Synthesis and Characterization of Strontium Bismuth Borate glass doped with Neodymium

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by

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DECLARATION BY STUDENT

I hereby declare that the data presented in this Dissertation report entitled, "Synthesis And Characterization of Strontium Bismuth Borate Glass doped with Neodymium" is based on the results of investigations carried out by (Siya Amonkar & Nandan Shetye) in the Physics at the School of Physics And Applied Sciences, Goa University under the Supervision/Mentorship of Mr/Ms/Dr/Prof. (Dr.Reshma Raut Dessai) and the same has not been submitted elsewhere for the award of a degree or diploma by me. Further, I understand that Goa University or its authorities will not be responsible for the correctness of observations / experimental or other findings given the dissertation.

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COMPLETION CERTIFICATE

This is to certify that the dissertation report "Synthesis and Characterization of Strontium Bismuth Borate Glass doped with Neodymium" is a bonafide work carried out by **Ms. Siya Sandeep Amonkar & Mr. Nandan Shivchandra Shetye** under my supervision/mentorship in partial fulfillment of the requirements for the award of the degree of **Master's in Physics** in the Discipline (Solid State Physics) at the School of Physical And Applied Sciences, Goa University.

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CHAPTER 1

Introduction and Objectives

1 Introduction

1.1 A brief History of glass

Glass has a long history, dating back to 5,000 years ago in ancient civilizations like Mesopotamia and Egypt. The earliest glass objects were beads found in Egypt, dating around 3,500 BCE. Glassmaking techniques were adopted by the Romans, who became skilled in this art. In the Middle Ages, glassmaking continued to flourish with the Venetians developing new techniques such as crystal and coloured glass. The Venetian glass industry peaked in the 16th century, producing intricate works of art by the Barovier family. In the 17th and 18th centuries, glassmaking spread to other parts of Europe, including England and France. George Ravenscroft's invention of lead glass, also known as crystal, in 1674 revolutionized the industry by producing high-quality, clear glass [1]

During the 19th century's Industrial Revolution, glassmaking technology advanced with the invention of the glass press and mechanized production methods. This led to glass becoming easily accessible and affordable, and it was used for windows, mirrors, and bottles. In the 20th century, tempered glass was developed, which is stronger due to heat treatment, making it safer for automobiles and architecture. Fiberglass was also invented, which is reinforced glass that enabled the construction of lightweight and sturdy structures like boats and aircraft. Glass is a significant material in various industries, including construction, automotive, electronics, and renewable energy. Ongoing progress in glass technology enables researchers to discover more possibilities like flexible glass and energy-storing glass.[2]

1.2 Amorphous and crystalline material

There are two main categories of solid materials: crystalline and amorphous. Their structure is the defining factor. Crystalline materials have a periodic arrangement of atoms or molecules and a well-defined, long-range order in its structure. In contrast, amorphous materials do not have long-range periodicity.

Unlike crystalline materials that have an atom or molecule periodic arrangement, amorphous materials have a disordered arrangement. Examples of amorphous materials are Glass, polymers. The absence of a well-defined melting point is one of the defining features of amorphous materials. Instead of melting at a specific temperature, amorphous materials gradually soften when heated. This is because of the disordered arrangement of atoms or molecules in amorphous materials which implies that no well-defined boundaries exist between the solid and liquid phases [3]. Schematic arrangement of atoms or molecules in crystalline and amorphous material is shown in figure 1.

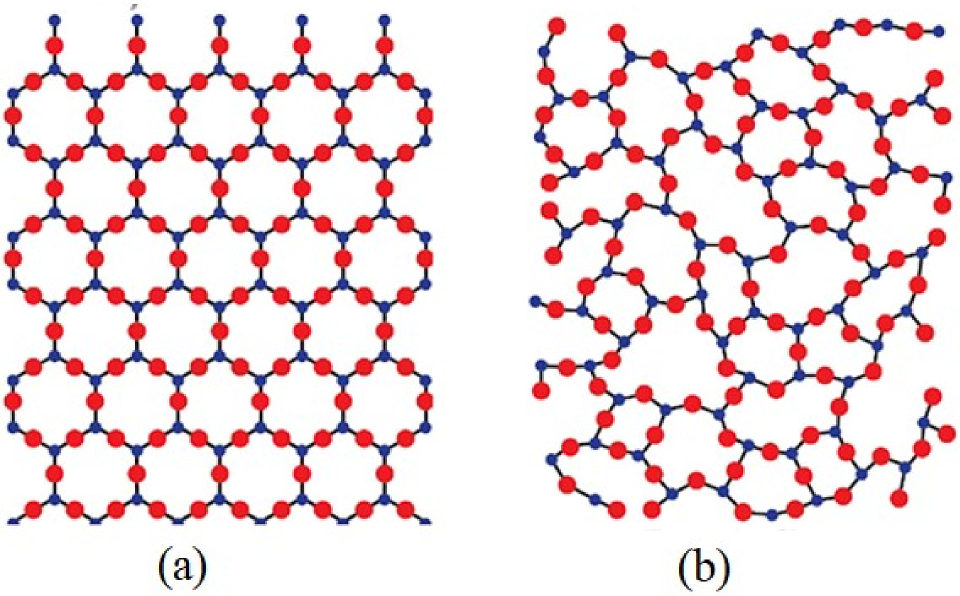


Figure 1. 1Schematic 2D representation of (a) Crystalline material (Rock salt) and (b) Amorphous solid (glass)

1.3 Definition of glass

Glass does not have a simple definition, various terminology used to define glass. In the beginning, glass was defined as an amorphous solid [4]. In the 1930 glass was considered to be a structureless solid. Glass was redefined as an inorganic substance in 1938 which is similar to the liquid state of that substance. In 1949 American Society for testing materials defined glass as an inorganic product of fusion which is cooled to a rigid condition without crystallization [5]. Since fusion is not the only method to prepare glass, this definition had restrictions. Glass was redefined in 1960 as a non-crystalline solid [6]. Later in 1968, glass was redefined as an amorphous solid which exhibits a glass transition [7]. And now it is defined as "An amorphous solid completely lacking in long-range order, periodic atomic structure and exhibiting a region of glass transformation behaviour" [8]. Glasses are supercooled liquids, transparent, and amorphous in nature. They are the inorganic product of fusion which has cooled to a rigid condition without any crystallization. Thus, glass can be defined as Amorphous solid completely lacking in long range, periodic atomic structure and exhibiting a region of glass transformation behaviours. Any material inorganic, organic, metallic, which exhibits glass transformation is a glass. [9]

1.4 Classification of glass

Glass components are divided into three categories depending on their functions and bond strength.

1. Network former (Glass former)

The bond strength of cation-oxygen in glass former is greater than 80 kcal/mol. Some of the glass formers are SiO_2, B_2O_3, P_2O_5, GeO_2, Sb_2O_5, V_2O_5, and As_2O_5. The coordination number is three for B_2O_3 and four for the rest of all. The above oxides except for B_2O_3 form tetrahedral units. B_2O_3 forms a triangular structure.

2. **Network modifier**

Oxides with low bond strength become network modifiers and not part of the network. network modifiers are introduced in the mixture to modify its properties. They do not form glass under ordinary conditions. Some of examples of network modifiers are Na_2O, K_2O, MgO, HgO, CaO, BaO, Li_2O, SrO, and ZnO. Their coordination number lies between 4 to 10. The selection of modifiers is important from the point of view of the applications of glass as in bioactive materials, sensor applications, optoelectronic devices and solid-state ionic conductors.

3. **Intermediates**

Intermediates are between glass former and modifiers. Some of the intermediates are TiO_2, ZnO, PbO, Al_2O_3, ZnO_2 and CdO. [10]

Glasses are classified based on glass-forming materials according to their composition:

1. **Oxide glasses** (silicates, Borates, Phosphates, etc.)

Oxide glasses basically consist of network formers, such as borate, silicate, phosphate, borosilicate, boron phosphate, and network modifiers such as alkali, alkaline earth and transition metals

2. **Chalcogenides Glasses**

Chalcogenide glasses are made Chalcogens such as S, As, Se, and Te, having electron shells that are easily polarizable under electromagnetic field excitation. Chalcogens have a total of 6 electrons in their valence shells. They may be also classified as covalent network solids.

Chalcogenide materials have lower band gap which contribute to very dissimilar optical and electrical properties. The classical chalcogenide glasses mainly sulfur-based As-S or Ge-S are strong glass-formers and possess glasses within large concentration regions. Glass-forming abilities decrease with increasing molar weight of constituent elements; i.e., S > Se > Te.

3. **Halides, Nitrides, Sulphates glasses**

One of the components in Halides glasses is halogens (fluorine, chlorine, bromine, or iodine) They have melted at high temperatures, usually several hundred degrees. They are used in optical applications due to their high transparency in infra-red region. They are also used in fibre optics and radiation shielding. Nitride glasses consists of nitrogen and one of the metallic elements (silicon, aluminium, and titanium) in their composition. Nitride glasses are often used in variety of applications, such as protective coatings for cutting tools, anti-reflective coatings for optical devices, and as insulators in electronic devices due to their unique properties such as hardness, transparency and corrosion resistance. In recent year they are also used for energy storage and conversion to biomedical engineering.

Metallic glasses- Metallic glasses are like alloys that lack regular ordered atomic structure. They have applications in electronic devices, biomedical implants and sports equipment. [11]

1.5. Types of Glasses

Glasses can be classified based on their chemical composition as follows:

1. Soda Lime Silica Glass: This is the most common glass which is composed of 70% of Sand (SiO_2), 15% of soda (Na_2O), Lime 10% (CaO). Here Silica (sand) is the glass-forming oxide, lime acts as a chemical stabilizer, and soda ash act as a fluxing agent.

2. Borosilicate Glass: In this type of glass, the main glass-forming components are silica and Boric oxides. The composition of borosilicate glass is Silica (70-80%) and Boric Oxide (7-13%) and with a small number of alkali oxides (i.e., Sodium oxides, potassium oxides, and aluminium oxides). These types of glasses have good thermal shock resistance and chemical durability and therefore they can be used as implantable medical devices (Artificial hip joints, bone cement, dental composite material). Due to their low coefficient in thermal expansions, they are used in glass mirrors of astronomical telescopes. [12]

3. Phosphate Glass: P_2O_5 (Phosphate Pentoxide) acts as network former in phosphate glasses. They have lower melting point (800°C) than the Borosilicate glass. They are doped with various colorants, including transition metal ions and rare earth oxides. This results in glasses that exhibit a unique and desirable transmission spectrum. Phosphate glasses are used in the military, medical as well as scientific applications. They are also used in optical fibres and heat absorbers.

4. Lead Glass: They are composed of SiO_2 (54-65%), PbO(18-38%), Soda(Na_2O) or Potash K_2 (13-15%), and various other oxides. When the content of PbO is less than 18% is known as crystal glass and high lead oxide contents (~65%) may be used in radiation shielding glass since lead absorbs gamma rays and other forms of harmful radiation and they are used in nuclear industries. [13]

1.6. Borate Glass

There are different types of borate glass with different chemical compositions and doped with other elements with different amounts of concentrations of the elements. Primary component of borate glasses is Boron oxide (B2O3). Borate in this glass help in improving the strength of the glass and hence has resistance to moisture. Improved transparency, brightness, and heat and chemical resistance and high refractive index makes them useful in the production of optical fibres and lenses.

1.6.1. Borate unit (BO_3^{3-})

Borates are boron containing oxyanions (boron and oxygen). They are tetrahedral boron anion.

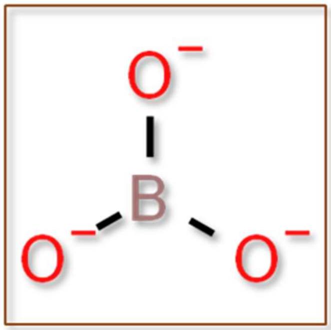
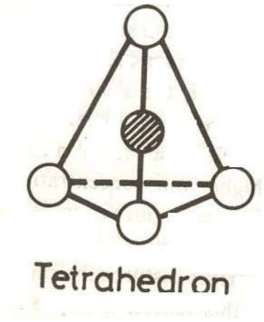


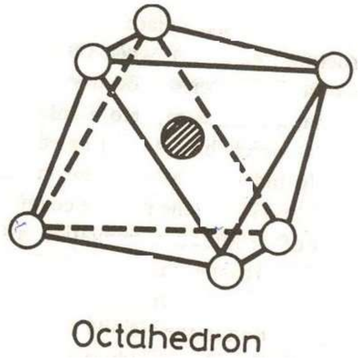
Figure 1. 2 Structure of Borate

Borate contains BO$_3^{3-}$ ions, and atoms are arranged in a trigonal planar BO$_3$ or tetrahedral arrangement. The oxidation state of boron in borates is +3. Oxygen atoms are joined together in a cyclic or linear manner. Bonds are formed by sp^2 hybrid orbitals on boron. Borates when present in glass enhance its strength and resistance to heat and chemicals. They are also used as fungicides and wood preservatives. Recently, glasses containing bismuth oxide have attained great attention, since they are used in a wide area of applications [14].

1.7. Structural Theories of glass formation

Goldschmidt developed one of the first structural theories of glass formation, stating that glasses of the general formula RnOm will form glasses when the ratio of the cation's ionic radii to the oxygen is between 0.2 and 0.4. When this condition is met, the cation has a tetrahedral coordination and is bonded to four oxygen atoms. As a outcome, Goldschmidt deduced that only cations with tetrahedral coordination would form glasses upon cooling. The conclusion was





empirical, and Goldschmidt made no attempt to explain his observation.

Figure 1. 3 Silicon tetrahedron and aluminium octahedron

The ideas of Goldschmidt were extended by Zachariasen. He considered the relative glass-forming ability of simple oxides and concluded that the ideal condition for glass formation is that the material should be capable of forming an extended three-dimensional network structure without any long-range order. Zachariasen pointed out that because of the random network, the internal energy of glass is slightly higher than that of the corresponding crystal which suggests that the polyhedra of the same type in the Crystal must be joined together in a similar way in the glass. For a glass made up of silicon dioxide ($Si0_2$), the crystalline form of silica contains $Si0_4$ tetrahedra joined at the corners (fig.3). Glassy (vitreous) silica must also contain $Si0_4$ tetrahedra joined at their corners. The only difference between crystalline and vitreous silica is that the relative orientation of adjacent tetrahedra is variable in the former whereas in the later it is constant throughout the structure. Zachariasen put forward a set of empirical rules known as Zachariasen's rules which an oxide must satisfy if it is to be a glass former: Oxides like SiO_2, GeO_2, etc. satisfy these empirical rules and are good glasses-forming oxides.

a) No oxygen atom may be linked to more than two atoms.
b) The number of oxygen atoms surrounding any given atom must be small.
c) The oxygen polyhedra share corners with each other, not edges or faces.
d) The polyhedra link up to form a three-dimensional network. i.e., at least three

corners of each polyhedron should be shared [15].

1.8. Glass Transition

The glass liquid transition or glass transition is a reversible process that occurs in amorphous materials. It involves changing from a hard and brittle "Glass" state to a more fluid or rubbery state as the temperature increases. This process is known as the glass transition. Any amorphous solid that can undergo this transition is called a glass. The glass transition temperature (T_g) of a material is the temperature at which this transition occurs. T_g is always lower than the melting temperature. This phenomenon in the amorphous solid phase demonstrates a change in the deviation of the thermodynamic parameter of the solid, transitioning from the crystalline phase to a liquid phase. [7]

1.8.1. Volume Temperature Relation

The volume temperature relation is shown in Figure 1.4. As the temperature of the liquid decreases from the starting point 'a' the volume of the given mass decreases along 'ab'. If the

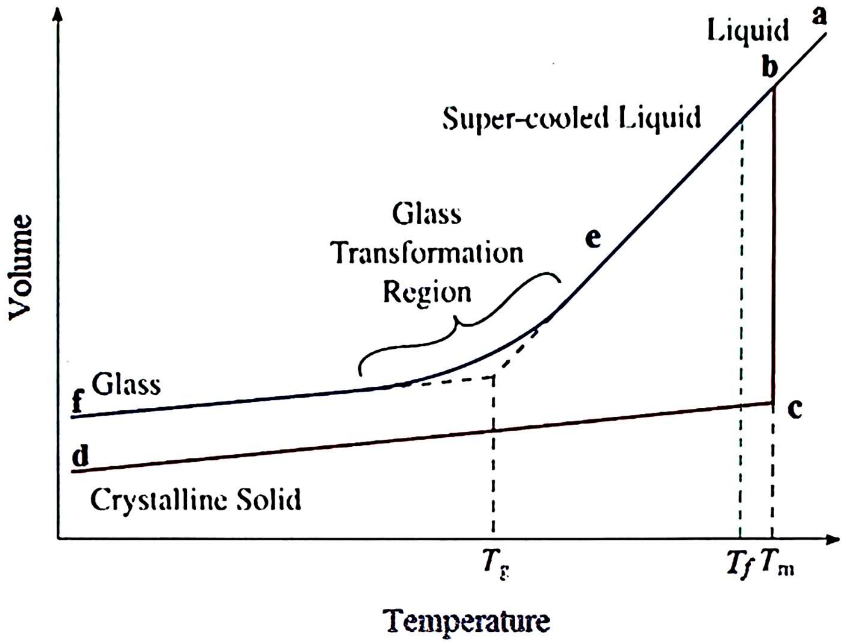


Figure 1. 4 Volume Temperature behaviour of glass

rate of cooling is low and nuclei are present in the melt, crystallization will take place at the temperature T_m, accompanied by a decrease in volume along line 'bc'. On further cooling the crystalline material contracts

along 'cd'. Whereas if the rate of cooling is appreciably high, crystallization does not take place at 'T_f'. As the cooling continues the volume of the supercooled liquid decreases along the line 'be' which is a smooth continuation of 'ab'. At a certain temperature t_g, the volume temperature curve of the supercooled liquid undergoes a marked change in the direction and continues almost parallel to the contraction curve of the crystalline state. This range of temperature over which the slope changes is called the glass transition temperature T_g. Between T_g and T_f (fictive temperature) the material is a supercooled liquid. The viscosity of the melt is very high of about 10^{13} poise at T_g. The difference between supercooled liquid and glass can be understood by what happens when the temperature of the glass is held constant at T, which is below T_g. It is found that the volume decreases slowly until it eventually reaches point 'f', which is a smooth continuation of the contraction curve of the supercooled liquid. This process by which a glass reaches a more stable condition is known as stabilization. Above T_g, no such time dependence is observed. Without crystallization, the supercooled liquid cannot achieve a more stable condition. Given a sufficiently long period of time, glass can achieve more stable conditions at a temperature well below T_g [14]. The properties of a given composition of glass depend to a certain extent on the rate at which it has been cooled through the temperature range near Tg. The exact value of T_g depends on the rate of cooling. However, Tg is an indicator of the approximate temperature where the supercooled liquid converts to a solid on cooling, or conversely, of which the solid begins to behave as a viscoelastic solid on heating [15].

1.9 Applications of Glass

Glass has a wide range of applications due to its unique properties such as transparency, hardness, and chemical resistance. Some of the most common applications of glass include:

1. **Lasers:** Bismuth borate glass doped with neodymium is an efficient laser material due to its high optical gain and ability to emit laser light at a wavelength of 1064 nm. This glass can be used in high-power laser systems for industrial applications such as welding, cutting, and drilling. [17]
2. **Optical amplifiers**: Bismuth borate glass doped with neodymium and strontium can be used as an optical amplifier for fibre optic communication systems. This glass can amplify signals in the 1300 nm and 1500 nm wavelength regions, which are commonly used in optical communication.
3. **Radiation shielding**: Bismuth borate glass doped with strontium has the potential to be used as a radiation shield due to its high atomic number and density. This glass can be used in nuclear power plants, medical imaging facilities, and other environments where radiation exposure is a concern. [18]

1.10. Objectives and Scope

1.10.1. Objectives

The objective of this study is to prepare strontium bismuth borate glass doped with different concentration of Neodymium oxide by melt quenching method. Investigation using spectroscopies like XRD, FTIR, UV and Raman to investigate and study the optical properties of glass due to variations in Neodymium concentrations.

1.10.2. Scope

Bismuth borate glass doped with strontium and neodymium has potential applications in various fields due to its unique properties. Some of the possible scopes of this type of glass include:

i. Bismuth borate glass is promising material for optical applications. Due to their transparency, high optical coefficient, high thermal stability and high damage threshold they are suitable for laser applications. [17]

ii. Incorporation of strontium in bismuth borate glass doped with neodymium can enhance the potential applications, in the field of lasers, strontium can increase the refractive index of glass. Addition of Strontium to the bismuth borate glass may help in shifting the laser emission towards longer wavelengths. [16]

iii. Neodymium doped bismuth borate glass have been in application in medical and dental surgery. Addition of strontium will enhance its application by improved optical properties. [16]

The glass composition Bismuth borate dopped with neodymium and strontium can give rise to new and improved optical glass with application in laser , sensor and medical.

CHAPTER 2

Experimental Technique of material characterization

In this chapter, we present details of Various experimental techniques of preparation of borate glasses and their characterization have been discussed.

2.1. Methods of preparation of Glass

Glass can be prepared using various methods depending on the intended application and the type of glass required. Here are a few common methods of glass preparation in a laboratory:

1. Melt quenching method:

This is the most commonly used method for glass synthesis. Melt quenching is the first method used in the preparation of glass for research as well as in the industry. The raw materials of the composition of glass are melted at high temperatures and then quenched rapidly to avoid crystallization and stimulate amorphous glass formation [19-20]. This method involves the following steps:

a. Raw material selection: Includes silica, boron oxides, alkali metal oxides, alkaline earth metals, and rare earth elements.

b. Melting in furnace: The glass composition is ground to a fine powder and melted in the furnace to its melting point. The temperature and time of melting depends on composition (1000 C to 1800C)

~~c.~~ Quenching the melt: The molten raw materials are then quickly cooled, typically by quenching it in water or a suitable cooling medium. This rapid cooling ensures that the material solidifies into a glassy state rather than crystallizing.

d. Annealing: This involves removing any internal stress that may have developed during cooling. this is achieved by heating the glass in the preheated furnace at a lower temperature of about 350 C for 24 hours. [21]

Figure 2. 1 Furnace used for melting of batch of glass.

2. Sol-gel method

Sol-gel process is a chemical route used to synthesize glass or glass ceramic materials, ceramic materials at relatively low temperatures. The method involves the preparation of a sol, the gelation of the sol, and the removal of the liquid existing in fine interconnected channels within the gel. Steps involved in the preparation of glass by sol-gel method

a. Preparation of the sol: Dissolution of precursor tetraethyl orthosilicate (TEOS) in a solvent like ethanol or water. after hydrolysis forms a sol which is a suspension of nanoparticles in the liquid.
b. Gelation: In gelation a catalyst or a crosslinking agent is added that induces the formation of a gel network.
c. Drying: The obtained gel is dried to remove solvent and residual water.
d. Sintering: The dried gel is heated to a high temperature to densify and form a solid glass.

Main advantage of the sol-gel method is that it gives rise to highly pure and homogeneous glass. [23]

3. Microwave method

The glass composition is heated and melted using microwave radiation. Highly homogeneous and pure samples may be synthesized by this method. the following steps are involved:

a. Raw materials of the glass composition are mixed together to form a batch.
b. The composition is placed in a microwave cavity and exposed to microwave radiation.
c. Microwave radiation will heat the glass leading to the glass melting.
d. the molten glass is then cooled and solidified to give the final glass product. [6]

4. Chemical vapor deposition

Chemical vapor deposition is mainly a thin film application technique. It is one of the most important methods for preparing thin films and coatings. It is a process where one or more volatile precursors are transported via the vapor phase to the reaction chamber, where they decompose on a heated substrate.

Metals, oxides, sulphides, nitrides, phosphides, arsenide, carbides, borides, and silicide can be deposited using the chemical vapour decomposition technique. [24]

2.2. Spectroscopic methods

Spectroscopy is the measurement and interpretation of electromagnetic radiation which is absorbed or emitted by atoms of a sample. This absorption or emission happens when the atoms of the sample move from one energy state to another in the presence of light. In other words, it is a science that studies how light interacts with matter. Natural light is a combination of many spectra. These spectra are the light rays of different wavelengths and frequencies. The spectrum used in spectroscopy varies from ultraviolet, visible, and infrared ranges. The wavelength range for these three spectra is 0-400, 400-700, and above. Schematic representation of electromagnetic spectrum is shown in figure (2.2). When a light ray falls on a compound, it gets absorbed to a certain extent and the remaining is reflected. The wavelength of absorbed light is specific to the material taken.

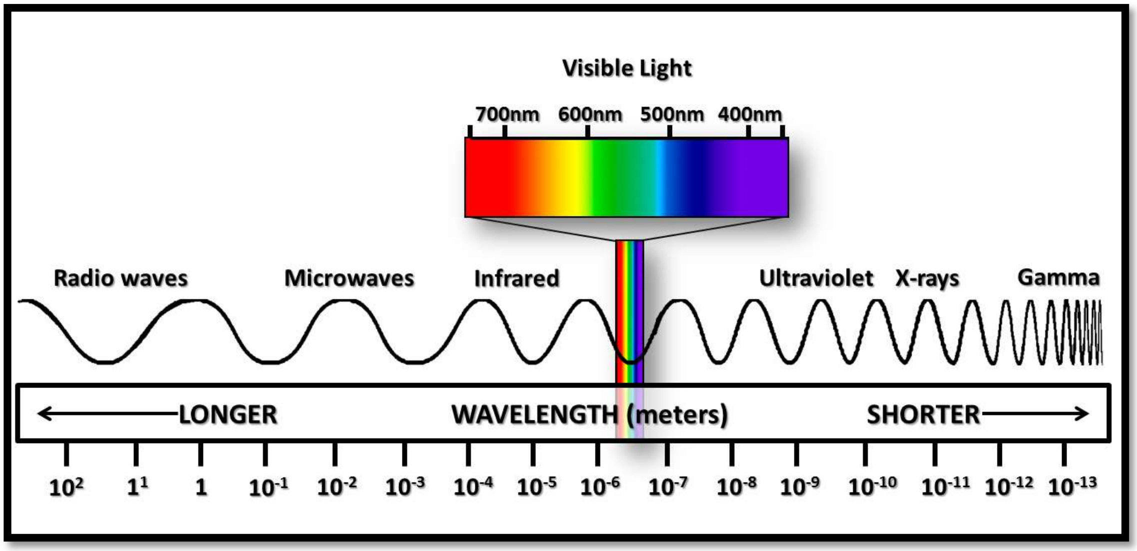


Figure 2. 2 Schematic representation of the electromagnetic spectrum

Spectroscopy is extended to study the substance based on the characteristic absorbance of the above three spectra. Similarly, at a given wavelength, the intensity of light absorbed is depended on the concentration (quantity) of the substance. Based on the above two phenomena, we try to identify and also measure the quantity of any given substance, wherein the absorbance of a specific wavelength of light by the molecules of the sample under test is determined. The more the number of molecules in a sample, the greater the absorbance and vice-versa.

Spectroscopy Principle: Every sample has molecules consisting of some functional groups by which they may experience color or some nature to absorb light of a specific wavelength. This wavelength at which the sample absorbs to a greater extent is called λ max. When the light beam is passed on to the sample, the electrons in the molecules absorb energy from the light and go to exited state. During this transition, some of the light energy is absorbed while the remaining light falls on the photo-electric detector. [25]

Spectroscopic techniques are powerful tools used for characterizing the properties of materials, including glasses. Some common spectroscopic techniques used for glass characterization are as follows:

2.2.1 Xray Diffraction

X-ray diffraction, also referred to as XRD, is a method used to examine the atomic or molecular composition of materials. This approach is usually called X-ray powder diffraction as the material being scrutinized is usually pulverized into a consistent state. Diffraction is the phenomenon in which light slightly changes its direction when it meets an obstacle or passes near the edge of an object.

Principle: In an X-ray diffraction experiment, a sample is placed in the centre of an instrument and illuminated with a beam of X-rays. The X-ray tube and detector move in a synchronized motion. The signal coming from the sample is recorded and graphed, where peaks are observed related to the atomic structure of the sample. Most materials are made up of many small crystals like sand on a beach. Each of these crystals is composed of a regular arrangement of atoms, and each atom is composed of a nucleus surrounded by a cloud of electrons. X-rays are high-energy light with a repeating period called wavelength. Since the wavelength of an X-ray is similar to the distance between atoms in a crystal, a special interference effect called "diffraction" can be used to measure the distance between the atoms. Interference occurs when X-rays interact with each other. If the waves are in alignment, the signal is

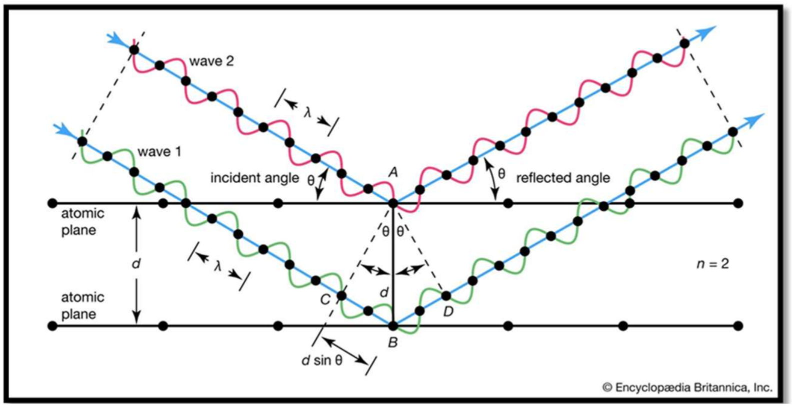


Figure 2. 3 Representation of Bragg's Law

amplified. This is called “constructive interference”. And if the waves are out of alignment, the signal is destroyed. This is called “destructive interference”. When an X-ray encounters an atom, its energy is absorbed by the electrons. Electrons occupy special energy states around an atom. Since this is not enough energy for the electron to be released, the energy must be re-emitted in the form of a new X-ray, but with the same energy as the original. This process is called “elastic scattering”. In a crystal, the repeating arrangement of atoms from distinct planes is separated by well-defined distances. When the atomic planes are exposed to an X-ray beam, X-rays are scattered by the regularly spaced atoms. Strong amplification of the emitted signal occurs at extremely specific angles. where the scattered waves constructively interfere. This effect is called "diffraction". The angle between the incident and the scattered beam is called 2-theta.

For constructive interference to occur, the scattered waves must be in alignment, meaning that the second wave must travel a whole number of wavelengths. In this case, one-half of a wavelength is travelled on the incident side, and one-half is on the scattered side, yielding one additional wavelength. In the case of the next X-ray, one wavelength has travelled on both the incident and the scattered side resulting in two wavelengths. This reinforcement occurs throughout the crystal. The exact angle at which diffraction occurs will be determined from the red triangle. The angle at the top is theta, half the angle between the incident and scattered beams. The long side is the distance between the atomic planes and the short side we know is one-half of a wavelength. The relationship between the diffraction angle and the spacing between the atoms can be determined by applying the sine function [26-28].

$$sin\,\theta = \frac{\lambda}{2d}$$

Rearranging this equation yields an equation commonly known as "Bragg's Law",

$$n\lambda = 2\ d\ sin\theta$$

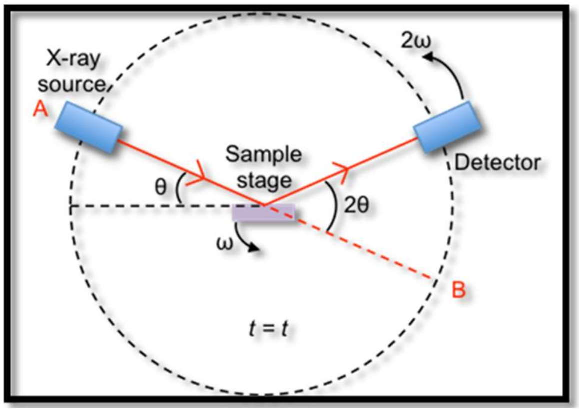


Figure 2. 4 Powder X-ray Diffraction setup

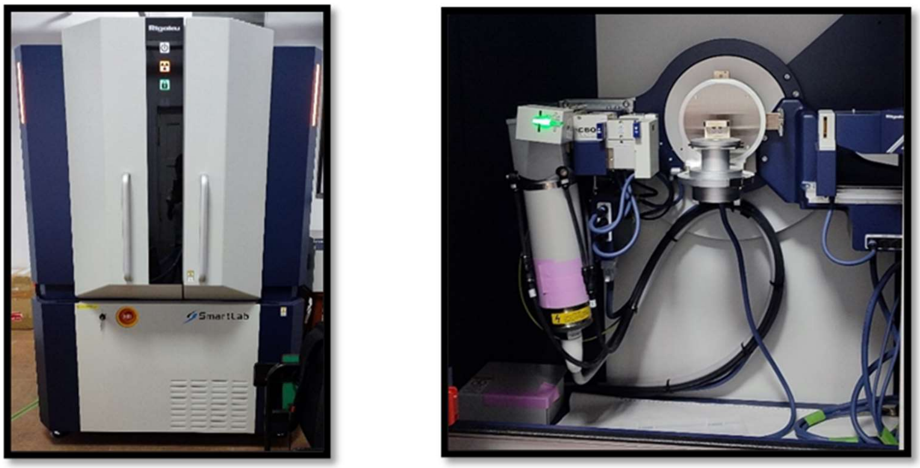


Figure 2. 5 Rigaku SmartLab SE Diffractometer

2.2.2 UV VIS spectroscopy

UV-Vis Spectroscopy (or Spectrophotometry) is a quantitative technique used to measure how much a chemical substance absorbs light. This is done by measuring the intensity of light that passes through a sample with respect to the intensity of light through a reference sample or blank.

Principle: The Principle of UV-Visible Spectroscopy is based on the absorption of ultraviolet light or visible light by chemical compounds, which results in the production of distinct spectra. When radiation is passed through the sample, it triggers a transition in the electrons from their ground state to an excited state. This transition is accompanied by vibrations in the molecules of the sample. As a result, the sample absorbs certain wavelengths of light, which is reflected in the UV spectra [30]. The extent of absorption is dependent on two factors:

1. The concentration of the sample and
2. The path length of the sample holder

These two factors determine the amount of light that passes through the sample and how many molecules are available to absorb the light, respectively. This was expressed by Beer-Lambert's law.

$$A = \varepsilon \mathrm{cl}$$

Where, A is the absorbance of the sample, ε is the molar absorptivity or extinction coefficient (a measure of how strongly the substance absorbs light at a specific wavelength), c is the concentration of the absorbing substance in the sample, and l is the path length of the light through the sample.

Instrumentation

- A monochromator is an essential tool in spectroscopy that is used for separating and isolating specific wavelengths of light. Comprising of two slits and one prism, it facilitates the process of diffraction where the light is scattered into its constituent wavelengths. When ultraviolet (UV) light passes through the first slit, S1, it is made parallel before falling onto the prism. The prism then diffracts the beam into its various wavelengths, which are then transmitted through the second slit, S2.
- The next step in the process involves splitting the light into two halves of equal intensity before passing through the reference cell and sample cell. As the light passes through the reference cell, the intensity remains constant, allowing for a comparison with the sample cell. The sample cell, however, absorbs some of the radiation, leading to a decrease in intensity.
- The transmitted ray of light undergoes detection by the highly sensitive detector, which then relays the information to the computer. The computer efficiently processes the data and accurately plots the graph of absorbance versus wavelength, providing valuable insights for further analysis. [31]

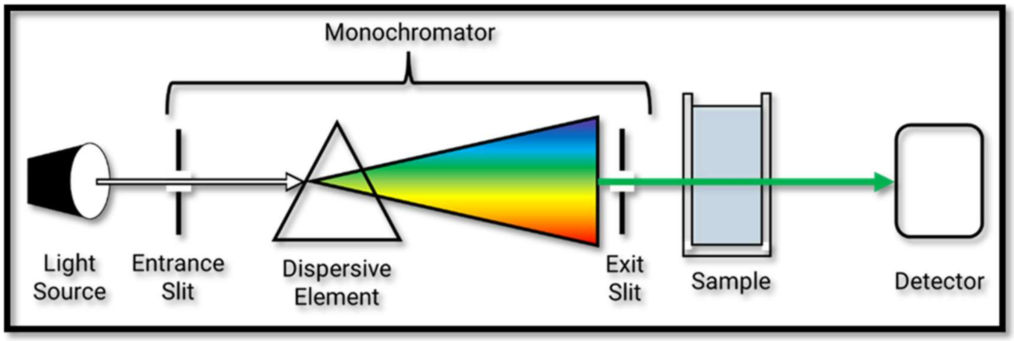


Figure 2. 6 Schematic representation of UV Spectroscopy

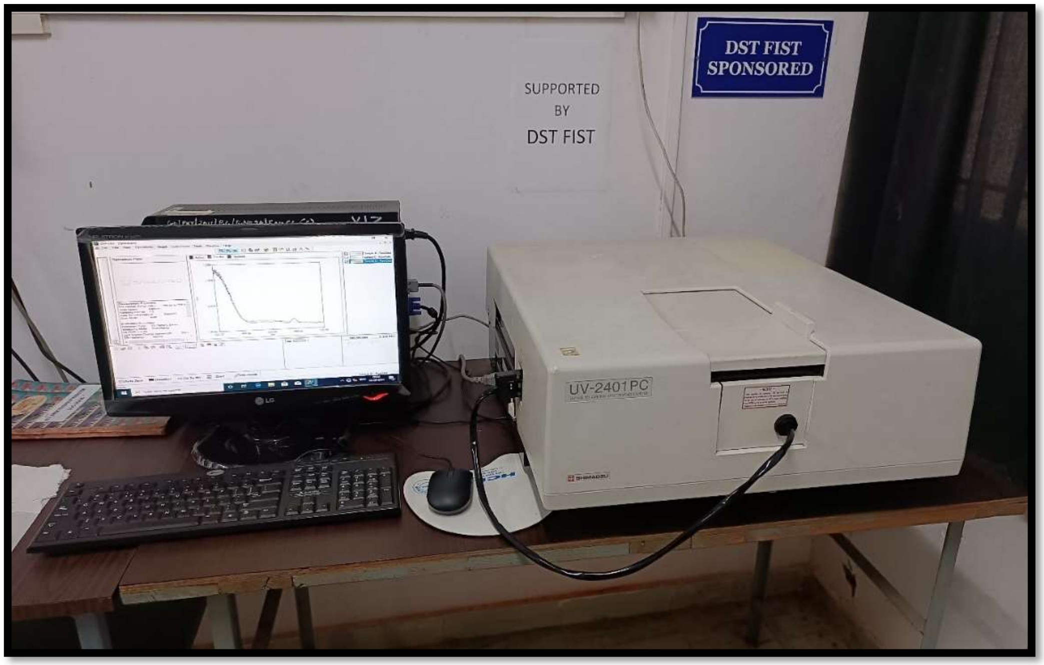


Figure 2. 7 Shimadzu UV-2401PC

2.2.3. Infrared spectroscopy

Infrared spectroscopy (IR spectroscopy) is the spectroscopy that deals with the infrared region of the electromagnetic spectrum, that is light with a longer wavelength and lower frequency than visible light. Infrared spectroscopy gives the fact that molecules absorb specific frequencies that are characteristic of their structure consisting of dipole moments. These absorptions are resonant frequencies, i.e., the frequency of the absorbed radiation matches the frequency of the bond or group that vibrates.

Principle: The absorption of IR radiations causes the excitation of molecules from lower to higher vibrational levels associated with several closely spaced rotational levels. So, IR spectra are considered Vibrational Rotational Spectra.

Absorption in the IR region is due to changes in Vibrational and rotational levels. When radiation with frequencies less than 100 cm^{-1} is absorbed, molecular rotation takes place. So, a single vibrational energy change is accompanied by many rotational energy changes. Thus, vibration spectra appear as Vibrational Rotational Spectra. [31]

All bonds in a molecule do not absorb IR energy but those bonds made by a change in dipole moment will absorb in the IR region. Absorption is due to the electronegativity of one of the elements in double bond formation. The excited electron due to the IR radiation will move towards the electronegative region and hence there will be a change in the dipole moment.

The absorption of energy and change in vibrational energy will depend on:

- Masses of the atoms present in the molecule
- Strength of the bonds
- The arrangement of atoms within the molecules

Instrumentation

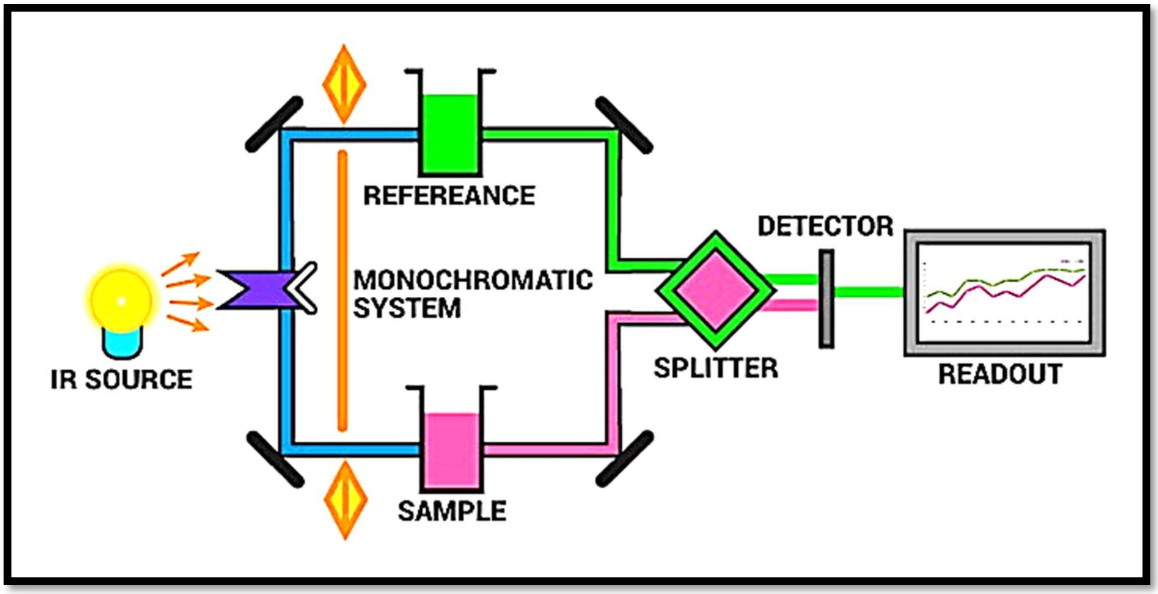


Figure 2. 8 Schematic representation of Infrared Spectroscopy

Steps involved in the working of IR spectroscopy are a follow:

1. Firstly, beam of IR light from the source is directed toward the reference and sample cell. These cells hold the sample that we wish to analyze. The beam of light is then split into two, with one beam passing through the reference and the other through the sample cell. This step is crucial in obtaining accurate results as it allows us to compare the absorption of light by the sample to that of the reference.
2. Next, both beams get reflected to pass through a beam splitter. The beam splitter is a crucial component in the process as it allows us to compare the intensity of the IR radiation that passes through the reference and sample. The split beams are then directed toward the detector, which is the key component of the instrument. The detector is responsible for measuring the intensity of IR radiation that reaches it.
3. Finally, the data that is collected by the detector is sent to the processor where it is analyzed and processed. The processor then gives the data passed through the detector, which is printed out as the required reading. This reading can be used to determine the presence and quantity of various molecules in the sample. [32]

2.3.4. Raman Spectroscopy

Raman spectroscopy makes use of the interaction of the sample with the incident laser light which is monochromatic hence of a certain wavelength the light can be absorbed, transmitted, or scattered. In scattered light would differentiate between Elastic or Rayleigh scattering and inelastic or Raman scattering. It is based on the interaction of light with the chemical bonds within a material. Raman spectroscopy probes the chemical structure of a material and provides information about:

- Chemical structure and identity
- Intrinsic stress/strain
- Contamination and impurity

Typically, a Raman spectrum is a distinct chemical fingerprint for a particular molecule or material and can be used to very quickly identify the material or distinguish it from others.

Principle: It is based on the inelastic scattering of monochromatic light from a laser source which changes its frequency upon interaction with the material. Photons from the laser are absorbed by the samples and it is remitted with a frequency shift up or down in comparison to the original monochromatic frequency this is called the Raman effect. These shifts in the frequency provide information about the rotational, vibrational, and other low-frequency transitions in the molecules.

Raman is a light scattering technique, whereby a molecule scatters incident light from a high-intensity laser light source. Most of the scattered light is at the same wavelength (or color) as the laser source and does not provide useful information – this is called Rayleigh Scatter. However, a small amount of light (typically 0.0000001%) is scattered at different wavelengths (or colors), which depend on the chemical structure of the analyte – this is called Raman Scatter.

A Raman spectrum features a number of peaks, showing the intensity and wavelength position of the Raman scattered light. Each peak corresponds to a specific molecular bond vibration, including individual bonds such as C-C, C=C, N-O, C-H etc., and groups of bonds such as benzene ring breathing mode, polymer chain vibrations, lattice modes, etc. [33]

Instrumentation

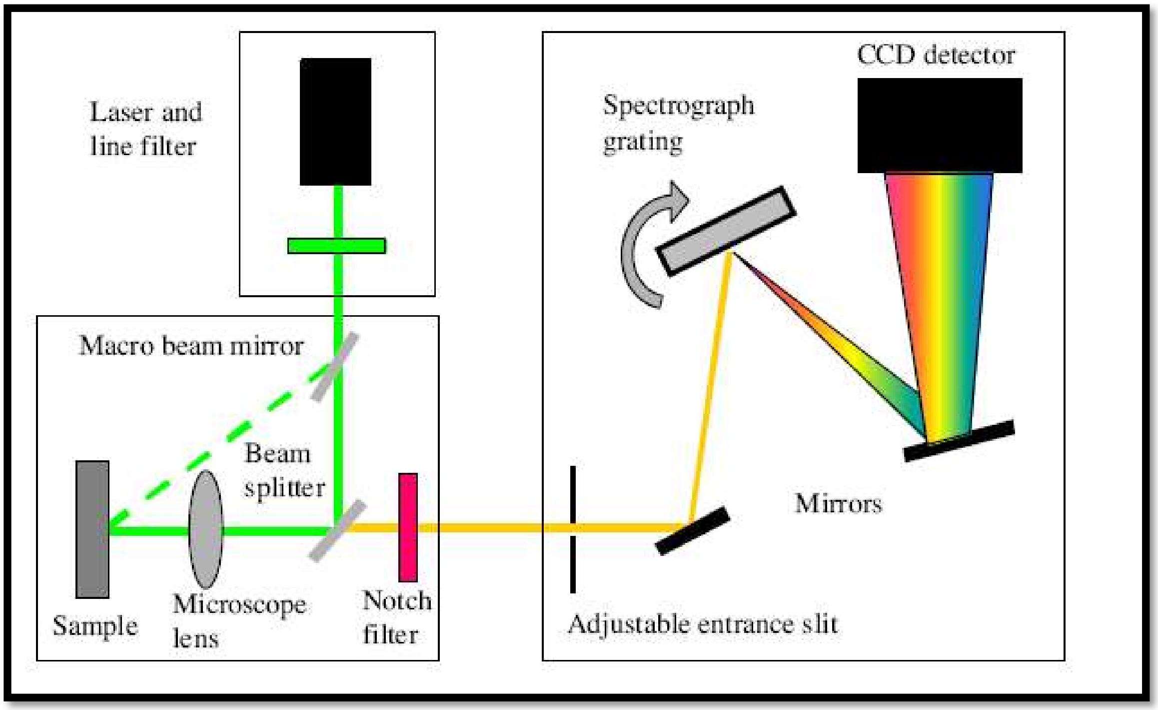


Figure 2. 9 Schematic of Raman Spectroscopy

The laser source plays an essential role as it provides excitation energy to the sample. Generally, a laser source of high power and stable wavelength is preferred for efficient excitation.

The injection/rejection filter is another vital component that helps to deliver the laser beam to the sample. The filter also allows the Raman scattered light to pass through, which is then directed to the spectrograph. The spectrograph, in turn, splits the light into its component wavelengths and measures the intensity of scattered light at each wavelength.

To focus the laser beam onto a specific area of the sample surface and collect the resulting Raman scattered light, a microscope is used. The microscope also magnifies the sample and allows for better resolution of the Raman scattered light.

Apart from these components, the computer is used for instrumental control and data handling. The computer allows for manipulation of the data obtained and can perform various calculations to determine the properties of the sample under investigation. Overall, these components work together to provide an accurate and detailed analysis of the sample's properties. [34-35]

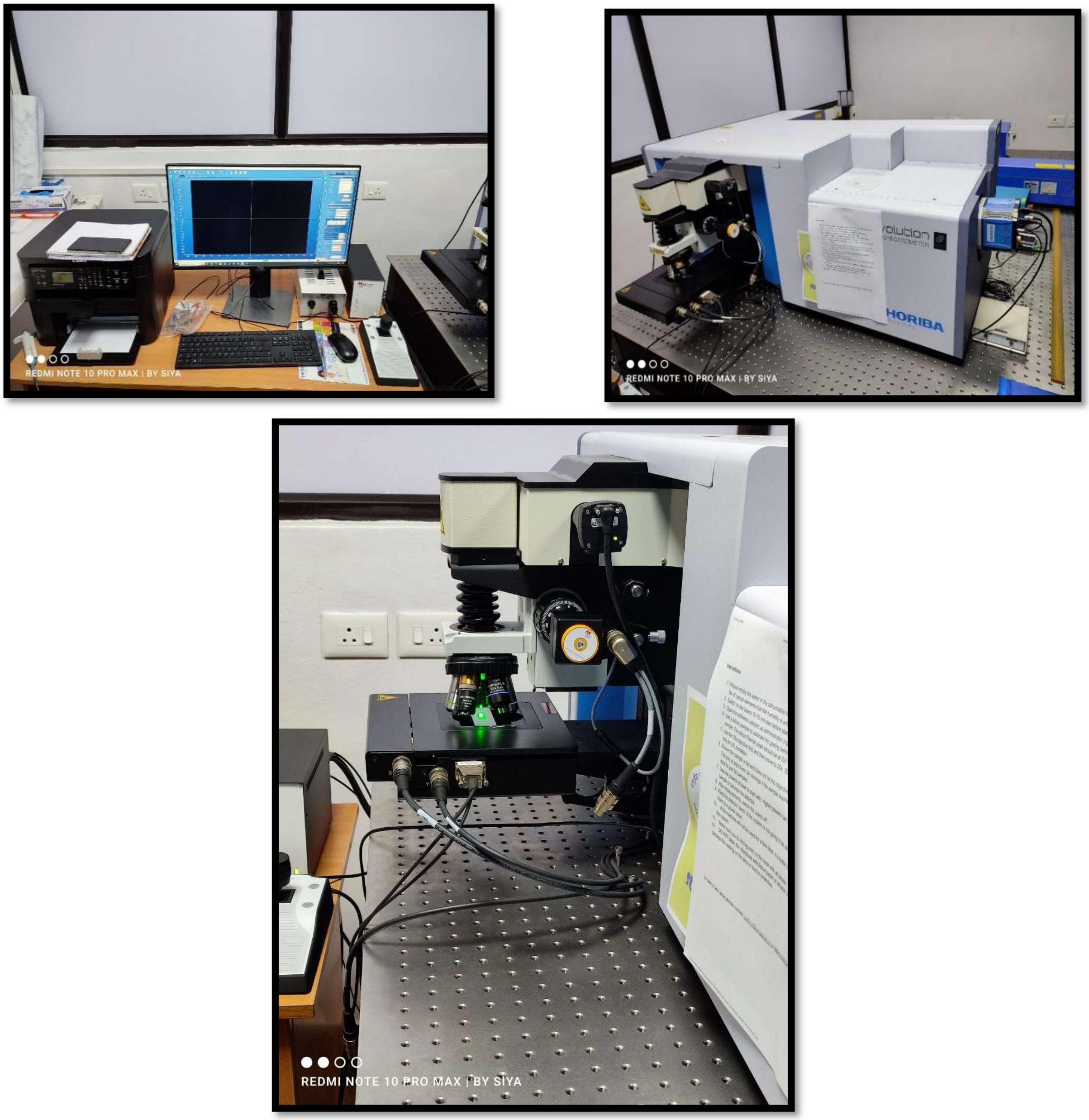


Figure 2. 10 HORIBA Evolution Scientific

CHAPTER 3

Synthesis and characterization

3.1. Synthesis of Bismuth Borate Strontium glass dopped with neodymium glass

Strontium bismuth borate glass doped with Neodymium B_2O_3-Bi_2O_3-$SrCO_3$-Nd_2O_3 were prepared using raw materials H_3BO_3, Bi_2O_3, Nd_2O_3, $SrCO_3$ using standard melt quenching method. All the oxides used for the preparation of glass were of analytical grade, 99.9% pure. Batch calculations were done and compounds were weighed according to the required mole percentages and then crushed to powder using a pestle and mortar and mixed to form a homogenous mixture. For trial, 1 gm of the mixture was ground and placed in an alumina boat and melted at different temperatures. The melting process is done using Carbolite furnace as shown in figure (2.1). Firstly, trials were carried out, in which samples of concentration 1g were prepared in alumina boats and heated till it melted to check if they were forming glass. The melt was then quickly taken out of the furnace and air quenched to obtain glass. This was done to check glass formation for that concentrations, and temperature of glass formation. Clear glass was formed at 1100°C. Once this had been confirmed and the glass formation temperature was determined, the final samples were prepared. A heating schedule was used for glass samples. After confirming the glass formation temperature, for the final sample, 10 gm of mixture was prepared and transferred into alumina crucible and heated in the furnace according to the schedule shown in the fig. (3.1) to fig. (3.3)

The melt was poured onto the steel plate. Different sizes of beads were obtained and used further for characterization. The glass melt was air quenched at 1100 °C. The proposed composition of glass with different percentage of N_d2O_3 were synthesized using the same schedule. The density and melting points of the compounds which were used is shown in table (3). The different proportions of the compounds used are shown in the table (4). The glass samples were characterised by Xray Powder Diffractometer (Rigaku Smart-lab), FTIR (Shimadzu, Prestige 21), Uv Visible Spectrometer (Shimadzu), Raman

Spectroscopy (Horiba Scientific Evolution. Bismuth Borate glass prepared by varying composition of B_2O_3-Bi_2O_3-$SrCO_3$-Nd_2O_3. Five Bismuth borate strontium glass dopped with various concentration of Neodymium Nd_2O_3 is prepared by melt quenching method. The exact composition of the glasses made in mole percentages is given in the Table I.

Chemicals used

1. Boric Acid (H_3BO_3)

Symbol	**Atomic Number**	**Block**	**Element Category**	**Electron configuration**	**Electrons per shell**
B	5	P-block	Metalloid	[He] $2s^2$ $2p^1$	2, 3

2. Bismuth Oxide (Bi_2O_3)

Symbol	**Atomic Number**	**Block**	**Element Category**	**Electron configuration**	**Electrons per shell**
Bi	83	P-block	Post-transition metal	[Xe] $4f^{14}$ $5d^{10}$ $6s^2$ $6p^3$	2, 8, 18, 32, 18, 5

3. Strontium Carbonate (Sr CO_3)

Symbol	**Atomic Number**	**Block**	**Element Category**	**Electron configuration**	**Electrons per shell**
Sr	38	S-block	Alkaline earth metal	[Kr] $5s^2$	2, 8, 18, 8, 2

4. Neodymium Oxide (Nd_2O_3)

Symbol	**Atomic Number**	**Block**	**Element Category**	**Electron configuration**	**Electrons per shell**
Nd	60	F-block	Lanthanide	[Xe] $4f^4\ 6s^2$	2, 8, 18, 22, 8, 2

Table 1 Molar weight compositions are as follows:

Composition of $BiBoSrNd_0$

COMPOUND	**GRAM MOLE**	**MOLE PERCENT**	**CORRECTED WEIGHT**	**5g**
H_3BO_3	61.8110	60	37.0866	1.1604
Bi_2O_3	465.9608	20	93.1922	2.9158
$SrCO_3$	147.6310	20	29.5262	0.9238
Nd_2O_3	336.4800	0	0.0000	0.0000

Composition of $BiBoSrNd_{0.5}$

COMPOUND	**GRAM MOLE**	**MOLE PERCENT**	**CORRECTED WEIGHT**	**5g**
H_3BO_3	61.8110	60	37.0866	1.1642
Bi_2O_3	465.9608	20	93.1922	2.9255
$SrCO_3$	147.6310	18.5	27.3117	0.8574
Nd_2O_3	336.4800	0.5	1.6824	0.0528

Composition of $BiBoSrNd_1$

COMPOUND	GRAM MOLE	MOLE PERCENT	CORRECTED WEIGHT	5g
H_3BO_3	61.8110	60	37.0866	1.1468
Bi_2O_3	465.9608	20	93.1922	2.8818
$SrCO_3$	147.6310	19	28.0499	0.8674
Nd_2O_3	336.4800	1	3.3648	0.1040

Composition of $BiBoSrNd_5$

COMPOUND	GRAM MOLE	MOLE PERCENT	CORRECTED WEIGHT	5g
H_3BO_3	61.8110	60	37.0866	1.0956
Bi_2O_3	465.9608	20	93.1922	2.7531
$SrCO_3$	147.6310	15	22.1447	0.6542
Nd_2O_3	336.4800	5	16.8240	0.4970

Composition of $BiBoSrNd_7$

COMOUND	GRAM MOLE	MOLE PERCENT	CORRECTED WEIGHT	5g
H_3BO_3	61.8110	60	37.0866	1.0717
Bi_2O_3	465.9608	20	93.1922	2.6930
$SrCO_3$	147.6310	13	19.1920	0.5546
Nd_2O_3	336.4800	7	23.5536	0.6806

Table 2 Chemical composition of glasses

Samples	H_3BO_3	Bi_2O_3	Nd_2O_3	$SrCO_3$
$BiBoSrNd_0$	60	20	0	20
$BiBoSrNd_{0.5}$	60	20	0.5	18.5
$BiBoSrNd_1$	60	20	1	19
$BiBoSrNd_5$	60	20	5	15
$BiBoSrNd_7$	60	20	7	13

The density of glass samples was determined by water displacement method and the obtained values of density are shown in the Table (3)

Table 3: Density and melting point of glass samples prepared

Compounds	Density (g/cm^3)
$BiBoSrNd_0$	2.30
$BiBoSrNd_{0.5}$	2.31
$BiBoSrNd_1$	3.64
$BiBoSrNd_5$	2.62
$BiBoSrNd_7$	3.56

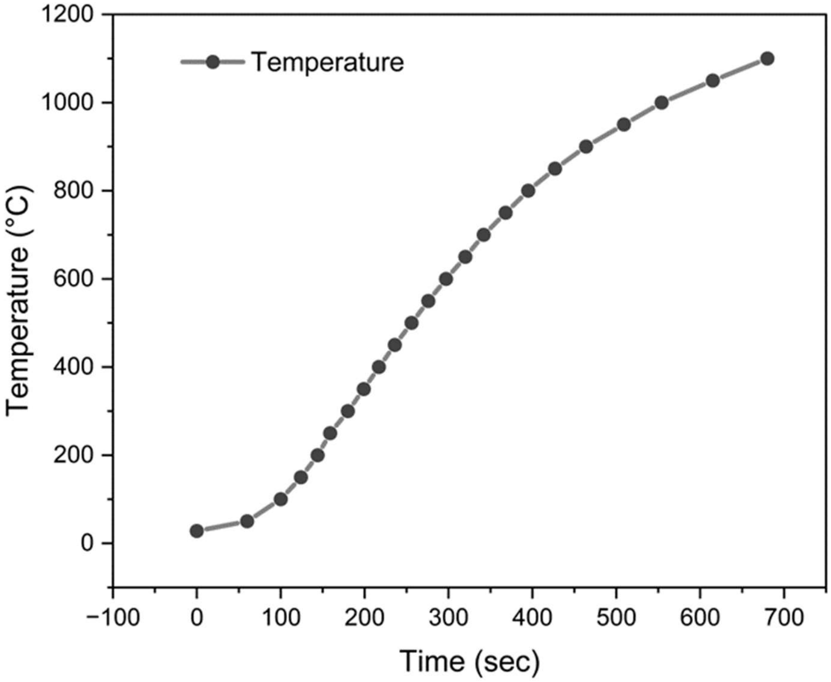


Figure 3. 1 Heating Schedule for undoped Bismuth Borate Glass

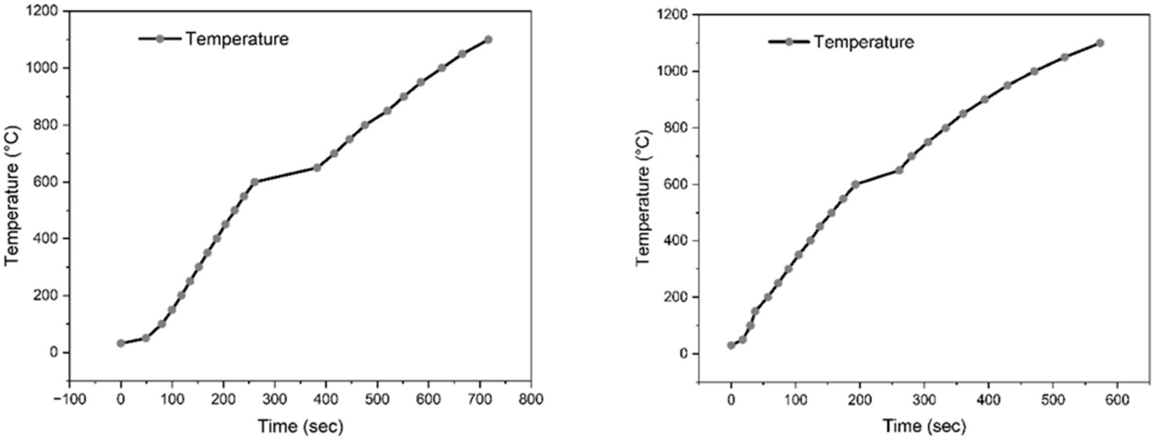


Figure 3. 2 Heating Schedule for Neodymium doped Bismuth Borate Glass

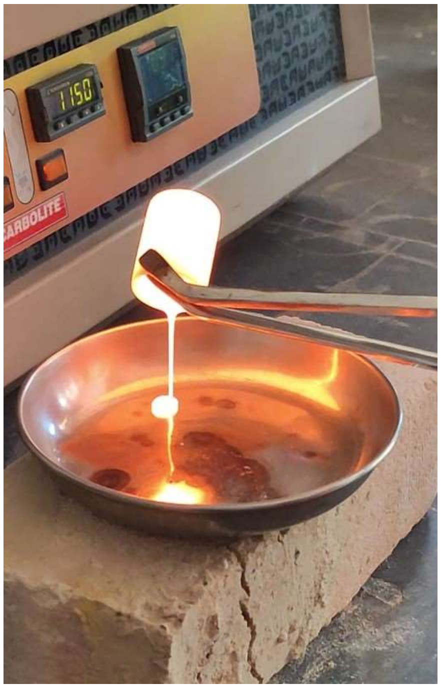


Figure 3. 4 Rapid quenching of glass sample

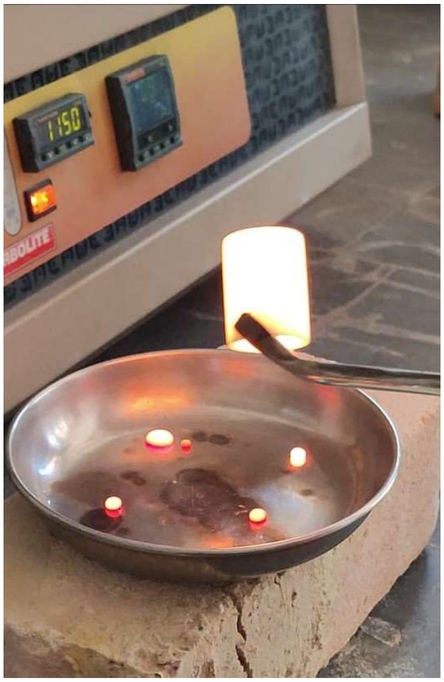


Figure 3. 3 Droplets of glass Formation of Glass

Figure 3. 5 Photo of glass H_3BO_3-Bi_2O_3-$SrCO_3$-Nd_2O_3 with varying composition of Neodymium

3.2 Characterisation, Data Interpretation, and results

3.2.1. X. Ray Diffraction

X-ray diffraction pattern of glass samples was studied using a Rigaku SmartLab diffractometer with incident CuKα radiation source at 40kV at 40 mA. Data were collected in the angular range from 10° to 120° in a step difference of 0.02°C with wavelength of 1.5418 Å. X-ray diffraction is used to identify the crystalline or amorphous nature of the synthesized samples. The XRD spectrum of the glasses obtained are shown graphically in Figure to Figure.

The XRD pattern of all the glass samples show no Bragg's peak, but only a broad diffuse hump around low angle region. This is a clear indication of amorphous nature of the samples with first hump at ~28° and the second hump is obtained at 46°. Thus, the X-ray diffraction data on these glasses confirmed their glassy nature and structural similarity.

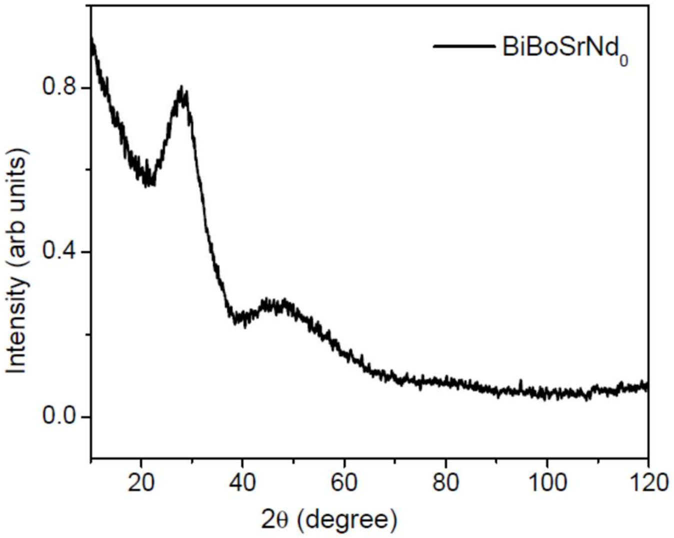


Figure 3. 6 X-ray Diffraction pattern for BiBoSrNd$_0$

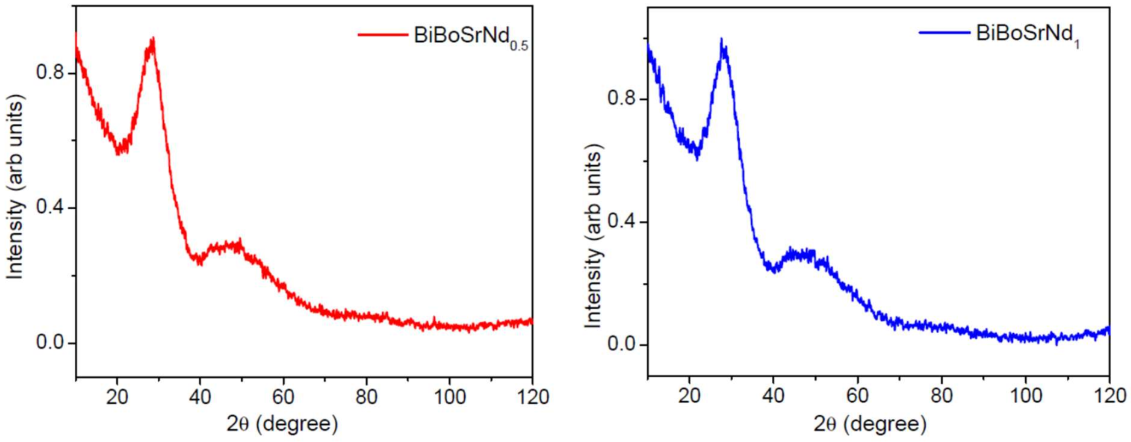


Figure 3. 7 X-ray Diffraction pattern for BiBoSrNd$_{0.5-1}$

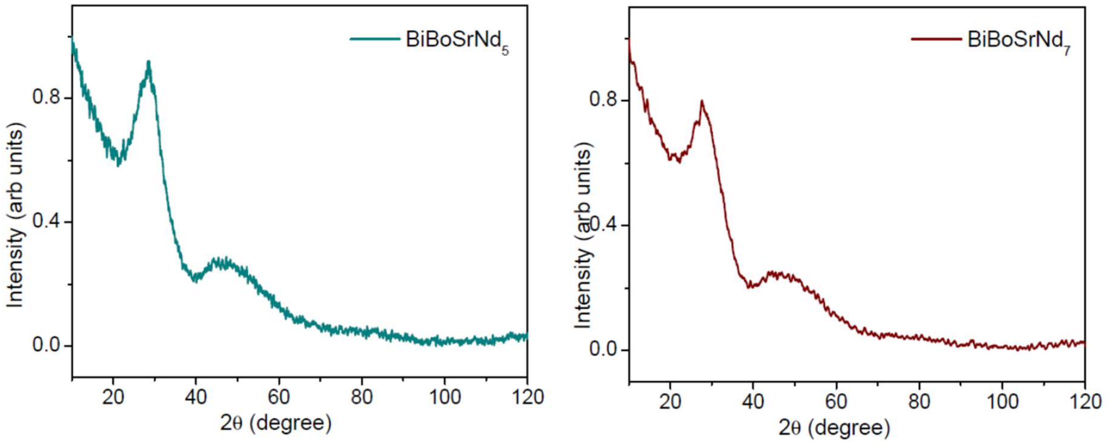


Figure 3. 8 X-ray Diffraction pattern for BiBoSrNd$_{5-7}$

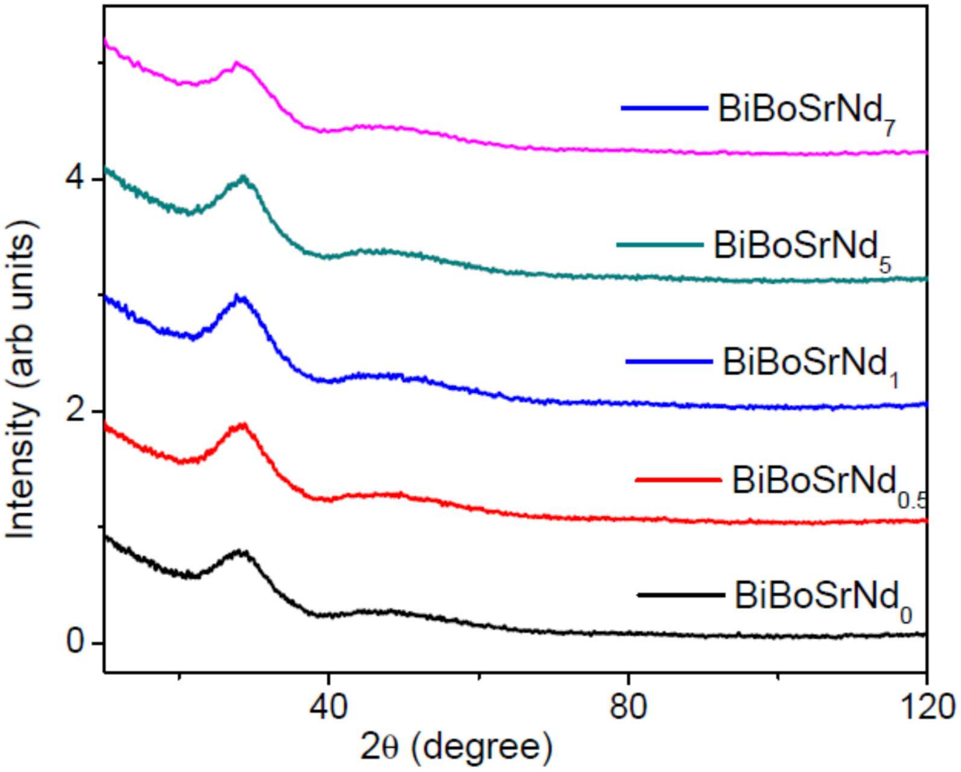


Figure 3. 9 The XRD pattern for Bi_2O_3-H_3BO_3 with no characteristic (sharp) peak

3.2.2 Infrared Spectroscopy

Infrared spectroscopy on glass samples provides information about the arrangement of the structural units of the glass samples. The infrared transmittance spectra have been recorded at room temperature on the Fourier transform infrared spectroscope in the frequency range 400 to 4000 cm^{-1} for all the glass samples. The FTIR spectra are shown in the figure (3.10). The fundamental absorption bands of borate glasses are clear at three principal bands the first band, which occurs between 800 and 1200 cm^{-1}, is due to the B–O bond stretching of tetrahedral BO_4 units. The second band that occurs between 1200 and 1600 cm^{-1} is due to stretching vibration of B–O of trigonal BO_3 units. The third band is observed around 700 cm^{-1} is due to the bending of various borate segments. The IR spectrum of the glass composition is shown in figure (3.10) to figure (3.14).

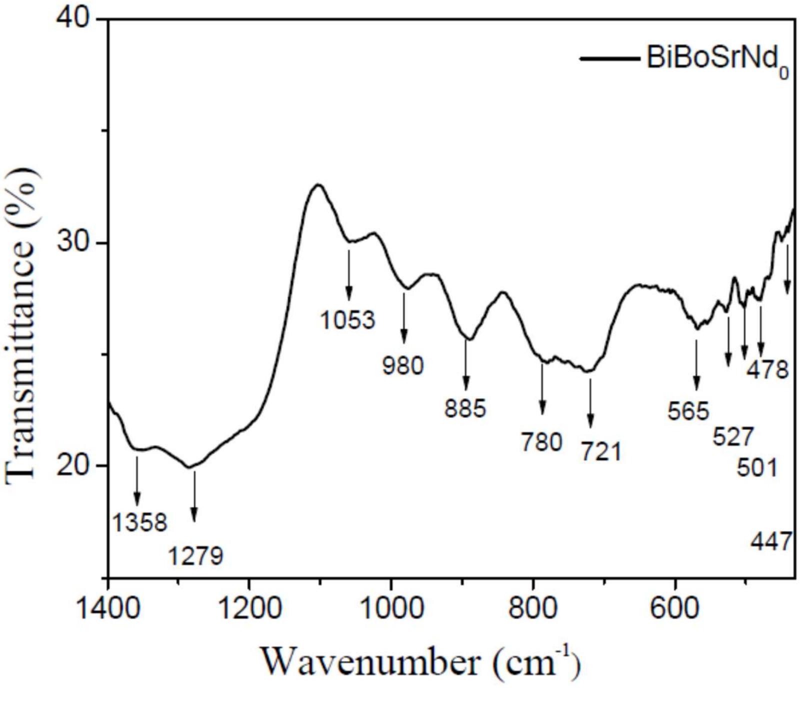


Figure 3. 10 FTIR spectra of the BiBoSrNd$_0$

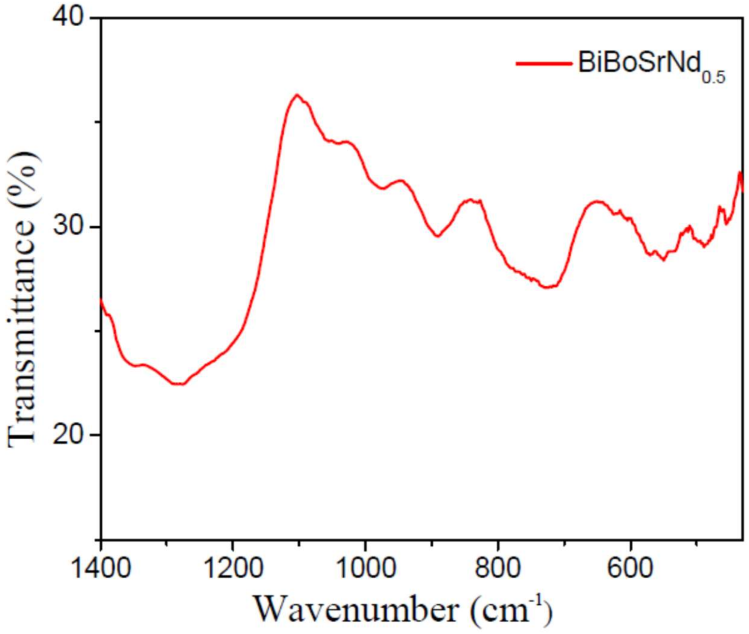


Figure 3. 11 FTIR spectra of the $BiBoSrNd_{0.5}$

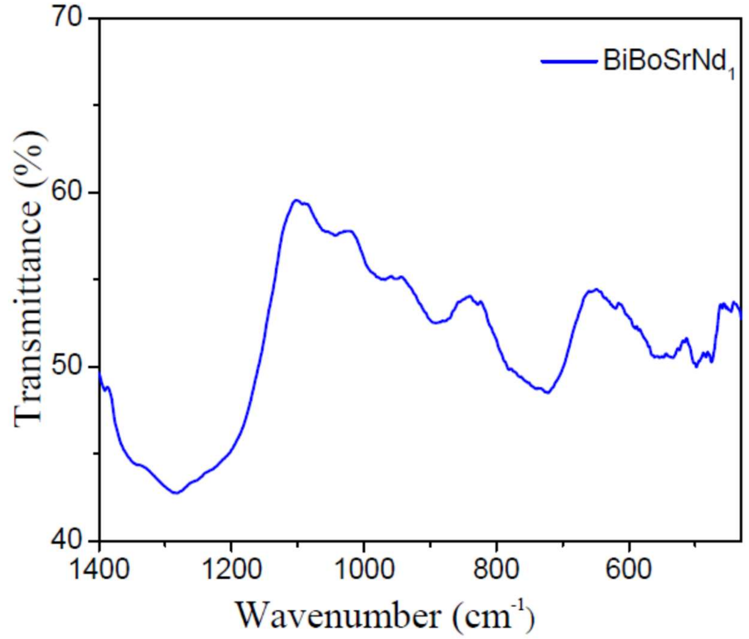


Figure 3. 12 FTIR spectra of the $BiBoSrNd_1$

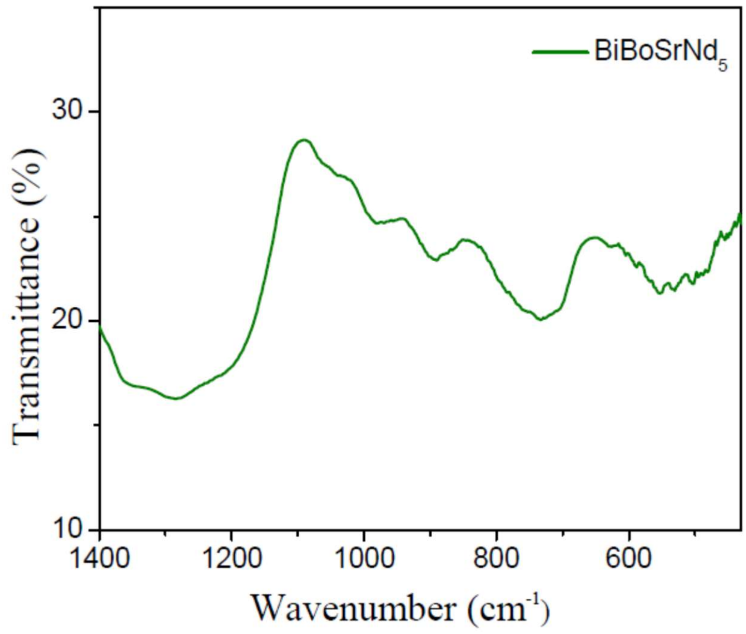


Figure 3. 13 FTIR spectra of the BiBoSrNd$_5$

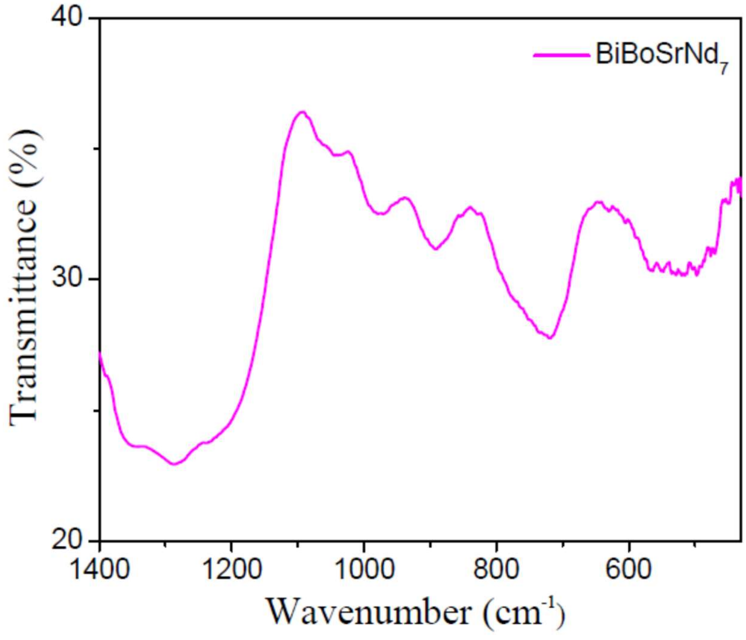


Figure 3. 14 FTIR spectra of the BiBoSrNd$_7$

Table 3 Observed Bands of the Different Composition of Glass Samples

Sr. No	Sample A	Sample B	Sample C	Sample D	Sample E	Assignment
	Wavenumber in cm^{-1}					
1	478	487	473	475	467	Bi-O-Bi stretching vibration of distorted octahedral BiO_6 units
2	527	527	533	527	530	Bending Vibrations of Bi-O bonds in strongly distorted BiO_6 octahedral units
3	565	570	565	553	567	Bending vibration of BO_4 unit Bi–O–Bi in BiO_6 octahedral
4	721	724	718	727	718	B-O-B bending vibration of trigonal and tetrahedral boron
5	885	891	891	894	891	Symmetric stretching vibration of the BO_4 unit
6	980	977	974	983	980	Symmetric stretching vibration of the BO_4 unit
7	1053	1053	1043	1039	1042	symmetric stretching vibration of the B-O bond.
8	1252	1226	1251	1215	1227	B–O stretching vibrations of BO_3 unit in metaborate chains and orthoborates
9	1279	1279	1282	1279	1285	B-O bond vibrations in BO_3 units

10	1358	1355	1346	1364	1352	B–O stretching vibrations of trigonal BO_3 units in metaborates, pyroborates and orthoborates

The analysis of IR spectra reveals following:

Infrared spectra collected from Bismuth lead borate sample (free from Neodymium) shows active peaks around 478, 565,721, 780, 885, 980, 1053,1252, 1279, 1358 cm^{-1}. The band at 478 cm^{-1}, 527 cm^{-1}and 565 cm^{-1} assigned to the Bi-O-Bi stretching vibration of distorted octahedral [BiO_6] units. The band at 721 cm^{-1} is due to B-O-B bending vibration of trigonal and tetrahedral. The band at 885 cm^{-1} and 980 cm^{-1} is due to stretching vibrations of tetrahedral BO_4 units The absorption band at 1053 cm^{-1} is due to the B-O stretching vibration of BO_4 tetrahedra, which is present as tetraborate and pentaborate groups. The absorption band at 1252 cm^{-1} and 1279 cm^{-1} was assigned to B–O asymmetric stretching vibrations in BO_3 unit from pyro- and ortho-borate groups. The band at 1358 cm^{-1} is assigned to the stretching vibrations of the B–O of trigonal BO_3 units in metaborates, pyroborates and orthoborates. It is observed that with inclusion of Neodymium with increasing concentration no dramatic changes seen in the spectrum as shown in (figure 3.8). In pure B_2O_3 glass, the 806 cm^{-1} frequency is a characteristic of boroxol ring. Absence of band around 806 cm^{-1} indicates absence of boroxol ring formation and substitution of this into triborate and tetraborate group is observed. It consists of BO_3 and BO_4 groups.

3.2.3 UV Visible

UV-Visible absorption spectra of rare-earth glasses were studied using a Shimadzu UV-2401PC spectrophotometer. The instrument covers a range of 300 to 800 nm and uses deuterium lamp is used as a source of UV light (200 to 400 nm) while tungsten-halogen lamp for the visible range (400 to 800 nm). The UV Visible absorbance spectra of prepared glasses dopped with Neodymium (stacked together) is shown in figure (3.15).

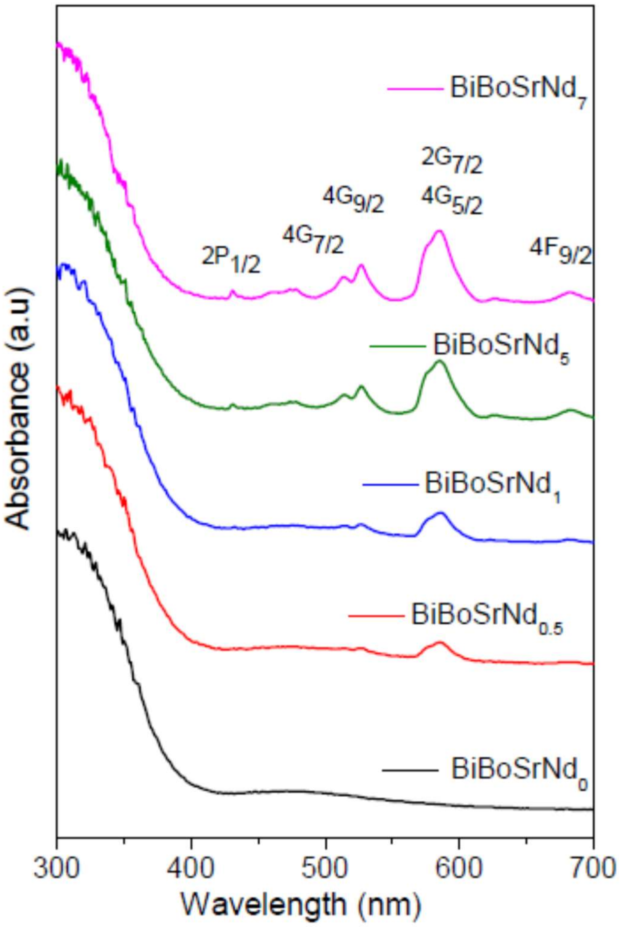


Figure 3. 15 UV Vis Spectra of Bi_2O_3-B_2O_3

The UV optical absorption edge is related to the light absorption due to electronic transitions in the material, using optical cut-off and was qualitatively estimated. We can determine the indirect or direct transition happening in band gap caused by optical absorption spectra at the fundamental absorption. The light waves interact with the electrons in the valance band, which are raised across the fundamental gap to the conduction band. In glassy materials a different type of optical absorption edge is observed. The Optical absorption spectra of the glasses in this study originates from the 4f electronic levels of the rare earth ions Nd. The optical absorption edges of Nd^{3+} doped in bismuth borate glasses are not sharply defined, this is in accordance with their amorphous nature (Chimalawong et al., 2010). Observed intensity increases with the increase in Neodymium concentration and depend on covalency and the asymmetry of Nd-O local structure among these host matrices. the spectra consist of various absorption levels corresponding to the transitions between the ground state and higher energy states. The absorption bands of Nd^{3+} correspond to transitions from the $^4I_{9/2}$ ground state to various excited levels. These transitions were assigned by comparing the band positions in the absorption spectra with a standard wavelength chart for the Nd^{3+} ion [18]. The various spectroscopic transitions observed are as follows: $^4F_{9/2}$ (686 nm), $^4G_{5/2} + {}^2G_{7/2}$(584 nm), $^4G_{9/2}$ (528nm) $^4G_{7/2}$ (515 nm) and $^2P_{½}$ (436 nm).

The optical band gap energy is studied using Tauc's plot and presented in Figures ().

It is found that there is a small increase band gap as the neodymium concentration is slightly increased.

Tauc plot is used to determine the optical band gap. Tauc plots shows $(\alpha h\nu)^2$ v/s $h\nu$. where α is the absorption coefficient of the material. The Tauc method assumes that the energy dependent coefficient α can be expressed by Davis-Mott relation (Davis and Mott (1970))

$$(\alpha h\nu)^{1/n} = B(h\nu - E_g)$$

where α is the absorption coefficient of the material, $h\nu$ is the incident photon energy, B is α energy independent constant known as the band tailing parameter, Eg is the optical band gap energy and n is an index which takes any of the following value:

1. n = 2 for direct allowed transition
2. n = ½ for indirect allowed transition
3. n = 2/3 forbidden direct transition
4. n = 1/3 forbidden indirect transition

$(\alpha h\nu)^2$ v/s $h\nu$ (photon energy) were plotted for each glass considering direct allowed transitions from valence to free states. The linear portion of the curve was extrapolated to the photon energy axis to obtain the optical band gap energy Eg as shown in Figure () and the obtained band gap energy is shown in table ()

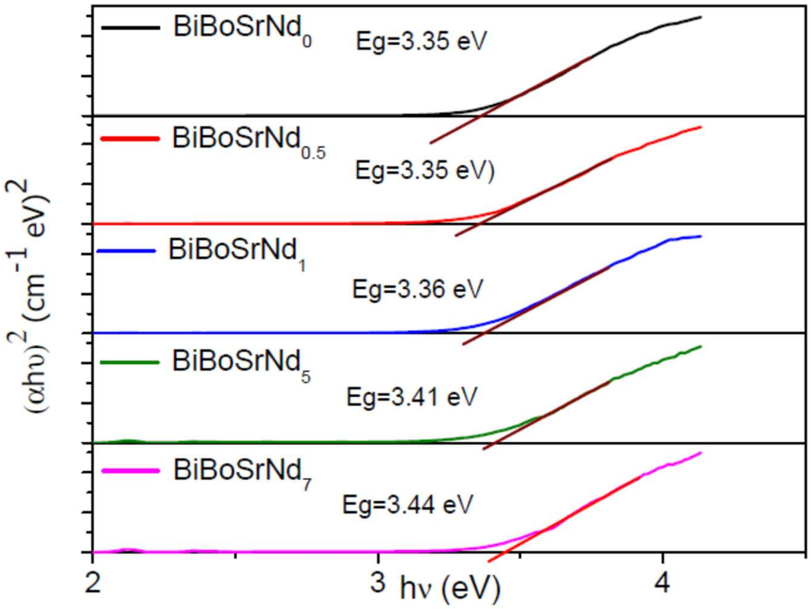


Figure 3. 16 Optical Band Gap of UV Vis Spectra Bi_2O_3-B_2O_3

Table 4 Optical band gap energy Eg

Sr. No	Sample	Band Gap in eV
1	$BiBoSrNd_0$	3.35
2	$BiBoSrNd_{0.5}$	3.35
3	$BiBoSrNd_1$	3.36
4	$BiBoSrNd_5$	3.41
5	$BiBoSrNd_7$	3.44

3.2.4 Raman spectroscopy

Raman Spectra of all the samples were collected using HORIBA Scientific with Labspace 6 software. we have used monochromatic incident wavelength of 532 nm and the wavelength ranging from 300-1700 cm^{-1}. the intensity was 5% with visibility of 10x. The acquisition time was 10 sec for the system at room temperature of 20 °C. The Raman spectra of Nd containing glass is shown below. Analysis will be carried out.

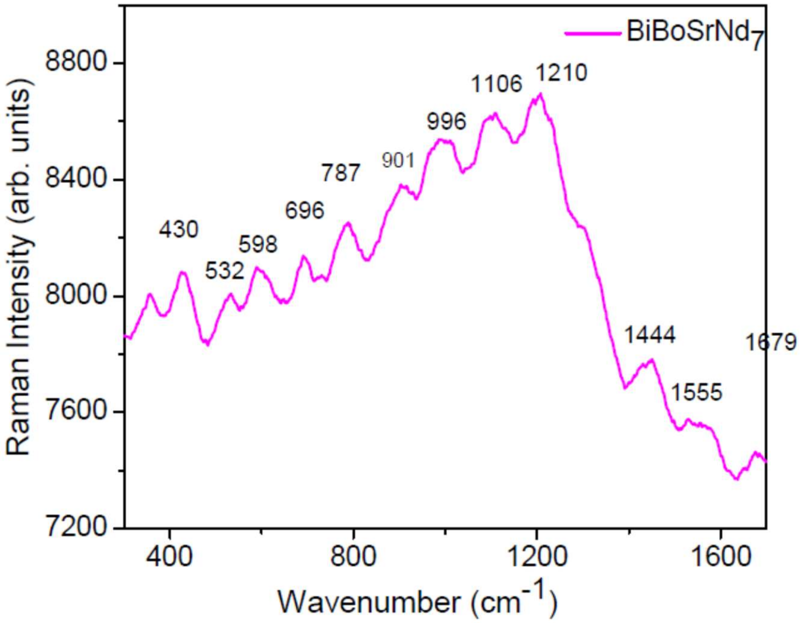


Figure 3. 17 : Raman spectra of $BiBoSrNd_7$

4 Conclusion

Glasses with borate as the host network along with Bismuth oxide and strontium oxide undoped and doped with Neodymium were synthesized by melt quenching method. Samples prepared were characterized by spectroscopic techniques; X-ray diffraction method, UV – Visible spectroscopy and IR spectroscopy

1. 60% (H_3BO_3)-20% (Bi_2O_3)-20%($SrCO_3$)-0% (Nd_2O_3)
2. 60% (H_3BO_3)-20% (Bi_2O_3)-18.5%($SrCO_3$)-0.5% (Nd_2O_3)
3. 60% (H_3BO_3)-20% (Bi_2O_3)-19%($SrCO_3$)-1% (Nd_2O_3)
4. 60% (H_3BO_3)-20% (Bi_2O_3)-15%($SrCO_3$)-5% (Nd_2O_3)
5. 60% (H_3BO_3)-20% (Bi_2O_3)-13%($SrCO_3$)-7% (Nd_2O_3)

The glasses were prepared by melt quenching method and the samples were characterized at room temperature. Following measurements were dome:

1. The X-ray diffraction were recorded Rigaku Smart-Lab diffractometer with incident CuKα (1.5406 A) radiation source at 40 to 50kV at 40 mA. The data was collected in the angular range from 10° to 120° in a step size of 0.02° and measuring speed was set to 5° per min.
2. Infra-red absorption spectra for all six samples were obtained on a Shimadzu 8900 Infra-red Spectrometer in the wave number range 400 cm^{-1} to 4000 cm^{-1}.
3. UV visible spectra obtained using SHIMADZU Spectrometer in the wavelength range from 200 to 700 nm.

The main conclusions drawn from the results of above studies are summarized below:

The densities of glass samples were found to be increased with concentration of neodymium which was as expected, since the density of chromium oxide is at a higher scale. The obtained glass is a totally amorphous material with only broad diffuse hump around low angle region at around 28° and second at 46° for all the samples. From the IR – spectra, all the samples show similar features at all frequencies. Hence, we can conclude that the presence of neodymium hardly affects the IR – spectra of the host borate. Peak at around $720cm^{-1}$ confirm the presence of **B – O – B** bond vibration mode. The band at 721 cm-1 is due to B-O-B bending vibration of trigonal and tetrahedra. It is observed that with inclusion of Neodymium with increasing concentration no dramatic changes seen in the Spectrum. In pure B2O3 glass, the 806 cm-1 frequency is a characteristic of boroxol ring. Absence of band around 806 cm-1 indicates absence of boroxol ring formation and substitution of this into triborate and tetraborate group is observed. It consists of BO3 and BO4 groups. Using UV Vis spectroscopy, we could see the absorption bands of Nd3+ correspond to transitions from the 4I9/2 ground state to various excited levels. These transitions were assigned by comparing

the band positions in the absorption spectra with a standard wavelength chart for the Nd^{3+} ion [18]. The various spectroscopic transitions observed are ${}^4F_{9/2}$ (686 nm), ${}^4G_{5/2}$ + ${}^2G_{7/2}$(584 nm), ${}^4G_{9/2}$ (528nm)

${}^4G_{7/2}$ (515 nm) and ${}^2P_{½}$ (436 nm).

The Strontium containing bismuth borate glass doped with different concentration of Neodymium was successfully synthesized by a melt quenching method. The attempt is made to investigate the effect of doping different concentration of Nd_2O_3 in the glass network. The characterization is carried out using XRD, FTIR, and UV Visible spectroscopy. These glasses can have potential application in Lasers.

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