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Conductivity studies of phosphate glasses

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ABSTRACT

Conductivity studies have been carried out on Phosphate glass samples having the nominal composition, 70P2O5-30Na2O(binary) and 65P2O5-10B2O3-25Na2 (ternary). Phosphate glass samples (both binary and ternary) are prepared using conventional melt quenching technique. DC and AC conductivities are measured by using two probe and LCR-Q meter. The activation energies are calculated using Arhenious equation. It is found that activation energies (from DC) vary from 0.5 eV to 0.7 eV with composition. This activation energy compared to the values calculated from AC conductivity and spectroscopic studies. Glass samples converts transparent to translucent if samples more rich in phosphate. This may attribute change in the energy gap. The band gap of binary samples to ternary samples changes from 3.98 eV to 4.55 eV.

KEYWORDS

Phosphate glass sample;
Conductivity;
Spectroscopic study.

INTRODUCTION

Phosphate glasses are used in the devices where we need high thermal expansion coefficients and electrical conductivity with low glass transition temperature. Earlier studies indicate that the chemical durability increases by addition of trivalent ions like Al, B, Bi etc.[1] The boro-phosphate glasses having improved durability are among the multi-component glasses studied for various interesting applications.[2] Changing their compositions can control the properties of these phosphate glasses and this gives us an opportunity to use them in different composition. In this paper we report the preparation of binary and ternary phosphate based glasses, conductivity (DC), structural studies by optical method (UV) and XRD.

EXPERIMENTAL

Glasses having composition $(100–x)Na_2O\text{-}xP_2O_5$, and $xNa_2O\text{-}yB_2O_3\text{-}(100(x+y))P_2O_5$, where x= 0-50 mol% were prepared by conventional melt quench technique. Analytical grade reagents with no water crystallization, Na_2CO_3, B_2O_3, and $NH_4H_2PO_4$, were used as starting material. Twenty-gram batches of initial charge were mixed thoroughly by repeated grinding. The compositions of the glass sample along with sample codes are given in TABLE 1. The ground mixtures were

heated in Alumina crucibles at 1000^{0}C for about 5-6 hours in a muffle furnace. When the melt was thoroughly homogenized and attained the desirable viscosity, it was poured on to a brass metal plate/graphite die. The glass was then annealed at appropriate temperatures (between 180-250^{0}C – which was preheated to 250^{0}C) for 3 hours and stored in a desiccators and allowed to cool at room temperature.

TABLE 1

Glass Code No	Composition of Glass	% of Trans.	Density g/cc	Vm cc	Band Gap E_g eV
B3	30Na2O5-70P2O5	70.52	2.689	43.86	3.98
T1	20Na2O5-20B2O360P2O5	0.7	2.376	46.92	---
T3	25Na2O5-10B2O365P2O5	80.38	2.458	46.66	4.55

GLASS CHARACTERISATION

The amorphous nature of the glass samples was confirmed by X-ray diffraction using Cu-Kα radiation to ascertain the glassy nature of the samples.[3]

Density (ρ) of the glass samples was measured at room temperature using Archimedes principle with an accuracy of ± 0.03 g/cm^2.

The molar volume, $V_m = (W_m / \text{Density})$ was calculated from density data. W_m being the corresponding formula weight.

The transmission spectra of glass samples were recorded using UV spectrophotometer in the wavelength region 200 – 800 nm at normal incidence as shown in Figure 1. The UV spectra were recorded at room temperature. It is clear from this UV spectra (Figure 1), that there is no sharp absorption edge, which is a characteristic of the glassy nature of the sample and which was verified by XRD spectra[4] as sown in Figure 2.

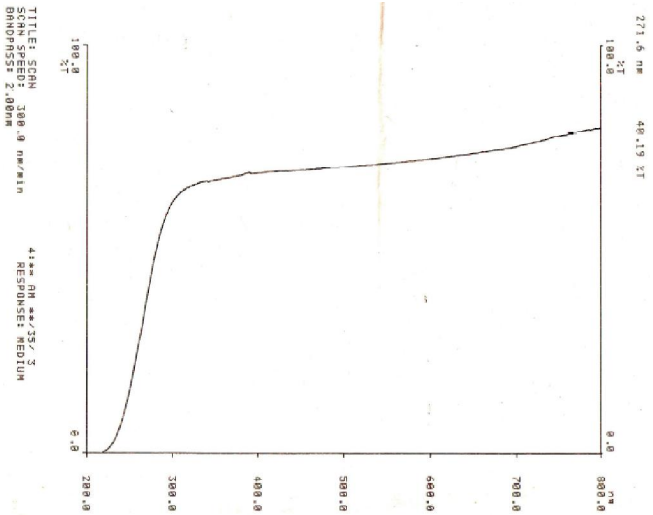

Figure 1 : UV spectra for T3 glass sample.

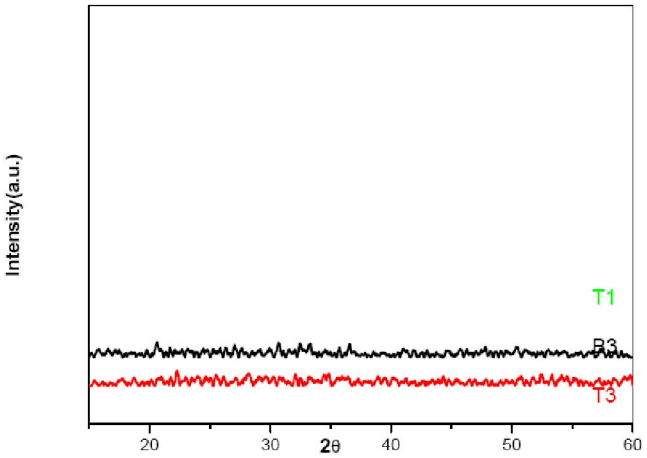

Figure 2 : XRD for the glass samples

RESULTS AND DISCUSSION

A glass is transparent to light in the wavelength region where intrinsic absorption does not occur, and on the short wavelength side of the UV-visible spectrum the electronic fundamental absorption bands limit the transparency. Strong absorption bands arising from electron excitations produce essentially a UV cut-off causing most glasses to appear opaque in the UV.[7,8] The band gap was calculated from UV cutoff (λ) data, Band Gap = (1236 / λ).[1]

The DC conductivity of the sample was determined from the two probe method.[5] The activation energies are calculated using Arrhenius equation. It is found that activation energies (from DC) vary from 0.5 eV to 0.7 eV with composition. The optical absorption in solids occurs by mechanism that involves the coupling of the electric field of the incident radiation to the dipole moment in the material and consequent transfer of energy. The energy gap increase from binary to ternary system. Arbuzov (1996), Stevels (1953) and Meswain et al (1963) suggested that in oxide glasses like alkali, alkaline earth borate, silicate or phosphate glasses. The shift of energy gap to lower energies could be related to the formation of non-bridging oxygen, which binds excited electron less tightly than bridging oxygen

Short Communication

CONCLUSIONS

Optical transmittance spectra of glass sample of composition (100 – x) Na_2O-xP_2O_5 and xNa_2O-yB_2O_3-(100 – (x+ y)) P_2O_5 were recorded in the UV-visible region and optical energy gap were determined. Optical energy was found to increase from binary to ternary glass samples as shown in TABLE 1. The variation in optical energy gap is discussed on the basis of formation of non-bridging oxygen

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REFERENCES

[1] T.Tsuchiya, T.Moriya; J.Non-Cryst-Solids, **38-39**, 323 **(1980)**.
[2] K.V.Shah, M.Goswami, M.N.Deo, A.Sarkar, S.Manikandan, V.K.Shrikhande, G.P.Kotiyal; Bull.Mater., Sci., **29**, 43 **(2006)**.
[3] K.J.Rao, Sundeepkumar; Current Science, **85**, 7 **(2003)**.
[4] Shajo Sebastian, M.Abdul Khader; Bull.Matter.Sci., **27**, 2 **(2004)**.
[5] Mahantappa S.Jogad; Materials Letters, **54**, 249 **(2002)**.
[6] N.Srinivasa Rao, Shashidhar Bale, M.Purnima, K.Siva Kumar, Syed Rahman; Bull.Mater.Sci., **28**, 6 **(2005)**.
[7] A.K.Varshneya; Fundamental of Inorganic Glasses, (New York: Academic Press), Ch.19, 473 **(1994)**.
[8] Shajo Sebastin, Abdul Khadar; Bull.Mater.Sci., **27**, 20 **(2004)**.