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"AN IMPERATIVE REVIEW ANALYSIS OF STRUCTURAL ,ELECTRICAL, OPTICAL AND THERMAL PROPERTIES OF CADMIUM, CALCIUM, BARIUM TARTTRATE CRYSTALS GROWN BY GEL METHOD"

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ABSTRACT

The recent advances in science and technology have brought a great demand of various crystals with numerous applications. A field of multidisciplinary nature in science and technology has been emerged, known as crystal growth, which deals with the crystal growth methods, crystals characterizations and crystal growth theories. There are different kinds of crystals having various applications grown by different techniques. Broadly speaking, there are three main categories of crystal growth processes. (1) S → S, process involving solid-solid phase transitions, (2) L → S, process involving liquidsolid phase transitions, and (3) V → S, process involving vapor (gas)-solid phase transitions. Potassium Dihydrogen Phosphate (KDP) and Potassium Dideuterium Phosphate (KDP) are among the most widely-used commercial NLO materials. They are commonly used for doubling, tripling and quadrupling of Nd:YAG laser at the room temperature. In addition, they are also excellent electro-optic crystals with high electrooptic coefficients, widely used as electro-optical modulators, Q switches and Pockels Cells, etc Different techniques of crystal growth, explaining the types of crystal structures,

history of crystal growth, and current research position of tartrate crystals, recent advances and future challenges along with necessary literature survey are included in current research endevour. The paper deals with the description of the experimental techniques employed in the characterisation of grown crystals. Apart from this, the other salient instrumentations discussed are the single crystal X-ray diffraction, thermal analyses such as TGA and DTA, Vickers hardness tester, dielectric, photoconductivity and AC/DC electrical conductivity experimental setups. These techniques have been employed for characterizing the grown crystals.

Keywords: *Single crystal XRD, TGA and DTA, Vickers hardness test, Dielectric and Photoconductivity techniques.*.

1. INTRODUCTION

An assessment technique to decide the perfection of the grown crystals is required to make rapid progress in the growth process and to improve the quality of the crystal. Post growth analysis of a crystal provides information on the process that occurred during growth. Consequently, the improvement in crystal growth can be followed from an early stage in the growth process and the route to perfection can be planned more efficiently. Characterization of a material can be defined as a complete description of its physical and chemical properties.

A thorough and extensive characterization of a single crystal is very difficult, because it requires a variety of tests using a number of sophisticated instruments, an accurate analysis of the results of these tests and their confirmation. The use of instrumentation is an exciting and fascinating part of any analysis that interacts with all the areas of chemistry and with many other fields of pure and applied science.

Analyses of Martian soils, the body fluids of racehorses and Olympic athletes, the engine oil of commercial and military jet aircraft, are examples of problems that require instrumental techniques. In most cases of chemical analysis, a signal is produced which reflects the chemical or physical property of a chemical system. Moreover, characterization of the grown crystals forms an integral part of the growth studies to be performed by the crystal grower. The characterization of a crystal essentially consists of an evaluation of the chemical composition, structure, defects and the study of their optical properties. The

study of growth defects includes the defects such as inclusions, mechanical stress etc.

The study of optical transmission and absorption of the crystal, FTIR, Kurtz powder method for SHG conversion efficiency, NLO coefficients, electro-optics coefficients and structural dependence of these properties leads to the complete understanding of the optical behaviour of the crystal.

- Crystal structure analysis by single crystal XRD using Enraf Nonius CAD4-F Diffractometer.
- Powder X-ray Analysis using STOE Model Powder X-ray diffarctometer.
- FT-IR analysis using BRUKER IFS 66V FT-IR spectrometer.
- UV spectral study to determine the transparency range using VARIAN CARRY 5E spectrophotometer.
- Kurtz powder technique employing Q-switched mode lock Nd: YAG laser to confirm NLO property.
- Study of thermal behaviour of the grown crystals using TG-DTG and DTA techniques.
- Study of microhardness of the crystals using Vickers hardness tester.

Keeping this in backdrop the current ***research endeavor is formulated to perform Imperative Review Analysis Of Structural ,Electrical, Optical And Thermal Properties Of Cadmium, Calcium, Barium Tarttrate Crystals Grown By Gel Method***.

2. HISTORICAL LITERATURE CITED

Menon,et al [2]. Arthropathies, i.e., bone and joint diseases, are caused by crystals such as hydroxyapatite, calcium pyrophosphate and monosodium urate monohydrate. Gupta et al [3] There are other crystals which play important role in various ailments, for This bio-crystallization occurring in human body causes suffering and it is not desirable to occur. This has been discussed in detail by the predecessors of the present author. There are several micro-organisms which synthesize crystals, for example, magneto-tactic bacteria synthesizing magnetite; chrysophytesinstance, f.c.c. type ferritin crystals in development of cataract. Brooks et al[4] and cholesterol crystals for cardiovascular diseases and gall stones.[5-9], diatoms and actinopoda synthesizing siliconous materials. Layer bacteria

synthesizing gypsum and calcium carbonate surface layers. Sarikaya et.al [10] Calcite crystals are found in mollusk shells. Bowen et. al [11] and as a component in gall stones. The wide span of crystallization occurring from the Earth crust to living organism and finally in the laboratory, requires multidisciplinary and multi-angle approach to study the phenomenon of crystal growth. he demand of piezoelectric crystals has reached 4.8 billion US Dollars (USD) and it is further expected to increase 6.91 billion USD and nearly 750 different manufacturing companies are involved in the supply.[13]. Silicon single crystals are generally grown for photovoltaic solar cells and silicon chips for device fabrications. In 2010 nearly 50,000 ton solar grade silicon is required for photovoltaic solar cell production.

The global silicon single crystal production is 10,000 tons per year. Similarly, production of semiconducting III-IV (GaAs, GaP, InP, etc) single crystals, whose total cost exceeds 300 million USD is a dynamically developing bunch of world electronic industry. In Asian countries, particularly, in China the growth of semiconductor market is so high that it can be positioned next to USA in 2010. As per one survey conducted by agency Frost and Sullivan, total market of semiconductor in India during 2006 remained 2.69 billion USD There is also a great demand for single crystal substrates, for example, sapphire single crystal substrates are used in LED and its demand has reached 4.2 billion USD worldwide. However, there are still large number of crystals awaits for large commercial applications, for instance, tartrate compound crystals.

4. RESEARCH METHODOLOGY

Current research endeavor is aimed to fulfill this grasp perform Imperative Review Analysis Of Structural ,Electrical, Optical And Thermal Properties Of Cadmium, Calcium, Barium Tarttrate Crystals Grown By Gel Method. Current research paper is exploratory in nature and based on secondary research methodology. Data is collected from various Journals, books, Websites, Lab reports, and published data in any source.

5. FINDINGS AND DISCUSSION

The advancement of science and technology in the recent years has replaced the traditional and laborious experimental techniques of analysis by sophisticated

instrumental techniques of analysis, which gives more accurate and reproducible results.

Characterization of grown crystals involves the assessment of the crystals in terms of its structure, composition and properties. For characterization of grown crystals, a large number of techniques are available.

There, it is necessary to give brief account of the various techniques used in the present work. Important factors, which must be taken into account, when selecting an appropriate method of analysis are,

• Nature of the information, which is sought

• The size of sample available and the proportion of the constituents to be determined

• The purpose for which the analytical data is required In the present work, grown crystals were characterized by following methods)

i) X-ray Diffraction (XRD)

ii) Infrared Spectroscopy (IR)

iii) Thermogravimetry Analysis (TGA)

iv) Differential Thermal Analysis (DTA)

v) Energy Dispersive Analysis by X-rays (EDAX)

vi) Scanning Electron Microscopy (SEM)

vii) Ultra Violet-Visible (UV-VIS) Spectrophotometry

Growth procedure Silica gel is a very good medium for growing good quality crystals of calcium tartrate, barium tartrate, and cadmium tartrate. The only limitation of this method is its inability to grow bigger crystals.

However nucleation control methods adopted in the present study are proved to be fruitful for controlling the nucleation to a desired level. The densities of gel, pH, concentration of feed solution etc. are optimized for the growth of better quality crystals.

The optimum conditions are given below

i. Calcium tartrate Density of sodium metasilicate(1.04gm/cm3), concentration of feed solution (1M),concentration of tartaric acid (1M),pH of the mixture (4.2),gel setting time (96 hours),gel aging time (144 hours).

ii. Barium tartrate Density of sodium metasilicate(1.04gm/cm3), concentration of feed solution (1.25M),concentration of tartaric acid (1M),pH of the mixture

(4.2),gel setting time (96 hours),gel aging time (120 hours). I

iii. Cadmium tartrate Density of sodium metasilicate(1.04gm/cm3), concentration of feed solution (1M),concentration of tartaric acid (1.25M),pH of the mixture (4.2),gel setting time (96 hours),gel aging time (72 hours). The morphological changes of the crystals depend upon the growth conditions. Concentration of feed solution and the pH of the gel played a vital role in moldings the shape of these crystals. The crystals grown and studied are calcium tartrate, barium tartrate, cadmium tartrate. During the study of these crystals, some unusual results have been obtained.

The morphology and growth pattern of calcium tartrate, barium tartrate, cadmium tartrate are similar in many respect. The crystals exhibits platy, diamond shape, pyramidal shaped, needle like morphologies. The crystals have almost perfect shining surface structures.

6. CONCLUSION

The grown crystals were examined physically and chemically. The elemental composition of the crystals has been confirmed by EDAX and chemical analysis. The Xray diffraction studies confirmed the crystallanity of crystals and found that these crystals crystallized in crystal structure of calcium tartrate has been orthorhombic, barium tartrate has been orthorhombic, and cadmium tartrate crystal is monoclinic. The FT -IR studies confirmed the expected functional groups present in the grown crystals. It is also inferred from FTIR that metal oxygen bond is present and it is the evidence of metal component present in the grown crystals. UV visible spectroscopy carried out in the wavelength range 200nm to 700nm depicted that the grown crystals exhibit higher band gap energy. All the grown crystals have shows NLO properties. SEM studies of all these crystals revels that the growth of crystal is due to addition of layers on grown surfaces.

Crystal's growth plays a key role in science and technology. Large numbers of national and intentional laboratories are busy with growth and characterization of crystal. Some especially busy put them for specific use. Growth of the single and mixed crystal has been the heart of research and development.

There is ample scope for the researchers to do in the field of development of newer and better methods of growing

large crystals and to control nucleation. For the exploration to explain the detailed nature of the gel structure, which is broadly, displaced by the growing crystals and the incorporation of gel particles into growing matrix as in the case of calcite a lot of work remains to be done.

This will help to understand why gel inclusion occurs and how it can be prevented to get proper products. Various types of gels, e.g. ZnS, CdS, PbS, ZnTe, PbSe, etc. can play a key role in the growth of Many important semiconductor crystals, with various acid set gels and to grow various shapes of highly perfect single crystals. A lot of work on the growth of doped and mixed crystals can be grown by using mixed reagents, and they can be generally doped with trace amount of additives, either in gel itself or in top reagent. An elaborate study made in this direction will be helpful in understanding the mechanism of mixed configurations and their x-ray diffraction data forms a lively subject of current research interest

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