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UV-VIS Study of Strontium iodate crystals grown in gel

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Abstract

A simple gel method is used to grow Strontium Iodate Crystals by using single diffusion technique. The optimum growth conditions were established for the growth of these crystals. The grown crystals were Cubical in shape. Some crystals are shining and quite transparent, hence are of reasonably good quality. The crystals were characterized using UV-VIS Spectrophotometry.

Keywords: Gel technique, Strontium iodate crystals, UV-VIS Spectrophotometrry.

INTRODUCTION

The need for better quality crystals in industries and technology has kept the human race developing their knowledge in the field of crystal growth. Nowadays, most of the solid-state investigations are made by using well-developed crystals. Due to lack of natural crystals or their availability in impure form, the growth of reasonably bigger crystals of greater purity and homogeneity has long been exercised the minds of research workers. An efficient process is one, which produces adequately perfect crystals for their use at minimum cost.

The growth of single crystals in gel at an ambient temperature, which are sparingly soluble in water, is a fascinating alternative to the techniques involving high temperature and expensive equipments. During the last few years, successful application of gel growth technique has been demonstrated by the preparation of single crystals of alkaline earth metal iodate. The gel growth technique appeared quite attractive for growing crystals of such compounds on account of its unique advantages in terms of crystals produced and the simplicity of process.

In the present work, crystals of Strontium iodate were grown by gel technique using single diffusion method. Optimum growth conditions for crystals were determined. Optimum conditions were established by varying various parameters.

MATERIALS AND METHODS

Test tubes were used as crystallizing vessels. The silica gel was used as a growth media. Gel was prepared from aqueous solution of sodium meta silicate. The gel was acidified by acetic acid. The chemicals used for growth of single crystals of Strontium iodate were CH_3COOH; $Na_2SiO_3.5H_2O$; KIO_3, $NaIO_3$; $Sr(NO_3)_2$. All chemicals were of AR grade.

A series of experiments using different pH values for the gel and the different concentrations for reactants were carried out. Different molar masses were tried to determine the optimum growth conditions. Out of the two reactants, $Sr(NO_3)_2$ was incorporated in gel and KIO_3 was used as the supernatant over the set gel. These experiments yield Cubical crystals of Strontium iodate of few mm size. Experiments were also carried out by interchanging the position of reactants. These experiments do not yield any crystals at all. $Sr(NO_3)_2$ having different concentrations was incorporated into the gel. This solution was then transferred to borosil glass tube of diameter 2.5 cm and 25 cm in height. The mouth of the tube was covered by cotton plug. After setting of the gel, it was left for aging for

different periods of time. Another reactant having different concentrations was then added as supernatant over the set gel. Experiments were carried out by changing different concentrations of the reactants.

The chemical reaction inside the gel can be expressed as

$$XCl_2 + 2YIO_3 \rightarrow X(IO_3)_2 + 2YCl$$

Where X = Sr and Y = K or Na

RESULTS AND DISCUSSION

Strontium iodate crystals cannot be crystallized by high temperature methods, as the material starts decomposing before melting. Therefore conventional high temperature methods for its growth are not applicable. Gel method is only the alternative technique to grow the crystals of the appreciable size and quality as reported in the present work at ambient temperature. Moreover, this method is simple and inexpensive. Hence the crystals of strontium iodate, monohydrate [$Sr(IO_3)_2 . H_2O$] were grown by gel method.

Different parameters such as gel density, gel setting time, gel aging time, concentrations of reactants, pH of gel etc have the considerable effect on the growth rate. In the steady state of concentration gradient, growth rate also becomes steady which favors well-developed crystals. However, very slow growth rate along particular directions results in the cubical crystals. Fast growth rate in one particular direction leads to the formation of elongated crystals like whiskers or dendrites.

UV-VIS Spectrophotometry:

Optical property of strontium iodate crystals can be studied using UV-VIS spectrophotometer. A fine powdered form of strontium iodate crystals was used as sample. The reflection and absorption spectra of crystals have been recorded over the wavelength range 200 to 700 nm using a UV-2450 spectrophotometer of SHIMADZU Scientific instruments at the room temperature. The experiment was carried out in the research laboratory of the physics department at pratap college, Amalner. With the help of this, absorption and reflection spectra are directly obtained through the computer using OOI base 32 software.

The absorption and reflection spectra of strontium iodate crystals recorded by UV-2450 spectrophotometer are as shown in the figures 1(a) and 1(b) respectively.

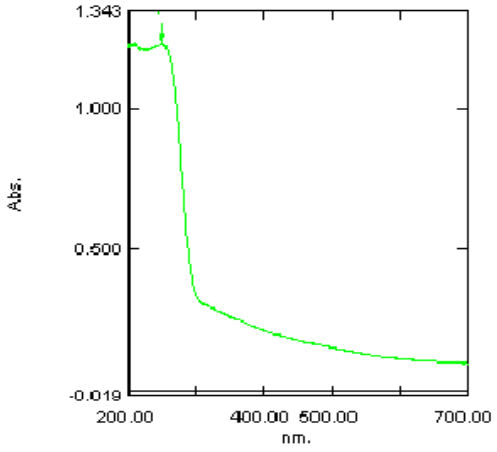

Figure.1(a) Absorption spectra

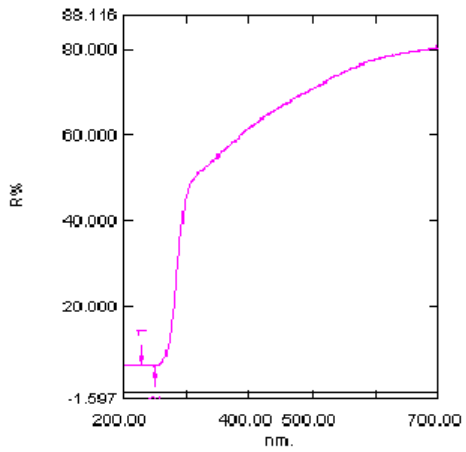

Figure.1(b) Reflection spectra

From the fig.1(a), it is observed that the absorption coefficient is high at lower wavelength and decreases sharply below a certain wavelength for strontium iodate crystals.

The excel data recorded by UV-2450 spectrophotometer is as shown in the table 1.

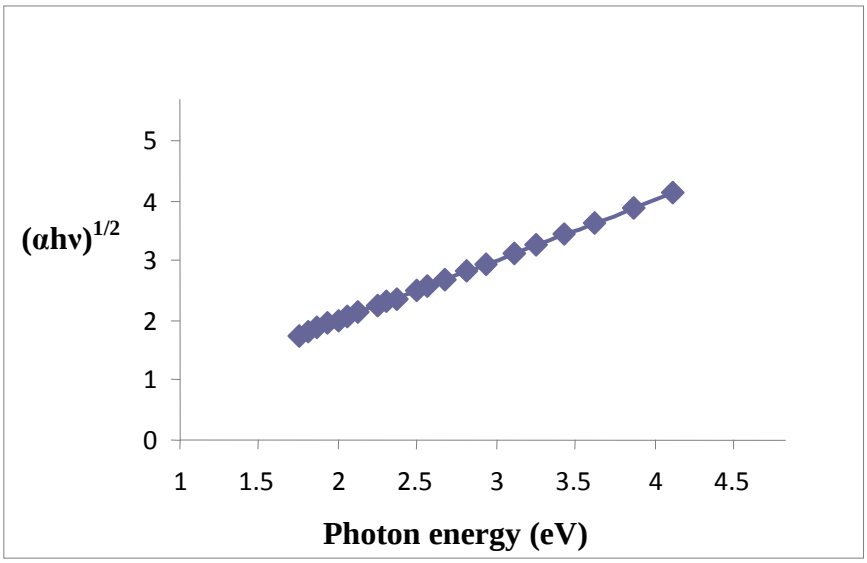

Figure 2(a) The graph of (hν) against $(\alpha h\nu)^{1/2}$

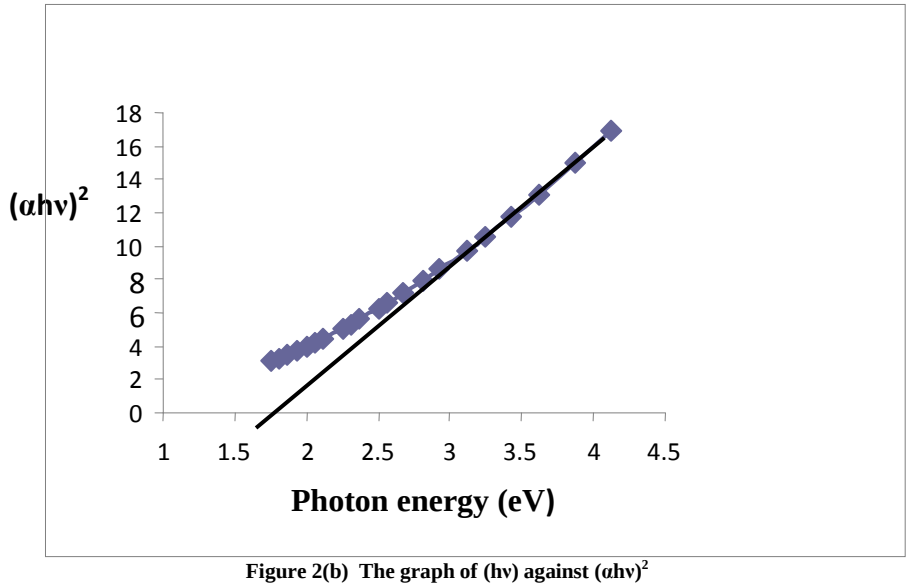

Figure 2(b) The graph of (hν) against $(\alpha h\nu)^2$

The Optical band gap energy is determined from absorption spectra with the help of Tauc relation using the recorded excel data. Using this Tauc relation, a graph is plotted between the square root of (αhν) and hν (Photon energy) as shown in the figure 2(a) as well as between the square of (αhν) and hν (Photon energy) as shown in the figure 2(b).

The extrapolation of straight line to $(\alpha h\nu)^2$ axis in figure gives the value of band gap energy. The energy band gap of the strontium iodate crystals is found to be 1.65 eV. It is in well agreement with the value reported elsewhere.

CONCLUSION

From the above studies we observe that

(I) Gel growth technique is suitable for growing the crystals of strontium iodate.
(II) Single diffusion method is convenient for the growth of the strontium iodate crystals.
(III) Different habits of strontium iodate crystals can be obtained by changing parameters like gel density, gel aging, pH of gel, Concentration of reactants etc.
(IV) Some crystals are shining and quite transparent, hence are of reasonably good quality.
(V) The optical band gap energy of the grown crystals is found to be match with the reported elsewhere.

Table 1 : Excel data of strontium iodate crystals

λ(nm)	Absorption coefficient (α)
300	0.336
320	0.293
340	0.27
360	0.249
380	0.229
400	0.211
420	0.196
440	0.183
460	0.170
480	0.161
500	0.151
520	0.141
540	0.131
560	0.122
580	0.116
600	0.111
620	0.106
640	0.102
660	0.099
680	0.097
700	0.094

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