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OPTICAL ABSORPTION SPECTRA OF $PbO\text{-}Ga_2O_3\text{-}P_2O_5$: WO_3 GLASSES

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ABSTRACT

Lead gallium phosphate glasses ($PbO\text{-}Ga_2O_3\text{-}P_2O_5$) containing different concentrations of tungsten oxide (WO_3) ranging from 0 to 5 mol% were prepared. Optical absorption spectra have been carried out. The optical absorption measurements on all the glasses suggest the reduction of W^{6+} ions in to W^{5+} ions with higher percentage in glass PGPW1.

KEYWORDS: Lead,gallium,phosphate glasses,tungsten ions and optical absorption spectra.

INTRODUCTION

Phosphate glasses are technologically important materials because they have higher thermal expansion coefficients, lower transition temperatures, low preparation temperatures, and higher electrical conductivities than silicate and borate glasses [1]. These properties have made them ideal materials for fundamental studies of the glass transition and devitrification effects. However, their poor chemical durability limits their diverse uses. Addition of different types of metal oxides like PbO, Fe_2O_3, Al_2O_3 and B_2O_3, to binary phosphate glasses has been found to improve the chemical durability and alter their physical–chemical properties like electrical conductivity, chemical durability and thermal expansion.Lead phosphate glasses and derived samples doped with some metal oxides, not only have high coefficients of thermal expansion but can also exhibit good optical properties while having an mproved chemical durability. In this lead phosphate glass, PbO can behave like a glass former as well as glass modifier [2]. The strong absorption in the ultraviolet range is assumed to be caused by electron transition in the divalent lead ion [2]. Also, the shift of the position of the absorption edge to longer wavelengths in these glasses is attributed to the increase in the concentration of non bridging oxygens [2]. The host materials of WO3 are also being used extensively in smart windows to control solar input of buildings or related to large area displays [3].

MATERIALS AND METHODS

Within the glass forming region of lead scandium phosphate glasses doped with tungsten ions, a particular composition $40PbO\text{-}(10 - x)Ga_2O_3\text{-}50P_2O_5{:}xWO_3$ (with x ranging from 0 to 5mol %) is chosen for the present study. We labeled them as PGPW0, PGPW1, PGPW2, PGPW3, PGPW4, and PGPW5 for x = 0, 1, 2, 3, 4, and 5 mol% ofWO_3:The starting materials to obtain the glass were $(NH_4)_2HPO_4$, PbO, Ga_2O_3, and WO_3 of reagent grade purity. The samples were prepared by weighing suitable proportions of the components; the powder was mixed thoroughly in an agate mortar and melted in a thick-walled platinum crucible at 1050–1200ºC in an automatic temperature controlled furnace for about 1 hour until a bubble free transparent liquid was formed. The resultant melt was then poured in a brass mould and subsequently annealed from 300ºC with a cooling rate of 1ºC/min. The samples were then ground and optically polished. The final dimensions of the samples used optical studies were about 1 cm X1 cm X 0.2 cm. The optical absorption spectra of the samples were recorded at room temperature in the wavelength range 300–1000 nm up to a resolution of 0.1 nm using CARY 5E UV–VIS NIR Spectrometer.

RESULTS AND DISCUSSION

Figure 1 presents optical absorption spectra of lead gallium phosphate glasses with different concentrations of WO_3 recorded at room temperature in the wavelength range 300–1000nm. The absorption edge for the glass PGPW5 is positioned at 341 nm whereas for the glass PGPW1 it is observed at 395nm. Additionally, the spectrum of glass PGPW1 exhibited a broad absorption band centered at about 879 nm. As the concentration of WO_3 is increased, the intensity of these bands is observed to decrease with a slight shift in the peak position toward lower wavelength. The broad band observed in the optical absorption spectra of lead gallium phosphate glasses doped with tungsten ions are recognized due to dxy $\rightarrow dx^2\text{-}y^2$ transition of W^{5+} ions.[4] In detail, two optical excitations were predicted starting from dxy ground state; possibly due to strong intervalence charge transfer transition between W^{5+} and W^{6+} ions, the two bands could not be resolved. For glass PGPW5 the intensity and half width of this band observed to be low in the spectrum suggests that the concentration of W^{5+} ions is fairly low in this glass. Thus, the study on optical absorption spectra of lead gallium phosphate glasses doped with tungsten ions confirms the presence of W^{5+} ions in all the glasses. Further, these studies also indicate the presence of the highest concentration of W^{5+} ions in the glass PGPW1. SuchW^{5+} ions may form$W^{5+}O_3$ molecular orbital states and are expected to articipate in the depolymerisation of glass network. Higher the concentration of $W^{5+}O_3$ modifiers, higher is the concentration of NBO in the glass network.

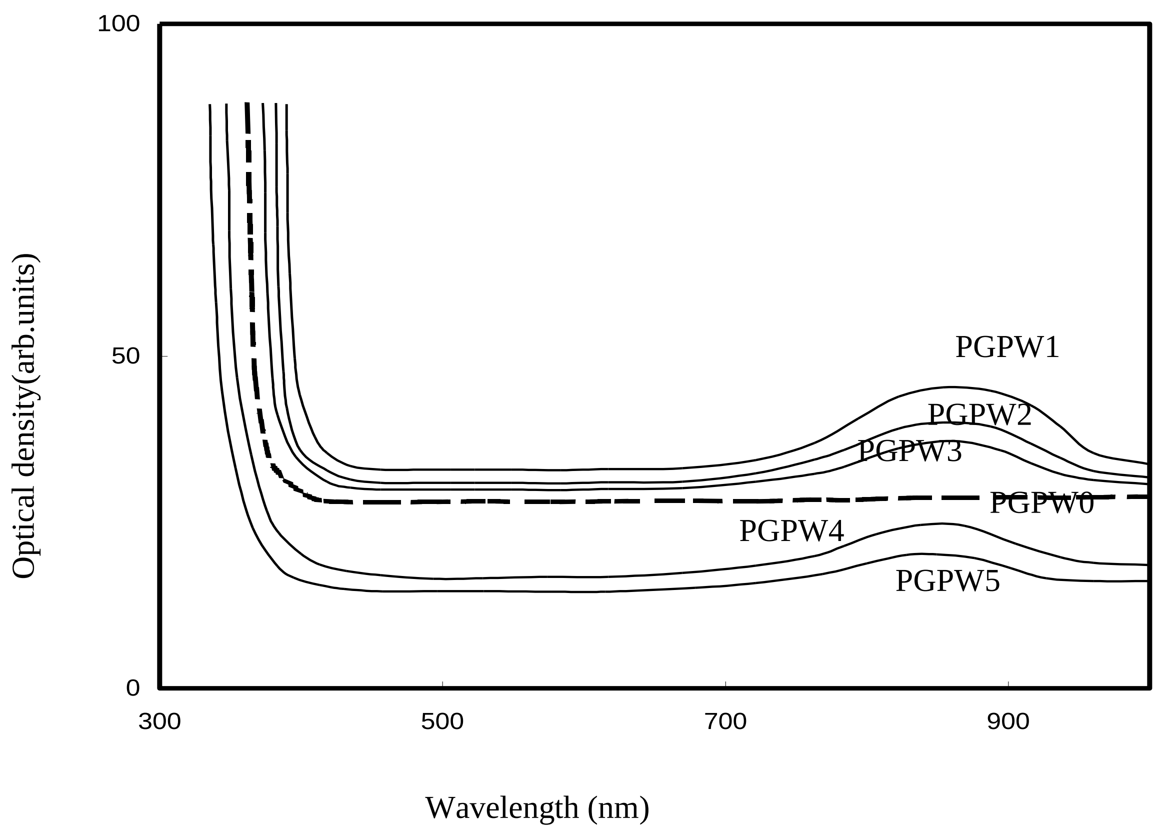

Fig.1 . Optical absorption spectra of PbO-Ga_2O_3-P_2O_5 :WO_3 glasses

CONCLUSIONS

The optical absorption measurements on all the glasses suggest the reduction of W^{6+} ions into W^{5+} ions with higher percentage in glass PGPW1.

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