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A Study on the Formulation of Bismuth Iodide

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Abstract – Single crystals are the fundamental building blocks for modern technology. The study of growth and characterization of single crystals is forming in backbone of modern scientific developments and also is receiving increasing importance due to their number of applications in solid state technology. These technical advantages have been accompanied by rapid strides in crystal growth. The modern technological developments depend greatly on the availability of suitable single crystals, whether it is for lasers, semiconductor, magnetic devices, superconductors, telecommunication. Crystals grow plays an important role in coming years of science and technology the crystal form by these technique are pure and perfect crystals in bulk. The production of laser crystals to ruby sapphire NOYAG and Non-linear crystal in field of solid state physics and electronic as well as in photonics which are based on crystal growth revolution. For technological advancement in the recent year we are in early step with respect to some important crystals such as Gallium, Nitride, Diamond and Silicon Carbide. Single crystals may field extensive application in field of conversion of solar energy information storage and manipulation on large capacity digital computer improves.

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INTRODUCTION

Some crystals are used in electro, electronic, optical & industrial instrument. So today's requirement to grow large crystal. Crystal growth process required the knowledge of chemical, relations, thermodynamics and about its mechanical properties at a time only. The primary information about crystal and the development in the crystal growth process and the efforts made by different scientists to grow various technological important crystals have been obtained from various National and International papers and references and these important references are summarized from[1-20]. Artificial sensors improves communication tools single crystal may be finded extensive application the importance of high purity and perfection and the chemical and physical properties of the chemical system, involved in the process of crystal growth.

History of Development of Crystal Growth

Man had admired crystals for long, as he had appreciated beauty. The gems and crystals delivered by the mother earth have always attracted our mankind. And the belief in the virtues of gems and some minerals dates back to at least two thousand years, the use of gems for ornamental purposes appears to be in practice since the birth of mankind. The history speaks the usage of unaffected gems of different colors to adorn the crowns of emperors and kings. During 15th century man had learned the tactics of cutting, cleaving and polishing of gemstones to raise the appearance of gems and enhanced the sparkle in gems. That was the inherent optical effects which arose from their high refractive index and dispersion. The significance of that beauty for a technological society and for the development of scientific knowledge has only begun to be realized in 15th century.

Crystallization of salt is mentioned on the Chinese print of 2700 B.C. and was also described on the Egyptian "Papyrus Ebers" of about 1500 B.C. and by Aristotle's (384-322 B.C.). There were also reports during 300 B.C. about the crystallization processes and the preparation of sugar from sugar cane syrup in India mentioned by Ray 1956 [21] and the crystallization of cupric sulphate (blue vitriol) and of a few other salts described by Pliny in his work "Naturalis Historia" and also by Arabian alchemists of the 9th to the 11th century.

Today, crystals are the pillars of modern technology along with electronics industry, photonic industry and fiber-optics communications Modern optical equipment. The essential requirement of electronic fiber-optics is the crystal of required properties. Same is the true for modern optical equipment. Progress in crystal growth and epitaxy technology is highly demanded in view of its essential role for the development of several important areas such as production of highefficiency photovoltaic cells and detectors for alternative energy and medicine. And the fabrication of bright long-lifetime light emitting diodes, for saving energy by wide use in illumination and traffic lights. Integrated microelectronics and the optoelectronics necessitate improved growth technology for large diameter silicon, GaAs and InP in combination with optimized defect and property control on submicron scale. High temperature high power electronics demands mastering of growth and processing proffer of difficult materials like SiC and GaN. The success of laser fusion energy depends on the timely development of high power laser crystals. Further wide potential of oxide superconductors with high transistor temperatures could not be explored so far because proper crystal growth and materials technology development was neglected.

Introduction to crystal

Crystal structure = Space Lattice + Basis

Space lattice: An infinite periodic array of points in space Basis: An atom or an identical group of atoms attached to every lattice point. It is identical for every lattice point in terms of composition, relative orientation and separation. A crystal is a solid composed of a periodic array of atoms i.e. a representative unit is repeated at intervals along any and all directions in crystals. Actual materials are made up of aggregates of single crystal and the properties of the aggregate will be some function of the properties of the units. Making up the aggregate. The crystals appear when a substance changes from one state to other state i.e. in phase transformation. A crystal is the regular polyhedral form, bounded by smooth surface, which is assumed by a chemical compound, under the action of its inter atomic forces, when passing from the state of a liquid or gas to that of a solid under suitable conditions or a crystal is a homogeneous, anisotropic body having natural shape of a polyhedron.

The basic conditions for the formation of crystalline matter that takes place are as follows.

- When a change from one solid phase to other solid phase takes place. There is an alternation of the shape of the crystal structure and recrystallization appears.
- A change from the liquid phase to solid crystallization occurs by sublimation.
- A change from the gaseous phase to solid crystallization occurs by sublimation.

Formation of crystals:

Crystal is the unacknowledged pillars of modern technology. The modern technology developments depend greatly on the availability of suitable crystal, whether it is for lasers, semiconductors, magnetic devices, optical devices, superconductors, telecommunication etc. In spite of great technological advancements in the recent years, we are still in the early stage with respect to the growth of several important crystals such as diamond, silicon carbide, PZT, gallium nitride and so on. Unless the science of growing these crystals is understood precisely, it is impossible to grow them as a large single crystal to be applied in modern industry. The large number of crystal are used in electro, electronic, optical and in industries, hence today's demand is to grow large single crystal with high purity and symmetry. A crystal can consist of any virtually pure single chemical compound.

The compound may be inorganic, such as in minerals and salts e.g. SiO_2 (Quartz) or NaCl (Salt) or organic such as sugar. In fact, any pure organic substance can be crystallized under the right conditions. Chemists actually use this process to purify their compounds as traces of impurity generally remain in solution when the crystals are formed while classic compounds such as $CuSO_2$ can be obtained in large form of crystals. Most compounds crystallize in smaller size which can be obtained in larger and well formed under suitable conditions and using proper techniques. Even proteins can be encouraged to crystallize nicely under appropriate condition. The large size of protein crystal helps scientists to study for the determination of structure of proteins and their by understand their function. Protein crystallography is a very hot field in biosciences in these days. Crystal can be exists as single crystal forms and aggregate forms.

A) Single crystal: The single crystal terms are used to describe a piece of material where there is no change in structure it may be platy or prismatic are used for the crystals as shown in fig 1.1 and fig 1.2

B) Aggregate crystal: Aggregate terms is used in which large number of crystals unites in groups at randomly and terms a unique shape, individual crystals in these aggregate forms are usually hard to discern.

These aggregate forms of crystals are known as dendrite or botryoidally as shown in fig 1.3 and 1.4. All these terms are subjectively and most of the material formed more than one forms of crystal and therefore it is not very diagnostic to know the differences about the different habits of growth of crystals. However, there are some materials that seem to be always found in one habit. Some examples of various habits are along with the compounds are also shown in fig 1.5, 1.6, 1.7, 1.8, 1.9, 1.10, 1.11, 1.12, 1.13, 1.14, to 1.18. Crystals have different shapes and sizes, which depends on two factors 1). The internal symmetry of the crystals and 2). The relative growth rates along the various directions in the crystal, for example, crystals has three mutually perpendicular axes, a, b and c. If the crystals grows at equal rates along a, b and c, then the crystal shape will be a cube. If the crystals grows fast in the a and b direction but very slowly in the c direction then the crystal will grow as thin plate with the face of the plate being perpendicular to c. These are only simple examples. More complicated shapes obtained when crystals doesn't have mutually perpendicular axes and also when the fastest direction of growth towards the faces or body diagonals of the crystal. It is also established 8 facts that fast growing faces are eliminated whereas slow growing faces persist during growing process of crystal.

The Bravais space lattices

There are number of ways in which actual crystal may be built up and atoms piled together resulting in a great many crystal structures. But each of the the structures consist of some fundamental patterns repeated at each point of a space lattice. The scheme of repetitions of a space lattice is very limited in number; while the possible crystal structures are almost unlimited. But it was shown by Bravais in 1848 that there are only 14 different arrays of networks of lattice in which points can be arranged in space that each point has identical surroundings. These are known as Bravais space lattices.

Table 1: seven crystallographic systems with axis of rotation and brief characteristics of various crystallization

Sr.No.	System	Number of lattice in the system	Space lattice or Bravias lattice	Lattice symbol	No of unit cell [Axial length & interaxial angle	Axis of rotation
1.	Cubic	3	1.Simple 2.Body centered 3.Face centered	P I F	a=b=c α = β =γ = 90 ⁰	4 threefold axis of rotation
2.	Tetragonal	2	1.Simple 2.Body centered	P I	a = b ≠ c α = β =γ = 90 ⁰	1 fourfold axis of rotation
3.	Orthorhombic	4	1.Simple 2.Base centered 3.Body centered 4.Face centered	P C I F	a ≠ b ≠ c α = β =γ = 90 ⁰	3 twofold axis of rotation or 1 twofold axis of rotation
4.	Monoclinic	2	1.Simple 2.Base centered	P C	a ≠ b ≠ c α = β = 90⁰ ≠ γ	1 twofold axis of rotation or one mirror plane
5.	Triclinic	1	1.Simple	P	a ≠ b ≠ c α ≠ β ≠ γ≠ 90⁰	Requires either a center or only translational symmetry
6.	Trigonal or Rhombohydral	1	1.Simple	P	a=b=c α = β = γ ≠ 90⁰	Require 1 threefold axis of rotation
7.	Hexagonal	1	1.Simple	P	a = b ≠ c α = β = 90⁰ & γ =120⁰	1Six fold axis of rotation

Crystallography Point Group

In crystallography, a crystallographic point group is a set of symmetry operations, like rotations or reflections, that leave a point fixed while moving each atom of the crystal to the position of an atom of the same kind. That is, an infinite crystal would look exactly the same before and after any of the operations in its point group. In the classification of crystals, each point group corresponds to a crystal class. There are infinitely many 3D point groups, in crystallography; however, they are restricted to be compatible with the discrete translation symmetries of a crystal lattice. This crystallographic restriction of the infinite families of general point groups results in 32 crystallographic point groups. The point group of a crystal, among other things, determines some of the crystal's optical properties, such as whether it is birefringent or whether it shows the pockels effect.

Classification of crystals

The classification of crystals on the basis of their physical/ chemical properties can be put into the following four categories.

i) Covalent crystal

ii) Metallic crystal

iii) Ionic crystal

iv) Molecular crystal

Covalent crystal: This is a crystal, which has chemical bond between all of the atoms. So a single covalent crystal is really just one big molecule. An example of this crystal diamond or zinc sulfide. Covalent crystal can have extremely high melting points.

Metallic crystal: This is a crystal in which individual metal atoms sit on lattices sites while the outer electrons from these atoms are able to flow freely around the lattice. Metallic crystals normally have high melting point and densities.

Ionic crystal: This is a crystal where the individual metal atom doesn't have covalent bonds between them, but are held together by a electrostatic force. An example of this type of crystal is sodium chloride (NaCl). Ionic crystals are hard and have relatively high melting points.

Molecular crystal: This is a crystal where there are recognizable molecules in the structure and the crystal is held together by non-covalent interaction like Vander walls forces or hydrogen bonding. An example of this type of crystal would be Sugar.

Molecular crystal tends to be soft and have lower high melting points.

Colourful crystal: The colour of any compound (whether or not it is a crystal) depends on how the atoms or molecules absorb light. Normally white light is considered to have all the wavelengths of light. If the white light is incident on colored compound, some of the light is absorbed as it's reflected off the surface. This gives rise to the idea of "complementary colours". If a compound absorbs light of certain colour, the compound is said to be complementary color compound. Table 1.2 shows color absorbed and their complements.

Table 1.2 Colour absorbed and their complements

Colour absorbed	Complement colour observed	Wavelength of complement colour in nm
Violet	Green-yellow	400-424
Blue	Yellow	424-491
Green	Red	491-570
Yellow	Blue	570-585
Orange	Green-Blue	585-674
Red	Green	647-700

If a crystal absorbs red light, it will appear green. Conversely, if the crystal absorbs green light, it will appear red, with regards to the optical properties of the crystal. Tony Linden adds one interesting feature of some crystals effect on object viz. a calcite crystal if placed over an object it looks doubled because of total internal reflection with the crystal.

Different features of the crystal:

a. Faces: The crystals are bounded by a number of perfectly flat surfaces. These are called faces. In some crystal all the faces are alike while in other crystal all the faces not like, i.e. they have unlike faces. In this way the faces may be like or unlike. The example of like faces crystals are which is generally obtained in cubes, alum, in regular octahedron and galena exhibits a combination of the cube and an octahedron etc.

b. Form: All the faces corresponding to a crystal are said to constitute a form. The crystal that consists of all like faces is termed to have simple form, while the crystal having two or more simple forms is called to have a combination form.

c. Edges and interfacial angles: The intersection of two adjacent faces forms the edge in space depends upon the position of faces whose intersection gives rise to it. The angle between any two faces of a crystal is formed as interfacial angle. The relationship between planes faces, straight edges and interfacial angles is expressed as,

$$f+c = e+2$$

Where, f=number of faces, c=number of angles and e=number of edges. 16 Steno (1669),[23] gave a law about the interfacial angles which is as follows "under the same physical conditions (same temperature, same chemical composition) the angle between the corresponding faces on various crystals of the same substance are constant". There is also a law about the constancy of symmetry which is as follows,

Crystal shape

Crystals of a material were obtained either in nature or were artificially grown. Since the only technique at their disposal was optical microscope, they could study only the external morphology of the crystals, the problem was then to find out the unit cell. It is at once clear that the external morphology would make it possible only to deduce the probable shape of the unit cell, i.e. only the angles α, β, and γ of the unit cell and the relative dimensions a: b: c. A survey of the older crystallographic literature reveals that the determination of the probable unit cell was gleaned through a judicious combination of the morphological data and the assumption that the actual a crystal faces are the planes with highest reticular density. In the following, proceed to elucidate the determining the probable unit cell based on studies of the external morphology.

Fig 1.1 Platy Crystal

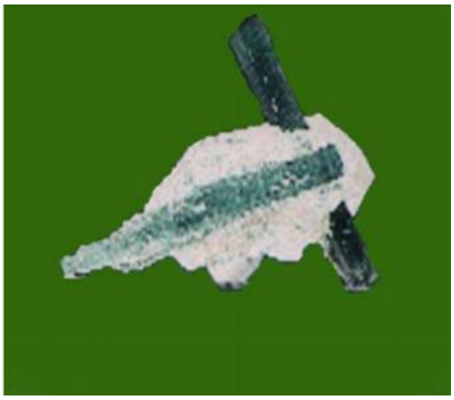

Fig 1.2 Prismatic Crystal

Fig 1.3 Dendrite Crystal

Fig 1.4 Dendrite Crystal

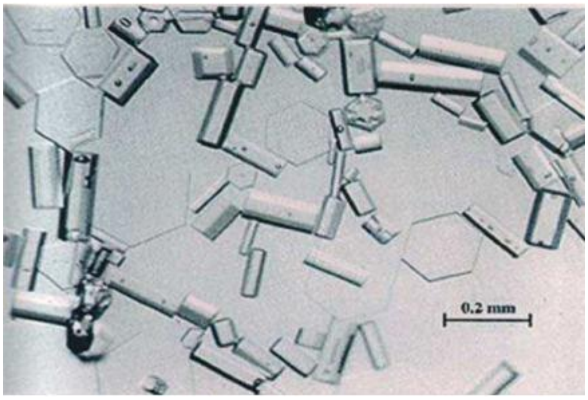

Fig 1.5 Real Crystal of ice with Hexagonal plate and ideal columns collected at South Pole.

CONCLUSION

Iodide is essential for synthesis of sufficient thyroid Iodine, which is converted into simple Iodide and almost completely absorbed from the gastro. Intentional tract blood Iodine is present in steady state as dictatory, Iodide from thyroid gland has all characteristics of an energy linked active transpert system stimulated by Na+ K+ Mg+ and ATP and sensitive to cyanide dinltrophenol and auabian. Iodide can function of an antioxidant as it is reducing species that can detoxify reactive oxygen species such as Hydrogen Peroxide over three million ago. Blue, Green, Algae use the most primitive photosynthesis organism. Iodides have been proposed to act by direct iodization of proteins. It may also oxidized tyrosine moistures or sulphidril groups in proteins causing inactivation.

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