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OPTICAL AND ELECTRICAL STUDY OF SODIUM ZINC PHOSPHATE GLASS

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Abstract

In this present study the oxide glasses of composition $30Na_2O$-$60P_2O_5$-10ZnO and doped with nickel/manganese were prepared by oldest melt quenching techniques and is one of the famous techniques. $Zn_3(PO_4)_2$ is an inorganic chemical compound having a chemical named zinc Phosphate. The other names for Zinc Phosphate are Zinc orthophosphate, Trizinc phosphate, and Trizinc diphosphate. This white powder compound is widely used as a corrosion-resistant coating, which is applied on metal surfaces, which are put as a part of electroplating or as a primer pigment. The glass samples were characterized using X-ray diffraction (XRD) and UV-visible spectrometer. The x-ray diffraction pattern shows that all the samples are amorphous in nature and the energy gaps calculated.

Keywords: *Sodium Zinc Phosphate glass, Energy gap, X-ray Diffraction, UV- Spectroscopy*

Introduction

Transparent glass-ceramics, characterized by their dual character, emit light as amorphous glasses, but their anisotropy has given rise to their optical parameters, optical dielectric constant, and refractive index in addition to other physical and chemical features.[1-3] In recent years, scientists have looked into phosphate-based glasses for a variety of technological applications such as sealing materials, solid-state electrolytes[2,3] radioactive waste containment[4,5] laser technologies, medical applications such as degradable tissue and bone scaffolds[6,7] and agro-fertilizers with controlled solubility.[6,9]

Any liquid with slow crystallization kinetics will become structurally halted and, as a result, will resemble glass in appearance. Glass is defined as a material that no longer has the capacity to flow.[10-14] Phosphate glasses are playing an increasingly significant role in optical technologies, including fiber, optical lenses, and energy laser applications.[16,16] When creating glasses for various purposes, it helps to consider how the host glass's structure and the doped ions' characteristics interact.[10-14] Due to their usage in memory switching, electrical threshold, and optical switching devices, phosphate glasses containing transition metal oxides (TMO) continue to be of interest.[15-17] The transition metal ions are used as dopants in glasses mainly for their well-defined and sharp energy level may serve as structural probes for the environment of the dopant and modifications of the energy level structure of the transition metal ions caused by the glassy environment may lead to

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interesting applications, such as new lasers and luminescence materials. The technological applications of phosphate glasses are clear, so a better understanding of the mechanical properties of glasses. The present paper is a description of work undertaken on oxide glass [$30Na_2O$-$60P_2O_5$-$10ZnO$] (referred as NPZ) Sodium Phosphate zinc glass and doped with nickel/manganese.[1,18-19]

Experimental Section

The formula of the phosphate $30Na_2O$-$60P_2O_5$-$10ZnO$ doped with $NiSO_4$ and MnO_2, the glass samples were made from materials of Na_2O, P_2O_5, and ZnO. The starting material's weight was measured using an analytical scale measurement instrument. The charge (50 gm) was then melted in an alumina crucible using a muffle furnace for three to four hours at a temperature ranging from 900 to 1000 0C after being thoroughly combined and ground for 50 to 60 minutes in a mortar and pestle.[1,18-19] The melt was poured onto a metal plate or graphite mold once it had been properly homogenized and reached the desired viscosity. The prepared glass was annealed (below the glass's softening point) at temperatures between 200 and 300 ^{0}C for two hours while being kept in desiccators. This technique relieves the stress that was created during the quenching process. To remove residual tensions and achieve crack-free glass, the glass was progressively cooled in the furnace from annealing temperature to room temperature. A precise temperature control furnace was employed for this reason.[1,18-20]

Result and discussions

X-ray diffraction (XRD)

The XRD plot for few samples is shown in Fig.1-2.[1] The amorphous and glassy nature of the samples were confirmed by the presence of broad peaks in X-ray diffraction patterns (at $2\theta=25^0$)

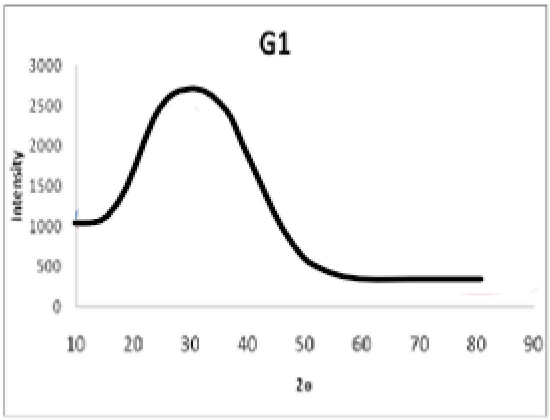

Fig. 1: XRD Pattern of sample (G1) doped with $NiSO_4$

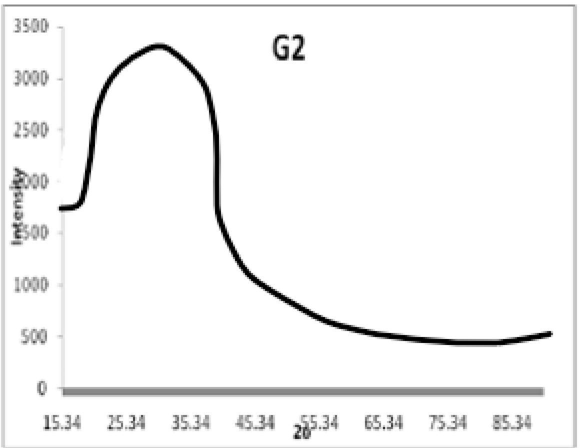

Fig. 2: XRD pattern of sample NPZ (G2) doped with MnO_2

Density of electrons

Density was measured for all glass samples at room temperature using water as immersion liquid. Density is generally measured by the fluid displacement method depending on Archimedes principle. According to the Archimedes principle, the buoyancy equals the weight of the displaced fluid. The density was obtained by employing the relation.[1]

$$\rho = (W_a/W_a\text{-}W)_b \times \rho_b$$

Where, W_a is the weight of sample glass in air, W_b is the weight of sample glass in buoyant liquid (W_a-W_b) is the buoyancy. Row b is the density of buoyant. All the measurements were made using a digital balance. The value of density shows that there is slight increase with $NiSO_4$ and MnO_2 these are given in Table.1.[1,21,22]

Table 1: Density and optical energy gap

Sr.No	Sample	X (mole %)	Density g/cm^3	Lower cut off wavelength (nm)	Eg (eV)
1	G1	1.9	3.11	4.8.5	2.87
2	G2	1.9	3.25	5.25	2.94

UV-visible

Ultraviolet and visible spectroscopy measures the absorption, transmission, and emission of ultraviolet and visible light wavelength by matter. Ultraviolet and visible light comprise only a small portion of the wide-ranging electromagnetic radiation spectrum. The ultraviolet band of the electromagnetic spectrum is further separated into three regions termed UV-SC1, UV-SC2, and UV- SC3. Although not all the researchers agree on the exact subdivisions of these wavelength, UV-SC1 isgenerally considered to be light with wavelength between 340-650 nm; UV-SC2 between 450-650 nm and UV-SC3 fall between 210-300 nm.[1,22,23]

Transition metal ion (TMI) doping has been characterized by UV visible spectrometer and it has shown interesting results. Optical transmission of the investigated glasses in the UV-visible region of the spectrum were measured in the range 200-800 nm using a computerized recording spectrometer type (Perkin Elmer 950). The experimental results obtained were recorded in the form of % of absorption as a function of wavelength in nm. These bands are expected to be due to the presence of $NiSO_4$ and MnO_2. When the material absorbs a photon of incident light, an electron is excited from lower to upper energy level or state. This transition of electron can be direct (without phonon assisted mechanism) or can be indirect (in which the interacted with a phonon takes place). The optical band gap NPZ glass and doped with $NiSO_4$ and MnO_2 were calculated by using absorption of light energy measurements. The equation used is mentioned in the following subsection.[23]

Conclusion

Pristine sample XRD pattern is glassy nature (broad spectrum). The TMI doped samples also glassy nature Optical energy gap varies with TMI doping. The shifting of absorption edge with $NiSO_4$ and MnO_4 towards longer wavelengths indicates ion Ni and Mn acts as modifiers, which lower the concentration of non-bridging ions (NBO’s) in the glass matrix. The presence of higher concentrationsof donor centers decreases the optical band gap and shifts the absorption edge towards higher wavelength. Based on the UV-visible optical absorption studies it is concluded that the Ni and Mn ionsact as network modifier with sodium zinc phosphate glasses in the present study. It is important glass for study of how effective to use this glass for nuclear waste storage.

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