CHAPTER I

INTRODUCTION AND REVIEW OF LITERATURE

INTRODUCTION

Ultrasonic Techniques

The mechanical longitudinal waves which are generated through the crystal are propagated through the matter - solid, liquid or gas. These waves may be divided roughly into the following classes according to their frequency:

(i) Infrasonic waves (below 20 Hz.)

(ii) Audible or sonic waves (between 20Hz to 20 kHz.)

(iii) Ultrasonic waves (between 20 kHz. to 1GHz)

(iv) Hypersonic waves (above 1GHz)

The term 'ultrasonic' is used to describe a vibrating wave of a frequency above that the upper frequency limit of the human ear; it generally embraces all frequencies above 20 kHz. Also, high amplitude ultrasonic waves are sometimes referred to as "sonic" [1]. Generally these waves are called as high frequency waves. The field of ultrasonics have applications for imaging, detection and navigation. The broad sectors of society that regularly apply ultrasonic technology are the medical community, industry, the military and private citizens [2].

Basic Theory for Ultrasonic Waves

Sound waves are simply organized mechanical vibrations travelling through a medium, which may be a solid, a liquid, or a gas. These waves will travel through a given medium at a specific speed or velocity, in a predictable direction, and when they encounter a boundary with a different medium they will be reflected or transmitted according to simple rules. This is the principle of physics that underlies ultrasonic flaw detection.

Of all the applications of industrial ultrasonic testing, flaw detection is the oldest and the most common. Since the 1940s, the laws of physics that govern the propagation of sound waves through solid materials have been used to detect hidden cracks, voids, porosity, and other internal discontinuities in metals, composites, plastics, and ceramics. High frequency sound waves reflect from flaws in predictable ways, producing distinctive echo patterns that can be displayed and recorded by portable instruments. Ultrasonic testing is completely non-destructive and safe, and it is a well established test method in many basic manufacturing, process, and service industries, especially in applications involving welds and structural metals.

Basic Theory of Pulse Echo Technique for Solids

Ultrasonic material analysis is based on a simple principle of physics: the motion of any wave will be affected by the medium through which it travels. Thus, changes in one or more of four easily measurable parameters associated with the passage of a high frequency sound wave through a material transit time, attenuation, scattering, and frequency content can often be correlated with changes in physical properties such as hardness, elastic modulus, density, homogeneity, or grain structure. Ultrasonic Inspection is a very useful and versatile NDT method. Ultrasonic nondestructive testing is a versatile technique that can be applied to a wide variety of material analysis applications. While ultrasonic NDT is perhaps better known in its more common applications for thickness gaging, flaw detection, and acoustic imaging, high frequency sound waves can also be used to discriminate and quantify some basic mechanical, structural, or compositional properties of solids and liquids.

Non-destructive ultrasonic pulse-echo technique for solid material is considered as one of the best technique for studying the microstructure, characterization, mechanical properties as well as evaluating the elastic constants and attenuation coefficient of glasses.

Ultrasonic pulse echo technique was used in the present study for measurement of the longitudinal and shear ultrasonic velocities in the glass samples.

There are two methods of receiving the ultrasound waveform that is reflection and attenuation. In reflection (or pulse-echo) mode, the transducer performs both the sending and the receiving of the pulsed waves as the "sound" is reflected back to the device. Reflected ultrasound comes from an interface, such as the back wall of the object or from an imperfection within the object. The diagnostic machine displays these results in the form of a signal with an amplitude representing the intensity of the reflection and the distance, representing the arrival time of the reflection. In attenuation (or through-transmission) mode, a transmitter sends ultrasound through one surface, and a separate receiver detects the amount that has reached it on another surface after travelling through the medium. Imperfections or other conditions in the space between the transmitter and receiver reduce the amount of sound transmitted, thus revealing their presence. Using the couplant increases the efficiency of the process by reducing the losses in the ultrasonic wave energy due to separation between the surfaces.

Introduction to Solid (Glass) material

Glass is now recognized as the one of the best scientific material in the branch of materials science due to its various applications. The exploitation of the electronic conducting property of many glasses is arguably the high tech development of the two decades. This is the only area of glass science so for where a Noble prize has been awarded. Nowadays glasses have a prominent role in the field of electronics and have wide applications in industry, space research, computer memories. In communications, we observe an evolution from electronic to optical to wireless technologies of particular interest are opportunities in low loss optical fibre, optical amplifiers and bend insensitive fibre.

Glass is a wonderful material that has found widespread application in our daily life, such as container glass, window glass, liquid crystal display substrate, and optical fiber. The importance of a variety of non-silicate glasses has also been recognized, such as chalcogenide glasses. It is a homogeneous material with a random, non-crystalline molecular structure. The manufacturing process requires that the raw materials be heated to a temperature sufficient to produce a completely fused melt, which, when cooled rapidly, becomes rigid without crystallization. Glass is a fourth state of matter that combines the rigidity of crystals with the random molecular structure of liquids [3].

Glasses are super cooled liquids, transparent, and amorphous in nature. They are inorganic product of fusion which has cooled to a rigid condition without any crystallization. The main distinction between glass and crystals is the presence of long-range order in the crystal structure [3]. The optimization of such properties as a function of composition and other processing parameters requires a good knowledge of the microscopic glassy structure.

During the past sixty years, there has been an expansion in the use of glass for technical purpose, which has been astonishing, even to those closely associated with the glass industry. To meet the steadily increasing challenge of varied applications, at present nearly five hundred different glass compositions are in commercial use, exclusive of optical glass. Special techniques have been developed for the manufacture of new composition and processes discovered for achieving unusual properties, for examples, the technique of tempering of the glass to increase its mechanical and thermal strength. Among later development, photo sensitive glasses and chemical machining processes are at standing. The most recent development, the conversion of special glasses in to glass-ceramic materials, present tremendous applications in future [4].

Recently considerable attention has been focused on the development of new glass with special properties like machinability, sensor and detectors etc. Glass will be prepared

though melt quenching technique. Scientific study of glass began with Faraday and others at the beginning of the nineteenth century and today it is still rapidly developing subject both in the invention of new glass with characteristics properties and their applications. The new scientific techniques to improve our understanding of the structure and behaviour of glass [5].

In the recent past, the technological applications have created enormous interest on the studies of oxide glasses. The most important part of the study on the studies of oxide glasses containing transition metal ions shows non-linear behaviour, which has applications in solid state devices, electrochemical, electric and electro-optic devices and non-linear optical parametric converters. Transition metal ions are known to influence the optical, electrical and magnetic properties of glasses due to their high sensitive response to the changes in the surrounding cations and their ability to posses more than one valence state. A host of borate rich glasses containing alkaline earth oxides along with ZnO, PbO, TeO_2 Bi_2O_3, MgO, CaO, SrO, and BaO as glass modifiers are optimistic materials for their probable applications in the fields of optical communications (optical fibres), laser hosts, optical filters, X- and γ-ray absorbers, photonic devices, and so forth [6-14].

In the semiconductor industry, feature sized on computer chips, as represented by conductor line widths, are decreasing is several steps from 130 nm to below 45 nm. The photo litho graphic tools needed to accomplish this degree of resolution require exposures using wavelengths decreasing from 248 nm laser, through 193 nm laser, to extreme UV reflective technologies. A significant technological challenge has been the development of materials for the illumination and focusing optics for the elaborate, multi lens exposure system. The optical materials must have exceptionally low absorption through billions of laser pulses, without suffering dimensional or stress changes. Various specially engineered

version of high purity fused silica (SiO_2) and alkaline earth fluoride crystals have been developed to meet the requirements.

The highly complex energy industry also provides many opportunities for glassy materials. Some examples include sealing materials for solid oxide fuel cells, nuclear waste storage materials, low weight durable materials for wind turbines, and in the solar power area, high temperature substrate for solar cells, silicon on glass and material for solar mirrors and concentrators.

In the present thesis, glass work deals with Elastic, Mechanical, Structural, Optical, Vibrational and Thermal studies of Na_2O-CaO-P_2O_5-B_2O_3 : CuO glasses.

Glass former oxides

B_2O_3 is considered as basic glass former because it has smaller heat of fusion, lower cation and higher bond strength. Boric oxide, B_2O_3, acts as one of the most important glass formers and flux materials. Melts with compositions rich in B_2O_3 exhibit rather high viscosity and tend to formation of glasses. B_2O_3 can form the glasses at low melting point, with high transparency, high thermal stability [15, 16].

Phosphorus pentoxide (**P_2O_5**) acts as one of the most important glass former and flux materials. Phosphate glass exhibit very important physical properties such as low melting temperature, high thermal expansion coefficient, low glass transition temperature, low softening temperature and high ultraviolet (UV) transmission [17, 18]. Despite their solubility, the lower processing temperature has led these glasses to be used in applications such as glass to metal seals, low temperature enamels for metals and for optical elements [19]. On phosphate-based glasses, several works have been carried out in the last decade, especially concerning an optimization of glass preparation, investigation of their properties and information about the glass structure. Phosphates glasses with various compositions are

of exceptional importance due to their interesting linear and nonlinear optical properties [20, 21].

Network former oxides

Na_2O acts as flux. Fluxes are used to reduce the processing temperature of the glasses, for stability and for the improvement in the glass formation. **Na_2O, CaO** - These oxides their own glass network do not form, change properties of glass drastically hence these oxides are also called property modifiers the addition of fluxes degrades the glass properties and hence to counteract their degradation the property modifiers.

Colorants

CuO in glasses is mainly used as a pigment. Depending on its concentration and glass composition CuO colours it light blue or blue-green by means of the ionic coloration [22]. Copper phosphate glasses have interesting electrical conduction and optical absorption in the visible, resulting in coloration of the glass. Copper in sodium Borophosphate glasses have improved chemical durability. So copper contribute to the stabilization of the glass structure.

Application of glasses

Glasses are optically transparent and typically brittle understanding the relationship between glass composition thermal history, handing and properties of the glass is essential for the production of reproducible high quality products with exact desired properties for a given application. The glasses of various types find fascinating applications in wide variety types of fields. Glasses are used in the wide variety of dental products wiz fillers in composite resin materials, dental cements and dental crown in addition, brides and glass ceramics for dental prosthetics. Bioactive glasses are also under research for use in repair of bones.

Many devices require formation of seals between the glasses and other glasses, metals or ceramics, solder glasses are applied as frit. Sol-gel glasses have been the subject of a considerable research for applications involving either film/ fibre formation. The application of glasses can be summarised as follows:

Chemical: Laboratory wave including tubes , test tubes, volumetric wave , round joints , stop cocks and special cylinders, tanks , jars, heat , exchanges.

Thermal: Heat absorbing flat glasses of double glazed windows, furnace window cores, linings, thermocouple protection tubes, thermometer tubes, fabric for heat and cold insulation garments.

Structural: Window glass and plate glass, temperate flat glass for doors windows, laminated safety glass windshields, building blocks.

Electrical and electronic: Envelops and tubing for radio receiving, power tubes for cathode rays, television cameras and X-ray tubes, special glass for metal seals, for glass bushing, resistors, capacitors.

Lightning and light filters: Envelops for incandescent lamps for light projection and photographic lamp envelops for sodium vapour lamps. Fluorescent tube light and neon tubes, clear opal and colour glasses to control light by diffusion, ultraviolet filters and bulbs for heating drying lamps.

Miscellaneous: Blue printed sheets and cylinders, lubricators and oil cups, precision bore tubing for precision instruments, glass containers of all shapes and sizes for food and beverages, household and industrial chemical ware and cosmetics.

Automobiles: The automobiles use glasses in various forms comprising of the head lights, for lights, window panes etc.

Basic Theory of Ultrasonic Interferrometer method for Liquids

An Ultrasonic Interferometer is a simple and NDT device to determine the ultrasonic velocity in liquids with a high degree of accuracy. The principle used in the measurement of velocity (ν) is based on the accurate determination of the wavelength (λ) in the medium. Ultrasonic waves of known frequency (*f*) are produced by a quartz crystal fixed at the bottom of the cell. These waves are reflected by a movable metallic plate kept parallel to the quartz crystal. If the separation between these two plates is exactly a whole multiple of the sound wavelength, standing waves are formed in the medium. This acoustic resonance gives rise to an electrical reaction on the generator driving the quartz crystal and the anode current of the generator becomes a maximum.

The propagation of ultrasonic waves in liquids and liquid mixtures provides much insight into the problems of basic physics, and finds large number of industrial, biological, chemical and medical applications by characterizing thermodynamic and physico – chemical behaviour of liquid mixtures. The measurement of ultrasonic velocity enables the accurate determination of some useful acoustical parameters which are highly sensitive to the study of molecular interactions. These acoustical parameters provide qualitative information about the physical nature and strength of the molecular interactions in the liquid mixtures. Acoustical and thermodynamic parameters have been used to understand different kinds of association, the molecular packing, molecular motion and their respective strength influenced by the size in pure components and in the mixtures.

The measurement of sound velocity provides a convenient means for determining certain properties of fluids, which are not easy to measure using other methods. The velocity measurement provides an important tool to understand the intra and inter molecular interactions in liquids. Ultrasonic techniques of liquid mixtures consisting of polar and non-

polar components are of considerable importance in understanding the intermolecular interactions between the component molecules.

Ultrasonic velocity together with density and viscosity data furnish sufficient information about the sum of total interactions between ions, dipoles, H-bonding, multi-polar dispersion forces and elastic forces. Hence, this technique seems to be complementary to spectroscopic and dielectric methods. The study of molecular interaction plays an important role in the development of molecular sciences.

The study of intermolecular interactions is of considerable importance in the elucidation of the formation of complexes and plays an important role in the liquid mixtures. The intermolecular interactions influence the structural arrangement along with the shape of molecules. In the case of liquid mixtures, the interactions so far reported between like as well as unlike molecules, such type of intermolecular interactions can be classified into two type viz., long range and short range. The long range intermolecular interaction arises when there is no overlapping of electron clouds of the interacting molecules and is due to electrostatic induction and dispersion forces. The short range interactions are due to dipole-dipole, dipole-induced dipole, charge transfer, complex formation and hydrogen bonding interactions. These forces arise when the molecules come close enough together causing a significant overlap of electron clouds and are often highly directional.

The long-range interaction leads to the existence of Vander Waals' force between the molecules in a liquid, which is the main reason for the behaviour of the liquid. The hydrogen bonding arises from short range interactions and this can be augmented by the fact that hydrogen bond distance is smaller than Van der Waals' radii.

Introduction to Liquids

Liquids in pure form have wide range of applications that includes automotives, pharmaceuticals, agrochemicals etc. However, mixtures of pure liquids (binary/ternary) have

been preferred in a number of engineering and scientific applications such as chemical industries, engineering design and for subsequent operations, heat transfer, mass transfer and fluid flow. Furthermore, mixing volume effects of mixtures received greater attention from both theoretical as well as practical applications which include paints, varnishes and printing ink industries. Thus the research work on pure liquids and liquid mixtures are never ending. The intermolecular interactions in pure liquids and binary/ternary mixtures are estimated by various physical methods such as Infrared (IR), Raman effect, Nuclear magnetic resonance (NMR), Dielectric, Ultraviolet (UV) and Ultrasonic method. Among these, ultrasonic method was found to be accurate and sensitive and used by many researchers in the past, to elucidate molecular interactions in liquids and in binary/ ternary mixtures. Ultrasonic is an area of intense scientific and technological research. In view of its extensive scientific and engineering applications, it has drawn attention of large cross section of students, teachers, researchers, non-destructive testing (NDT) professionals, industrialists, technologists, medical researchers, instrumentation engineers, software engineers, material scientists and others. Ultrasound, a mechanical wave, which interacts with matters with a variety of wave modes, longitudinal to several surface waves, which is possible for diverse applications. Ultrasonic started from the basic subject of sound in physics and now represents a vast field of its own with several branches and sub-branches of scientific pursuit and technological importance.

In order to get more information about the nature of the molecular interactions it is necessary to calculate certain acoustical parameters such as adiabatic compressibility, free length, free volume and internal pressure. The non-linear variation of these parameters with concentration of the solute may be explained on the basis of structural changes occurring in a liquid mixture.

Ultrasonic propagation parameters yield valuable information regarding the behaviour of liquid ternary systems because intramolecular and intermolecular association, dipolar interactions, complex formation and related structural changes affect the compressibility variations in the ultrasonic velocity . Ultrasonic methods find extensive application owing to their ability of characterizing the physico-chemical behaviour of liquid systems from velocity data. Thermodynamic studies in liquids and liquid mixtures play an important role in understanding the nature of molecular interactions. The size, shape and polarity of molecules play an important role in molecular interactions. The interaction is characteristic of a class of liquids showing pronounced structural properties.

The knowledge of the structure and molecular interaction of liquid mixtures is very important from fundamental and engineering point of view. Fundamental thermodynamic and thermo physical properties are essential sources of information necessary for a better understanding of the non-ideal behaviour of complex systems because of physical and chemical effects, which are caused by molecular interactions, intermolecular forces, *etc*., of unlike molecules. From a practical point of view, these properties are necessary for the development of thermodynamic models required in adequate and optimized processes of the chemical, petrochemical, pharmaceutical and other industries. In addition, extensive information about structural phenomena of mixtures is of essential importance in the development of theories of the liquid state and predictive methods. The concentration and temperature dependence of acoustic and volumetric properties of multicomponent liquid mixtures has proved to be an useful indicator of the existence of significant effects resulting from intermolecular interactions. Mixed solvents are frequently used as media for many chemical, industrial and biological processes, because they provide a wide range of desired properties. Temperature dependence of transport properties is of valuable importance in understanding the molecular behaviour in binary liquid mixtures. Derived parameters from

ultrasonic speed measurements and the corresponding excess functions provide qualitative information regarding the nature and strength of interactions in liquid mixtures.

The ultrasonic studies are extensively carried out to measure the thermodynamic properties and predict the intermolecular interactions of ternary mixtures. From the values of thermo-acoustical parameters and excess thermodynamic functions were used to investigate the nature, type and strength of intermolecular interactions present in the ternary mixtures.

In the present thesis, liquid work deals with the molecular interaction studies amounting to complex formation in ternary solutions of Methylbenzene (toluene), 2,2,4-trimethylpentane (isooctane) with 1-propanol, 1-butanol, 1-pentanol and 1-hexanol at Temperature (303, 308, 313) K.

Methylbenzene (toluene) is an important precursor to synthetic drugs & also a non-polar common solvent. 2,2,4-trimethylpentane (isooctane) was easily mix with other compounds. It is also a non-polar solvent. 1-alkanols are polar liquids, strongly self-associated by hydrogen bonding to extents of polymerization that may differ depending upon temperature, chain length and position of the OH group. Alkanol size, chain length etc., (which is related through density and velocity) are important parameters that must be taken into account to explain the behavior of the Toluene, Isooctane with 1-alkanols mixtures.

Application of liquids

Methylbenzene (toluene)

Toluene occurs naturally at low level in crude oil. Toluene is a common solvent, e.g. for paints, paint thinners, silicon sealants, many chemical reactants, rubber, printing ink, adhesive (glues), lacquers, leather tanners and disinfectants. Toluene can be used as an octane booster in gasoline fuels for internal combustion engines.

2,2,4-trimethylpentane (isooctane)

Isooctane is produced in the petroleum industry by distillation of petroleum. Isooctane or 2, 2, 4-Trimethylpentane is mainly used in the production of gasoline. When added, it reduces engine knocking.

1-alkanols (propanol, butanol, pentanol, hexanol)

Alkanols have applications in industry and science as reagents or solvents. Because of its relatively low toxicity compared with other alkanols and ability to dissolve non-polar substances. In organic synthesis, alkanols serve as versatile intermediates.

Introduction to Semi-empirical theories for sound velocity in Liquids

The ultrasonic velocity measurements play an important role in understanding the molecular interaction between the components of the mixtures and provides an insight into the physico-chemical properties of liquid mixtures such as molecular association and dissociation as well as the strength of interaction between the components successful attempts have been made in recent years on the theoretical evaluation of ultrasonic velocity and its correlation with other thermodynamic properties in ternary liquid mixtures using statistical and semi-empirical theories. Further, the best suitable theory for the given molecular system under study is also done by calculating the average percentage error.

Theoretical work have been correlated the experimental ultrasonic velocities with the Semi-empirical models such as Nomoto's Relation (NR), Impedance Dependance Relation (IDR), Vandeal-Vangeel's Ideal Mixing Relation (IMR), Free Length Theory (FLT), Collision Factor Theory (CFT) and Junjie's Relation (JM) at room temperature.

REVIEW OF LITERATURE

Tsvetan Vassilev *et. al.,* (2016) have explained glass transition temperatures and structures of Na_2O-B_2O_3-SiO_2-Al_2O_3 glasses. DSC and FT-IR characterizations were carried out. A detailed analysis of the infrared spectra reveals that at constant total content of the glass-forming oxides (B_2O_3, SiO_2 and Al_2O_3) in the glasses investigated, the borate network progressively depolymerizes when Na_2O is substituted for PbO.

Z.Y. Yao *et. al.,* (2016) have analysed Structure and mechanical properties of copper–lead and copper–zinc borate glasses. Structural characterization was done by optical absorption, electron spin resonance (ESR), Raman and infrared (IR) spectroscopy. The mechanical properties were investigated through in-depth instrumented indentation and mechanical resonance analyses. Elastic moduli and hardness in the lead borate glass series, but a decrease of these properties in the copper–zinc borate glasses, whereby copper–zinc borate glasses are stiffer and harder than copper–lead borate glasses.

Ashok Bhogi *et. al.,* (2015) have investigated the effect of alkaline earths on spectroscopic and structural properties of Cu^{2+} ions-doped lithium borate glasses. Structural studies carried out by XRD. Spectroscopic studies such as optical absorption, EPR and FTIR were used. The FTIR studies showed that these glasses are made up of BO_3 and BO_4 units. The variation of optical and spectroscopic parameters was discussed in terms of the ionic radius of alkaline earth metal modifier.

Asha Rajiv *et. al.,* (2014) have explained thermal and optical properties of (80-x) $NaPO_3$-20ZnO-xNd_2O_3 glass system. Density, glass transition, refractive index, optical absorption and photoluminescence properties were investigated. The results found that the correlation of the refractive index to the density and electronic polarizability of the glass. The optical studies showed that these glasses are suitable as laser materials. The structural

and absorption properties helped to understanding the radiative and non-radiative phenomena. The luminescence spectra had transitions in the range of $^4F_{1/2}$ to $^4L_{9/2}$ and $^4F_{3/2}$ to $^4L_{11/2}$ which makes it suitable for lasing applications.

H. Sinouh *et. al.,* (2014) have analysed BaO effect on the thermal properties of the phosphate glasses inside the Na_2O-SrO-TiO_2-B_2O_3-P_2O_5 system.Characterization techniques of the glasses used by XRD, SEM, DSC, density and microhardness measurements. XRD and SEM showed the crystalline kinetics of glasses. The calculated values for the avarmi parameter indicated that surface crystallization was the dominant crystallization mechanism.

Armando Mandlule *et. al.,* (2014) have investigated the changes in structure and thermal properties of P_2O_5-CaO-Na_2O ternary glass system. Structurre and thermal properties were studied by Raman spectra, DTA, DSC and density measurements. Glass density and molar volume decreased with increasing modifier content, owing to a more densely packed glass structure. Increasing concentration of the non-bridging oxygens with increasing modifier content resulted in a pronounced increase in glass transition temperature.

Refka Oueslati Omrani *et. al.,* (2014) have reported structural and thermochemical study of Na_2O-ZnO-P_2O_5 glasses. Glasses were analysed by Inductively Coupled Plasma (ICP), Measurement of density, DSC investigations, Calorimetric dissolution, FT-IR, Raman and NMR spectroscopies. Structural investigations showed the conservation of linear chains which can be related to the monotonic variation of the endothermic dissolution phenomenon over all the glass composition range.

W.J. Gawande *et. al.,* (2014) have explained synthesis and characterization of CuO-MnO-B_2O_3 glasses. Glasses were characterized by XRD and DTA. XRD results showed that the glasses are perfectly amorphous in nature and from the DTA analysis, the values of glass transition temperature and glass melting temperature are found to be composition dependent.

N. Sdiri *et. al*., (2014) have presented the effects of substituting P_2O_5 and B_2O_3 on the thermal and optical properties of sodium borophosphate glasses. Structural, thermal and optical properties were studied by XRD, DSC, Raman spectra, Optical absorption spectra and Photoluminescence. DSC measurements showed that the substitution of P_2O_5 and B_2O_3 improves the thermal shock resistant of the glasses. Raman spectroscopy showed that the addition of B_2O_3 causes the formation of B-O-P, which are responsible for more rigid borophosphate glass network.

Yutawa Fujimoto *et. al*., (2013) have explained luminescence properties and radiation response of sodium borate glasses scintillators activated with Pb^{2+}, Cu^{+}, V^{5+}, W^{6+} and Yb^{3+}. Glasses were characterized by Optical absorption, photoluminescence and decay time measuring.,An irradiated pulse spectra, Cu^{+} doped glass demonstrated the highest scintillation output in the glasses.

Khamirul Amin Matori *et. al*., (2013) have analyzed the elastic properties of $(PbO)_x(P_2O_5)_{1-x}$ phosphate glass. Elastic properties were studied by sound wave velocity measurement. Density was measured by using Achimedes principle. The addition of PbO and decrease of the P_2O_5 in the glass network caused the densities to increase, which indicated that the Pb2+ acts as a network modifier, altering the structure of the glass by reducing the NBOs in the network and causing the structure to be more compact.

Sunil Thomas *et. al.,* (2013) have determined the spectroscopic and dielectric studies of Sm^{3+} ions in Li_2CO_3-H_2BO_3-ZuF_2-Sm_2O_3 glasses. Thermal stability, amorphous nature and vibrational modes of lithium borate glasses have been studied by using Differential Scanning Calorimetry, X-ray diffraction and Fourier Transform Infrared Spectroscopy. From the FT-IR results, OH absorption is comparatively very weak due to the presence of fluorine in the glass matrix. Thus the proposed glass matrix meets the requirement of very low OH group content to achive optimum laser performance.

Papia Haque *et. al.*, (2013) have investigated the degradation properties and microstructural analysis of $40P_2O_5$ – 24MgO-16CaO-$16Na_2O$-$4Fe_2O_3$ phosphate glass fibres. Mechanical properties of the glass were determined by varying the fibre diameter which was observed using XPS. Surface of fibres characterized by XRD, FT-IR , DSC and SEM. Degradation rate, microstructures and thermal stability of the glass are discussed.

F.A. Moustafa *et. al.,* (2013) have studied the effect of gamma radiation in UV, visible and infrared studies of borate glasses with $xR_2O.(100\text{-}x)B_2O_3$ where R=Na, K were coloured by doping with one of the trasnsition metal ions Ni, Cr, Fe or doping with mixing of them. The induced absorbtion spectra exibit the characteristic absorbtion bands caused by the intrinsic base borates glasses and the respective trasition metal ions.

Sk. Mahamuda *et. al.,* (2013) have determined the spectroscopis properties and luminescence behavior of Nd^{3+} doped zinc alumino bismuth borate glasses. They studied physical, absorption and luminescenc properties to understand the lasering potentialities of glasses using X-ray diffraction, UV and photoluminescence. From the absorption and emission studies, the glasses to generate a strong laser emission at 1060 nm.

G. Rama sundari *et. al.,* (2013) have reported the glasses of 19.9ZnO – xLi_2O – $(30\text{-}x)Na_2O$ – $50B_2O_3$ ($5<x<25$) doped with Fe_2O_3. Physical and spectroscopic investigations are studied using X-ray diffraction, FT-IR, UV and Electron paramagnetic resonance (EPR) spectra. From the physical and spectroscopic studies, they concluded that the prepared glass samples are found to be strong and stable in structure.Absorption and FT-IR spectra exhibited characteristic bands of Fe^{3+} and vibrations of BO_3 and BO_4 units.

Simon Striepe *et. al.,* (2013) have prepared xNa2O-10CaO-(90-x)B2O3 glasses. Elastic and Micromechanical properties were studied using ultrasonic and vicker's indentation techniques. Finally the calculated elastic parameters are correlated with changes in glass samples. The compression results in a compaction of the overall network and an

increase in the atomic packing factor. The elastic moduli increases linearly with the degree of compression and density of the compressed glasses.

R.V. Barde and S.A.Waghuley (2013) have studied the AC electrical properties of V_2O_5-P_2O_5-B_2O_3-Dy_2O_3 glasses. The prepared glasses were analysed by X-ray diffraction and Thermo gravimetric – Differential thermal analysis (TG/DTA). From XRD and TG/DTA results, they concluded the amorphous and excellent stability of the glasses. The AC conductivity results indicate that at the high temperature, the sample is more conductive.

T.G.V.M. Rao *et. al.,* (2013) have determined optical and structural investigation of Eu^{3+} doped with MgO-PbO-B_2O_3-SiO_2-Nd_2O_3 glasses. Optical and structural characterizations are carried out by UV-VIS, Photoluminescence, FT-IR and X-ray diffraction. XRD spectra reveal that these glasses have amorphous nature. Optical absorption and luminescence spectra reveals that modification of the intensities of the bands due to the ion-ion interaction and intensive stable luminescence bands are observed $^5D_0$ – $^7F_2$, $^5D_0$ – $^7F_4$.

S. Rada *et. al.,* (2013) have reported the physical properties and electrochemical performance of xMoO_3 – (100-x)[7GeO_2-3PbO] glasses. Glass samples are characterized by FT-IR, UV-VIS and EPR. Spectroscopic studies indicated that causes the depolymerization of host glass matrix. Optical studied shows that the structural modifications in the glass matrix. EPR spectra observed the hyperfine structure of Mo ions with increase of MoO_3 content. The electrochemical performance were demonstrated by cyclic voltammetry.

M.S. Gaafar *et. al.,* (2013) have studied structural and mechanical properties of some borate glasses doped with different alkali and cobalt oxides. Elastic properties and FT-IR spectroscopic studies have been employed to study the role of CoO and mixed alkali effect on the structure of the glass system. Infrared spectra of glasses revealed that the borate network was affected by the increase in the concentration of CoO content and mixed alkali

oxides. Elastic moduli were observed to increase with the increase of CoO due to the increased average bond connectivity.

R. Ezhil Pavai and C. Tirumal (2013) have analysed FTIR and ultrasonic investigations on B_2O_3-BaO-CuO glasses. Elastic moduli, Poisson's ratio and Debye temperature have been calculated using ultrasonic velocities and density measurements.The IR measurements revealed an existence of trigonal BO_3 pyramid, tetrahedral BO_4, Cu-O and Cu^{2+}-O structural units in the network of the investigated glass. Decrease in density and increase in molar volume with increasing CuO content reveals that formation of non-bridging oxygen in the structural network.

S. Tirumaran and N. Karthikeyan (2013) have submitted structural elucidation of some borate glass specimen by employing ultrasonic and spectroscopic technique. Ultrasonic and Spectroscopic studies were carried out by studying the ultrasonic velocities, FT-IR and SEM. The results are concluded in the light of the role of borate glasses in the formation of glassy structural network.

P. Vasantharani and N. Sangeetha (2013) have presented characterization of Lead based binary and ternary glass systems using spectroscopic methods. Characterization of glasses was carried out using FT-IR, XRD and SEM analysis. From FT-IR studies, the intensity of the absorption bands suggests that the structure of glass matrix is very strong and stable in PB compared with PBC system by the little influence of copper ions.

Hamdan *et. al.,* (2012) have investigated optical and ultrasonic properties of Chromium Oxide in Sodium Zinc Phosphate glass. Characterization of glassy materials were carried out by XRD and FT-IR. Ultrasonic compression and shear wave velocity measurements were made by pulse-echo technique. From the results this type of glass doped with Cr_2O_3 as Acsto-optical Q-switching in laser devices.

K. Srinivasulu *et. al.,* (2012) have determined the spectral studies on Cu^{2+} ions in sodium-lead borophosphate glasses. XRD, Electron paramagnetic resonance (EPR), UV, FT-IR and Photoluminescence analysis have studied. The optical absorption spectra of all the glass samples show a single broadband, which has been assigned to the $^2B_{1g}$ to $^2B_{2g}$ transition of Cu^{2+} ions. The optical band gap energy and Urbach energies of the glasses are found to depend on Cu^{2+} ion concentration. The emission bands observed in the ultraviolet and blue region attributed to $3d^9 4s$ to $3d^{10}$ triplet transition in Cu^+ ion.

C. Bootjomchai *et. al*., (2012) have determined the structural investigation of borosilicate glasses of xBi_2O_3-50BaO-(50-x) borosilicate glass system. Structural investigations have been studied using ultrasonic and FT-IR. The changes are strongly dependent on the internal structure of the absorbing materials, the ultrasonic velocities are measured before and after gamma-irradiation as a function of composition, from which the structural changes in the B-O and Si-O bond due to irradiation are obtained.

Razvan Stefan *et. al.,* (2012) have reported the effect of copper ions addition on structural and optical properties of $xCuO$-$(100-x)[55B_2O_3$-45ZnO] glasses. Structural and optical properties have beeb investigated using X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FT-IR), differentil thermal analysis (DTA), electron paramagnetic resonance (EPR), ultraviolet-visible (UV-VIS) spectroscopy and density measurements. The major changes of structural and optical properties of the glasses can be seen from the data obtained by FT-IR EPR, XRD, DTA and UV-VIS spectroscopies. CuO plays the network modifier role in the studied glasses determining the formation of NBOs.

H.A. Elbatal *et. al.,* (2012) have presented the optical and FT-IR studies of CuO doped $70PbO$-$30B_2O_3$ glasses. The experimental results indicate that the undoped sample reveals strong UV near visible absorption while copper doped samples show distinctly broad visible band due to (Cu^{2+}) ions.

Kai Zheng *et. al.,* (2012) have studied the characteristics and biocompatibility of Na_2O-K_2O-CaO-MgO-SrO-B_2O_3-P_2O_5 borophosphate glass fibers. Thermal properties including DTA and viscosity measurement of the glass were presented. The reaction of glass fibers in the SBF solution is characterized by XRD, SEM and FT-IR. The bioactivity and biocompatibility of the glass fiber make it good potential prospect in the field of tissue engineering.

A.M. Ozerova *et. al.,* (2012) have determined the Cobalt borate catalysts for hydrogen production on via hydrolysis of sodium borohydride. Amorphous phase of cobalt borate shows high activity in $NABH_4$ hydrolysis due to its reduction resulting in catalytically active cobalt-containing phase.

Vandana Sharma *et. al.,* (2012) have presented synthesis and optical characterization of Silver doped Sodium Borate Glasses. Glasses are characterized by XRD, FT-IR and UV-VIS. XRD results showed that the amorphous nature of the glasses. From FT-IR, it is seen that BO_3 and BO_4 act as nework structural groups. Optical band gap increases with increase of Silver content.

R. Laopaiboon *et. al*., (2011) have studied elastic properties investigation of gamma-radiated barium lead borosilicate glass using ultrasonic technique. From the results, it was found that ultrasonic velocity, elastic moduli and microhardness increase with increasing barium oxide content and increasing gamma-radiation dose.

Shiv Prakash Singh and Basudeb Karmakar (2011) have explained synthesis and characterization of low softening point high Bi_2O_3 glasses in the K_2O-B_2O_3-Bi_2O system. Structural, Optical, Thermal, Electrical and other physical properties have been evaluated by XRD, TEM, FESEM, FT-IR, UV-VIS, Dilatometer, LCR meter techniques. The decrease in the values of glass softening temperature, glass transition temperature and glass deformation

temperature indicates that the glass network becomes less tightly packed due to formation of nonbridging oxygen.

Petru Pascuta *et. al.,* (2011) have investigated thermal, structural and magnetic properties of some zinc phosphate glasses doped with magnese ions. Thermal, structural and magnetic properties of glasses were found by DTA, EPR and magnetic susceptibility measurements. DTA data indicated that good thermal stability of the glasses. EPR and magnetic susceptibility data reveal that both Mn^{2+} and Mn^{3+} are present in the glass.

Mitsuru Kawashima *et. al.,* (2011) have found temperature dependence of elastic properties in xM_2O-$(100-x)B_2O_3$ (M = Li, Na, K, Rb, Cs) glasses. Prepared glasses investigated by Brillouin scattering spectroscopy for temperature. Results indicated that fragility of alkali borate glasses increases as the size of an alkali ion decreases. The formation of the four-coordinated boron atom plays the dominate role in the fragility of the borate glass system.

B. Pandyalk *et. al.,* (2010) have explained synthesis and spectroscopy of Lithium and Potassium tetraborate glasses doped with copper. EPR and optical spectroscopy (absorption, emission and luminescence excitation) characterization results were analysed. EPR and optical spectra of the Cu^{2+} and Cu^{+} centres weakly dependent on the basic chemical composition of the tetraborate glass matrix.

G. Rajkumar *et. al.,* (2010) have investigated structural analysis of zirconia-doped calcium phosphate glasses. Characterization such as ultrasonic velocities, DTA, XRD, energy dispersive XRD, in vitro studies, pH measurements, FT-IR and SEM were carried out. Crystalline peaks were observed in the XRD pattern confirm the formation of a hydroxyapatite layer on the surface of the glass. The results that were observed revealed the existence of bioactivity in all the glasses.

A.V. Gayathri Devi *et. al.,* (2010) have reported ultrasonic characterization of calcium phosphate glasses and glass-ceramics with addition of TiO_2. XRD, Density, Molar volume, ultrasonic velocities, attenuation, elastic constants and microhardness were used to study the structural and mechanical properties. Results indicated that added TiO_2 increases the cross link density of the glasses and thus results in higher network stability.

M.**S. Gaafar *et. al.,* (2009)** have investigated effect of doping by different transition metals on the acoustical properties of Alkali borate glasses. Ultrasonic wave velocities were measurements using pulse echo technique. The decrease in the ultrasonic velocities, elastic moduli with increasing P_2O_5 content is attributed to the breaking of B-O-B bridges and the formation of phosphate units with NBO atoms and consequently the decrease in both the rigidity and vibrations of the glass network.

A.N. Kannappan *et. al.,* (2009) have analysed the elastic and mechanical properties of glass specimen by ultrasonic method. Measured ultrasonic velocities were used to carry out the elastic moduli, acoustic impedance, elastic moduli, Micro hardness, debye temperature and thermal coefficient have been discussed in terms of the prepared glasses.

A. Chahine *et. al.,* (2004) have studied FT-IR and raman spectra of Na_2O-CuO-Bi_2O_3-P_2O_5 glasses. FTIR and Raman spectra revealed the formation of P-O-Bi and P-O-Cu bonds in glasses and indicated that Bi_2o_3 behaves as a network former and CuO act as a network modifier.

A.B. Dikko *et. al.,* (2015) have evaluated the ultrasonic velocity and some acoustic and thermodynamic parameters of ethanol-1-propanol-benzene ternary mixtures at T = (303.15 to 328.15) K. The experimental data have been used to calculate some acoustic and thermodynamic parameters. The linear variation of acoustical parameters with temperature showed that there exist less intermolecular forces between components of ternary liquid mixture.

A.B. Dikko *et. al.,* (2015) have studied the effect of temperature change on ultrasonic velocity and some acoustic parameters of ternary liquid mixture of methanol – ethanol – 1-propanol at T = (303 to 328) K. From the experimental data some acoustic parameters have been calculated. Density and viscosity of the mixture decrease with increase in temperature due to energy obtained to overcome the resistance to flow.

CH. Srinivasu *et. al.,* (2015) have explained the study of excess acoustic parameters in binary mixture containing acetophenone and n-butanol at T = (303.15 to 323.15) K. From the experimental data, excess values of adiabatic compressibility, molar volume and acoustic impedance were calculated. The negative and positive variations of these excess parameters have been explained on the basis of the intermolecular interactions present in the liquid mixture.

S. Balakrishnan and R. Palani (2015) have measured the acoustical and excess thermodynamical studies of molecular interaction in ternary liquid mixtures of tetrahydrofuran – octane – decane at T = 303, 308 and 313 K. The experimental data have been used to calculate some excess thermodynamical parameters. The results of excess acoustical and thermodynamical property revealed that the existence of weak molecular interaction between the components in the mixture, which may be due to the dominance of dispersion forces and dipolar interaction between the unlike molecules.

Kirandeep Kaur and Kailash C. Juglan (2015) have presented the studies of molecular interaction in the binary mixture of chloroform and methanol by using ultrasonic technique at T = 295 K. Obtained experimental values are used for determining various thermo - acoustical parameters. The linear variation in most of the acoustical parameters showed that there is no complex formation in the mixture. The weak interaction between the molecules of the binary mixture is found.

Subraraj Panda *et. al.,* (2014) have reported the variation of thermo-acoustic parameters of aqueous dextran with concentration and temperature at T = (303 to 323) K. Various parameters such as adiabatic compressibility, intermolecular free length, relaxation time, acoustic impedance and Gibb's free energy have been calculated using experimental determined values of ultrasonic velocity, density and viscosity. The results showed that the solute – solvent interactions play an important role for explaining acoustic parameters.

S. Meena *et. al.,* (2014) have determined the ultrasonic studies of ternary mixtures of N-alkanols in etylmethacrylate and benzene at T = (303 to313) K. From the experimental data acoustical parameters and their excess values have been calculated. The negative deviation of excess free volume is an indication of the existence of strong interaction between the components.

S. Punitha *et. al.,* (2014) have explained the physico-chemical studies on Fructose, Lactose and Sucrose in Hydroxy Prophyl Cellulose solutions at T = (303 to 323) K. The acoustical parameters such as adiabatic compressibility, intermolecular free length, internal pressure, rao's contant, relaxation time, acoustical impedance, absorption coefficient, free volume, cohesive energy and salvation number have been computed. The non linear variations of acoustical parameters with concentration and temperature indicated the existence of strong molecular interaction in the systems.

N. Calvar *et. al.,* (2013) have measured the vapour pressures and osmotic coefficients of binary mixtures containing primary (1-propanol, 1-butanol and 1-pentanol) and secondary (2-propanol and 2-butanol) alcohols with pyrolidinium – based ionic liquids at T = 323.15 K. From the results obtained, it can be deduced that the position of the functional group of the alcohol has a small influence on the ion-ion interactions, although the solute-solvent interactions are higher when the secondary alcohol present in the mixtures.

Lenka Morakova *et. al.,* (2013) have studied the volumetric behaviour of the 2,2,4-trimethylpentane – methylbenzene – butan-ol ternary system and its binary sub-systems at T = (298.15 to 328.15) K. The Excess acoustical parameters were calculated and the data were correlated using the Redlich-Kister equation. Experimental excess molar volumes analysed by Extened Real Associated Solution (ERAS) model. Results concluded that the proposed association scheme for ERAS captures semi-quantitatively the main features of the excess volume for ternary system.

Hana Houskova *et. al.,* (2013) have determined volumetric behavior of the ternary system benzene-2-methoxy-2-methylbutane-2,2,4-trimethylpentane and all binary sub-systems at T = (298.15–318.15) K. Excess molar volumes of the mixtures are calculated from the experimental densities and then correlated using the Redlich–Kister equation. From the results they concluded that benzene has a molecular order in the pure liquid, the influence of 2,2,4-trimethylpentane as a strong structure-breaker is stronger as well as the presence of 2-methoxy-2methylbutane considerable role in the liquid mixture.

Arvind R. Mahajan *et. al.,* (2012) have studied thermo – acoustical parameters of binary mixture n-octane, n-decane, n-dodecane and n-tetradecane with octan-2-ol and application of theories of sound speed. The positive values of excess adiabatic compressibility and excess free volume suggest that the rupture of hydrogen bonded chain of dipolar interaction between solute and 2-octanol.

N. Sundharam and L. Palaniappan (2012) have determined the molecular interactions of aniline – ethanol – toluene liquid system at T = 303 K. From the basic measurements of ultrasonic such as sound velocity, density and viscosity, acoustical parameters and their excess values were estimated using standard relations. The results interpreted in terms of molecular interaction between the components of mixtures. Observed

excess values in all the mixtures indicated dipolar and weak dispersive type interactions exist in the system.

Manoj Ku. Praharaj *et. al*., (2012) have studied thermodynamic and transport properties of ternary liquid mixture of N-N dimethyl formamide, cyclohexane and chlorobenzene at T = (288 K, 298 K, 308 K and 318) K. Experimental data have been used to estimate the thermodynamic parameters and their excess values. Dispersive forces are found to exist between the components of the mixture.

M.K. Praharaj *et. al.,* (2012) have presented the ultrasonic study of ternary liquid mixture of N-N dimethyl formamide, cychlohexane and nitrobenzene at T = (288 to 308) K. Acoutic parameters like adiabatic compressibility, free length, free volume, available volume, vander waals constant, internal pressure, relaxation time, acoustic impedance and Gibb's free energy and their exces values have been computed. The change in excess parameters indicated that there is a strong interaction between unlike molecules as the concentration of DMF increases and the interaction decreases as temperature increases.

J. Asghar *et. al.,* (2010) have explained thermodynamic studies of molecular interactions in ternary liquid mixtures of 1-pentanol, 1-hexanol, 1-octanol with methyl methacrylate in cyclohexane at T = (303 to 323) K. The experimental data was used to calculate various acoustical parameters. The results concluded that there exists a molecular interaction between MMA and 1-alkanols due to hydrogen bonding and degree of complexation varies with the carbon chain length of 1-alkanols.

S. Tirumaran and P. Thenmozhi (2010) have measured the ultrasonic velocity, density and viscosity for the mixtures of alkanols namely 1-propanol, 1-butanol, 1-pentanol with cholorobenzene in toluene at 303 K. From the experimental data, acoustical parameters and their excess values were calculated. From the results, existence of strong molecular

association was observed. Such molecular association is found by hydrogen bonding through dipole-dipole interactions.

S. Tirumaran and J. Earnest Jayakumer (2009) have reports the ultrasonic study of alkanols namely 1-propanol, 1-butanol, 1-pentanol with nitrobenzene in toluene at 303 K. From the measured data of ultrasonic velocity, density and viscosity, the acoustical parameters and their excess values were calculated. The results interpreted interms of molecular interactions such as dipole- dipole interaction through hydrogen bonding.

S. Tirumaran and Deepesh George (2009) have evaluated the ultrasonic study of intermolecular association through hydrogen bonding in ternary liquid mixtures of cresols namely, m-cresol, o-cresol and p-cresol with N,N-Dimethyl formamide (DMF) in CCl_4 at 303, 308 and 313 K. From the experimental data, acoustical parameters and their excess values have been calculated. The results are interpreted in terms of molecular interactions present in the mixtures.

Adel S. Al-Jimaz *et. al.,* (2007) have estimated the acoustical and excess properties of Chlorobenzene – 1- hexanol, or 1 - heptanol, or 1 – octanol, or 1 – decanol at T = (298.15 to 313.15) K and atmospheric pressure. From the basic values of ultrasonics, acoustical parameters and their excess values were calculated. From the excess values of molar volume increase, sound velocity decrease as the chain length of 1-alkanol increases.

G.V. Rama Rao *et. al.,* (2005) have evaluated the excess free volumes and excess internal pressures of binary mixtures of o-chlorophenol with ethyl benzoate, anisic aldehyde and acetronitrile at T = (303.15 to 318.15) K. Excess values of internal pressure, free volume, enthalpy and Gibb's free energy of activation have been calculated. The results concluded that o-chlorophenol whuch is self-associating polar organic liquid has a tendency to form complexes with ethyl benzoate, anisic aldehyde and acetronitrile.

A. Villares *et. al*., (2004) have investigated the densities and speeds of sound for binary mixtures of 1,3-dioxolane or 1,4-dioxane with 2-methyl-1-prpanol or 2-methyl-2-propanol at T = (298.15 to 313.15) K. Excess volumes and excess adiabatic compressibility have been calculated from the experimental data and fitted by means of a redlich-kister type equation. Calculated excess volumes greater that experimental ones, being the smallest deviations those for the liquid systems with 2-methyl-2-propanol.

Nandhibatia V. Sastry and Mahendra K. Valand (1996) have reported the viscosities and densities for Heptane – 1-pentanol, 1-hexanol, 1-octanol, 1-decanol and 1-dodecanol at T = (298.15 K and 303.15) K. The viscosity deviations were calculated and fitted to the semiempirical equations of Grunberg – Nissan, Heric, McAllister and Auslander. The smaller standard deviation values suggest that the empirical relations give satisfactory fits for representing the present mixture viscosity data.

T. Kasthury *et. al*., (2014) have evaluated theoretically ultrasonic velocities in the ternary liquidmixtures of methyl isobutyl ketone +benzene + alkanols. Comparison of ultrasonic velocity evaluated from Nomoto's relation, Van Deal-Vangeel ideal mixing relation, Impedance dependence relation, Rao's specific velocity and Junjie method with that of experimental values. The observed deviation of both theoretical and experimental values show molecular interaction are taking place between the unlike molecules and in liquid mixture.

M. Arvinthraj and J. Udayaaseelan (2014) have studied the theoretical evaluation of ultrasonic velocity in the ternary mixture of amide – benzene – amines at T = 303 K. The theoretical ultrasonic velocity in ternary mixtures of amide in benzene with amines at 303 K have been evaluated by using theoretical models of liquid mixtures such as, Nomoto's relation, Free Length Theory, Ideal mixture relation, Junjie's method, Impedance dependence relation and Rao's relation. Ultrasonic velocity of these mixtures has been

measured as a function of mole fraction and the experimental values are compared with theoretical values. The results are interpreted in terms of percentage deviation and intermolecular associations between the component molecules in the form of Hydrogen bonding.

Durga Bhavani *et. al.*, (2013) have presented the theoretical evaluation of ultrasonic velocities in binary liquid mixtures of o-anisidine with o-cresol at T = (303.15 to 318.15) K. Ultrasonic velocities calculated from various theoretical models and relations like, Nomoto's relation, Vandael ideal mixing relation, Impedance relation, Rao's specific velocity relation and Junjie's theory are compared with experimental values. From the results, out of all the theoretical models, Van Deal ideal mixing relation gives best result followed by Rao's theory.

Shaik Babu *et. al.,* (2012) have reported the experimental and theoretical studies of ultrasonic velocity in binary mixtures of ethyl benzoate with 1-propanol, 1-butanol, 1-pentanol at T = 303 K. Theoretical values of ultrasonic velocity have been evaluated using Nomoto's relation, Impedance relation, Ideal mixture relation, Junjie's method and Free length theory and compared with the experimental values. The validity of the theories was checked by chi-square test and by calculating the average percentage error (APE).

T. Sumathi *et. al.,* (2012) have presented the theoretical evaluation of sound velocity in ternary liquid 1-alkanols-benzene – anisole systems. The velocity of Nomoto, Van Deal-Vangeel, Impedance relation, Ideal mixture relation and Collision factor theories have been checked and comparative study of the above models is made. Results showed that the Collision factor theory is best suited.

B. Hemalatha *et. al.,* (2005) have measured acoustical parameters for 1-propanol, 1-butanol with cyclohexane in decane at temperatures 303, 308 and 313 K. Also comparison

has been done with theoretical models. The parameters interpreted in terms of the strength of the interaction.

C.L. Prabhavathi *et. al*., (2004) have calculated the excess molar volume for xylene with 1-propanol, 1-butanol, 1-pentanol at 303.15 K. The results explained interms of ntermolecular interactions between molecules of liquid mixtures. Also comparison has been made between the experimental and theoretical values of ultrasonic velocities in liquid mixtures.

AIM of the work

M.S. Gaafar *et. al*., (2009) was studied the elastic properties of alkali borate glasses doped with different Transition metal oxides. The decrease in the ultrasonic velocities, elastic moduli with increasing P_2O_5 content is attributed to the breaking of B-O-B bridges and the formation of phosphate units with NBO atoms and consequently the decrease in both the rigidity and vibrations of the glass network. M.S.Gaafar and is coworkers studied the Ultrasonic properties with composition of (SiO_2-Na_2O-B_2O_3-TMO=NiO, Y_2O_5, Fe_2O_3, MnO_2, TiO_2, Cr_2O_3, CuO, CoO). But they are not done the other properties such as structural, optical, vibrational and thermal. From the literature point of view it was found that the synthesis and properties of NCPBC glass materials has not been done. Hence, in the present study, it was proposed to carried out synthesis & elastic, structural, optical, vibrational, thermal and mechanical properties of CuO doped borophosphate glasses was followed by chapters II, III, IV & V. From the liquid work, it was carried out the thermo – acoustical parameters and their excess values are evaluated for ternary mixtures materials of methylbenzene and 2,2,4-trimethylpentane with 1-alkanols (1-propanol, 1-butanol, 1-pentanol and 1-hexanol) at various temperatures T = 303, 308, 313 K. Comparative studies were also taken for experimental values with various theoretical models such as Nomoto's Relation (NR), Impedance Dependance Relation (IDR), Vandeal-Vangeel's Ideal Mixing

Relation (IMR), Free Length Theory (FLT), Collision Factor Theory (CFT) and Junjie's Relation (JM). Liquid work was followed by the chapters II, VI & VII.

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