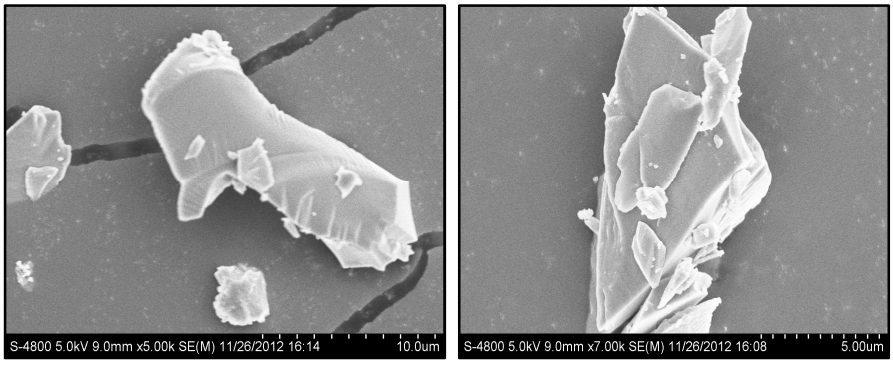


Figure 2 a-b SEM images of SCT crystal

The study of the surface morphology of the crystal gives valuable information about its internal structure. Figure 2a-b shows the SEM photographs with two different photographs of SrCT crystal. The SEM images reveal that the platy structure, It is like ice cube. The individual plates of samples are flat and the plates with the sharp edges were observed. The boundary was clear.

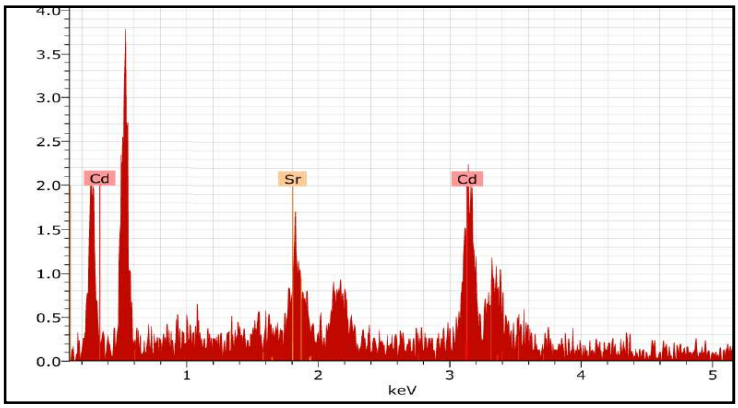


Figure 3 EDAX spectra of SrCT crystal

3.3 Energy dispersive Analysis by X-rays (EDAX)

Energy dispersive analysis by X-rays (EDAX) is used for the quantitative analysis. In the present work elemental analysis of gel grown SrCT crystals was carried out at the UDCT, NMU Jalgaon.

The EDAX spectrum of SrCT is shown in figure 3. The EDAX pattern confirms the presence of Sr and Cd. The average atomic percentage was found as Sr = 28.87 and Cd = 71.13.

3.4 Fourier Transform Infrared (FT-IR) Spectral Analysis

Infrared spectroscopy is one of the most power analytical techniques, which offers the possibility of chemical identification and structural analysis. In the present study IR spectrum of SrCT sample was recorded within the range of 500-4500 nm wave number at research center lab, M.J. College, Jalgaon. The figure 4 shows the IR spectra of SrCT crystal.

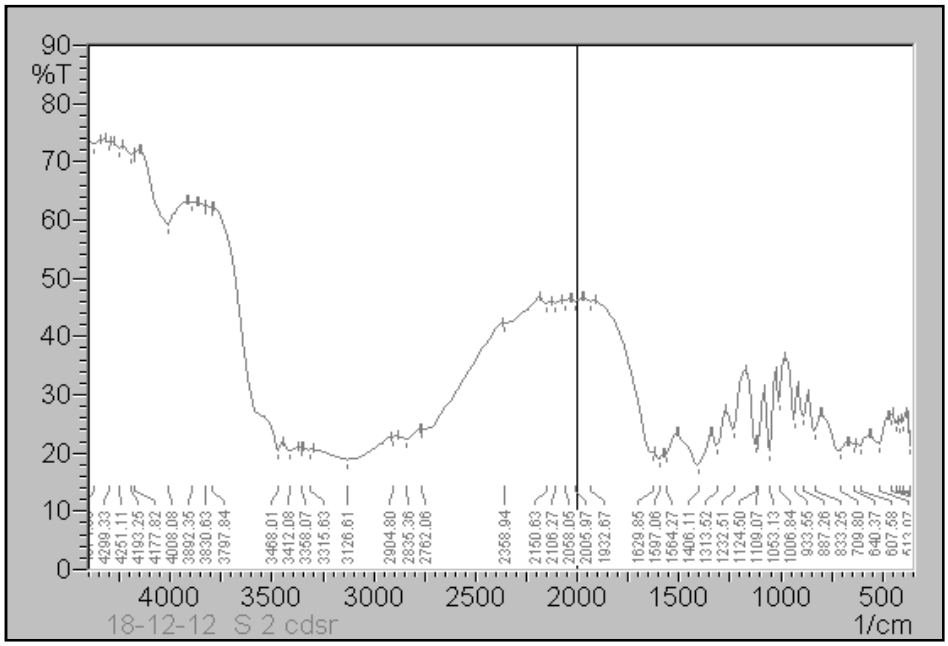


Figure-4.FT-IR spectra of SrCT crystal

In the IR spectrum of strontium cadmium tartrate, the absorption bands at 3468.01 cm^{-1} are due to O-H stretching bending and water of crystallization. Band at 2762.06 cm^{-1} 2358.94 cm^{-1} are assigned to C-H starching vibrations. Strong asymmetrical band at 1597.06 cm^{-1} is attributed due to the C=O weaker symmetric starching in carboxylate ion. The peaks at 1406 cm^{-1}, 1313 cm^{-1} are due the O-H in plane bending. The bands at 1124.50 cm^{-1} and 1053 cm^{-1} are due to the C-O stretching mode. The absorption bands at 833 cm^{-1} – 708 cm^{-1} are due to metal oxygen bonding (Metal = Cd- Sr). It is confirmed that in the present work water of crystallization and metal oxygen bonding is present. The IR spectrum obtained in the present study for strontium cadmium tartrate crystals is similar to the IR spectrum of strontium cadmium tartrate crystals [19-20],

3.5 UV Absorption Spectroscopy

The optical properties of SrCT crystal were studied by UV-VIS Spectrophotometer (Shimaszu-2450) were recorded within 200-1100 nm wavelength at M.J. College, Jalgaon. Figure 4 shows UV absorption spectra of SrCT crystals.

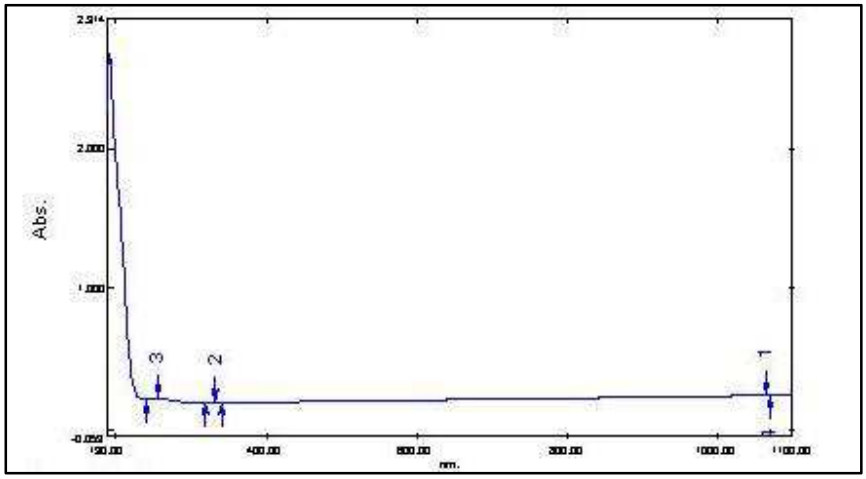


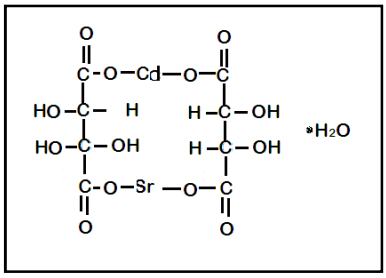
Figure 4 Absorbance of SCT crystal

The absorbance spectra reveal that the sample has sufficient transmission in the entire visible and IR region. The absorption coefficient is high at lower wavelength and the wide transparency from 240nm suggestive their suitability for second and third harmonic generations of the 1064 nm radiation [25-26]. The band gap energy of the SrCT crystal was calculating 5.16 eV by using following formula:

Band energy (eV) = 1240 / wavelength (nm).

CONCLUSION

1. The XRD spectrum reveals that the sample is polycrystalline and tetragonal in shape.
2. The IR spectrum revealed the presence of water molecules, O-H band, C-O and carbonyl C=O bands. The C-OH in plane bending and out of plane bending is identified. The presence of metal cadmium and strontium identified was confirmed by chemical analysis.



3. EDAX confirms the presence of Sr and Cd elements.
4. The optical band gap was found to 5.16 eV.

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