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EFFECT OF GAMMA IRRADIATION ON OPTICAL PROPERTIES OF CERIUM DOPED PHOSPHATE GLASSES

Manpreet Kaur

Department of Physics, DAV College, Amritsar, Punjab, (India)

ABSTRACT

Transparent bubble free phosphate glasses with composition $50P_2O_5$-$10Al_2O_3$-20CaO-(20-x)Na_2O-xCeO_2 (x varying from 0 to 4 mol %) have been prepared using melt quenching technique. The amorphous nature of the prepared glass samples has been confirmed from XRD spectra. The optical absorption coefficient has been determined from the UV- visible absorption spectra. The prepared glass samples have been irradiated with gamma rays of dose up to 100 kGy. The XRD spectra revealed that there was no change in the amorphous nature of glasses with irradiation. The absorbance was found to increase with the gamma irradiation. Thus, these glasses can be used as shielding materials.

***Keywords: Phosphate Glass, XRD, Optical Spectra, Gamma Irradiation*.**

I. INTRODUCTION

Phosphate glasses are characterised by low melting temperature (T_m), high thermal expansion coefficient (α) and low glass transition temperature (T_g). These properties make them the host materials for different technological applications like solid state electrolytes, low frequency waveguides, photoconductors, biomaterials, laser hosts and many more [1-8]. In earlier days it was thought that the phosphate glasses are hygroscopic in nature, therefore their use was limited but nowadays with the addition of alkaline earth oxides like calcium oxide which acts as the modifier, their stability has been improved significantly. In recent years, study of radiation-induced defect centers in glasses has been an interesting subject. These studies help in examining the suitability of glasses as radiation dosimeters [9]. Gamma irradiation on glasses produces secondary electrons from the sites where they are in a stable state and have an excess energy. These excited electrons traverse in the glass network depending upon their energy and the composition of the glass and are finally trapped, thus forming color centers [10]. The interaction of ionizing radiation with glasses, depends on the type of radiation, glass composition and the defects within it. The radiation interaction can cause the displacement of lattice atoms or electronic defects which involve changes in the valence state of the lattice or impurity atoms. The displacement of an atom creates a point defect which is the simplest disturbance within the lattice. It is also possible to produce groups of vacancies by prolonged irradiation [11]. The purpose of this work is to study the effect of addition of irradiation on cerium doped phosphate glasses. In the present work, we have reported the structural and optical properties by using the techniques like XRD (X-ray diffraction) and UV-Vis Spectroscopy.

II. MATERIAL AND METHODS

2.1 Sample preparation

Samples with composition $50P_2O_5$-$10Al_2O_3$-20CaO-(20-x)Na_2O-xCeO_2 (x varying from 0 to 4 mol %) were prepared using conventional melt quenching technique. They were mixed in appropriate amounts and were grinded for 30 minutes and a homogeneous batch of 10 g was prepared. The grinded mixture was melted in a high quality alumina crucible for 1 h at 1050^0 C in an electric furnace. The melt was then poured onto a preheated steel plate kept at temperatures 200^0 C for 1 h to remove the internal stress. The final samples were then annealed at 400 ^{0} C for 2 hours. The annealed glass samples were then ground and polished to obtain uniform thickness of about 1mm and good transparency.

2.2 Measurements

The non-crystalline nature of the samples was confirmed by X-ray diffraction (XRD) analysis using Cu Kα radiation in XRD -7000 Shimadzu X-Ray Diffractometer. The optical absorption measurements were carried out in 200-1000 nm range with 2 nm resolution on UV-Vis Perkin Elmer Lambda 35 Spectrometer.

III. RESULTS AND DISCUSSIONS

3.1 X-ray Diffraction

Bubble free, clear glasses were obtained for all the compositions in the series $50P_2O_5$-$10Al_2O_3$-20CaO-(20-x)Na_2O-xCeO_2. Powder X-ray diffraction patterns for all the glasses showed no continuous or discrete sharp peaks but exhibit a broad hump as is shown in Figure.1 which is the characteristic of the glassy nature of the samples. Even after irradiation, there is no change in the XRD spectra which confirmed that glasses remained amorphous even after irradiation.

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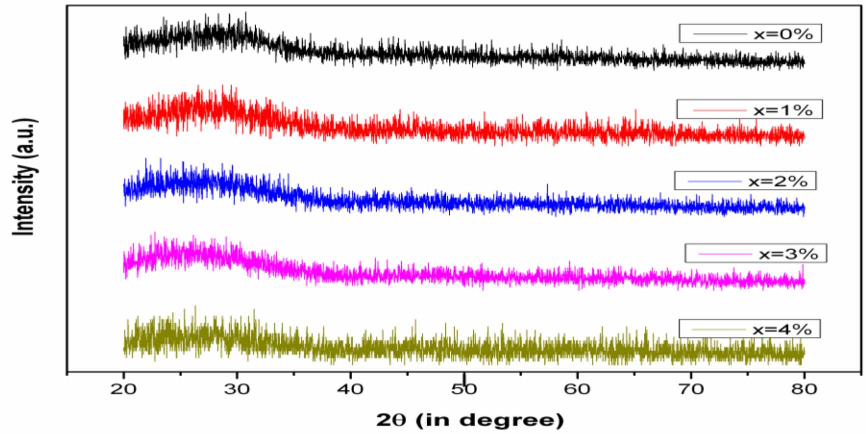

Figure 3.1 XRD spectra of prepared glass samples before irradiation

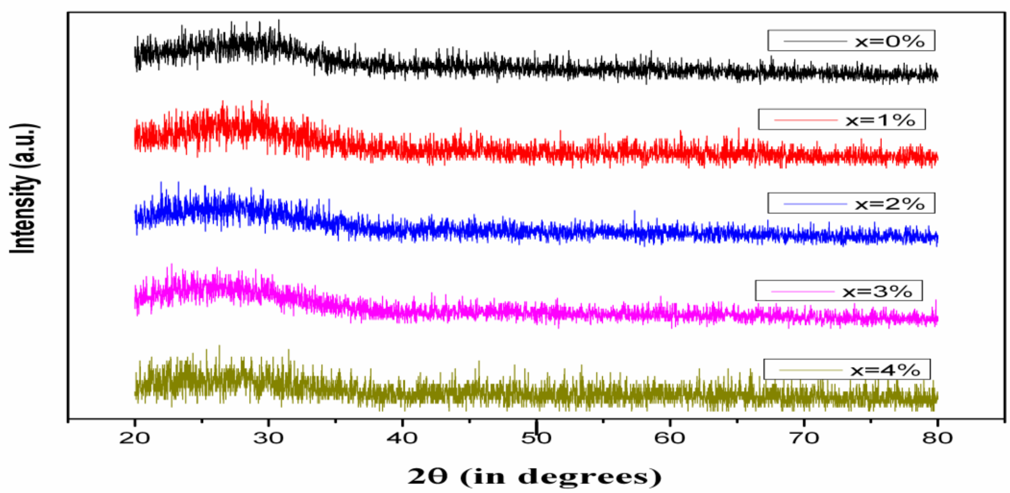

Figure 3.2 XRD spectra of prepared glass samples after irradiation

3.2 UV Visible Spectroscopy

The unirradiated host glass is colorless with no characteristic bands in both of the ultraviolet and visible regions, and it exhibits only a UV cut-off region extending from the beginning of measurement (200 nm) up to 350 nm (3.5 eV). This cut-off wavelength is independent of composition because no significant shift in the wavelength has been observed for samples doped with cerium oxide. For glasses doped with more than 3 mol % of CeO_2, a light yellow

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colour has been observed, but no prominent band is observed in the visible region. Figure 3.3 shows the UV Visible spectra of prepared glass samples.

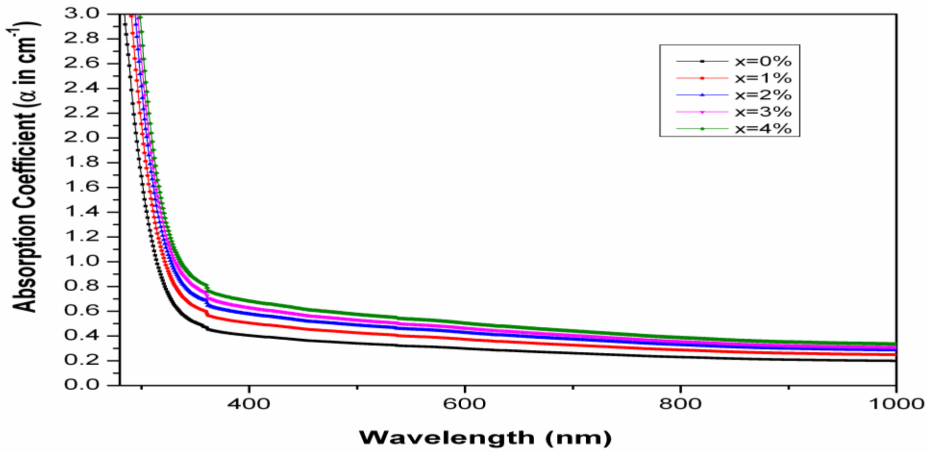

Figure 3.3 UV Visible Spectra of $50P_2O_5$-$10Al_2O_3$-20CaO-(20-x)Na_2O-xCeO_2 glass series before irradiation

With irradiation of glass samples with 100 kGy dose of gamma rays, the UV cut off region is not shifted but the absorbance has been enhanced significantly in UV region as is depicted in figure 3.4. This shows the formation of defect centres within the phosphate glass network.

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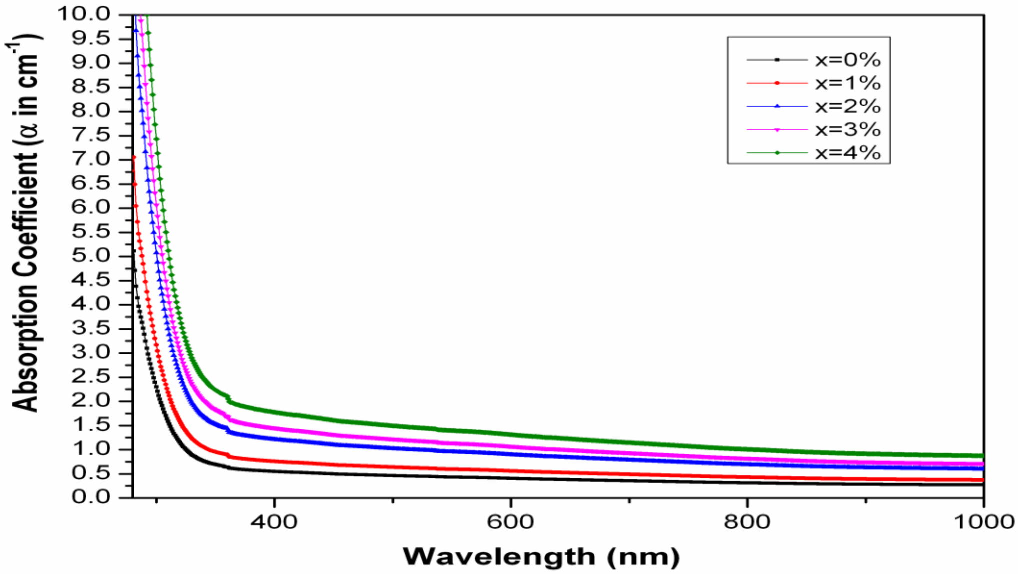

Figure 3.4 UV Visible Spectra of $50P_2O_5$-$10Al_2O_3$-20CaO-(20-x)Na_2O-xCeO_2 glass series after irradiation

IV CONCLUSION

The amorphous nature of prepared glass samples has been maintained even after irradiation of glasses with gamma rays of dose 100 kGy. The absorbance and hence the absorption coefficient of all the glasses has been found to be elevated with irradiation. Thus, these glasses can be used as UV absorbers and hence photoluminescence dosimeters.

REFERENCES

[1] Luka Pavie, Manuel P.F. Graca, Zeljko Skoko, Andrea Mogus-Milankovic and Manuel A. Valente, "Magnetic Properties of Iron Phosphate Glass and Glass Ceramics," *J. Am. Ceram. Soc., 97 [8], 2517-24* (2014).

[2] R. K. Brow, "Structure of Simple Phosphate Glasses," *J. Non-Cryst. Solids, 263-264, 1-28* (2000).

[3] K. V. Shah, M. Goswami, M. N. Deo, A. Sarkar, S. Manikandan, V. K. Shubhande, and G. P. Kothiyal, "Effect of B_2O_3 Addition on Microhardness and Structural features of $40Na_2O$-10BaO-xB_2O_3-(50-x) P_2O_5 Glass System," *Bulletin of Material Science, 29* (2006).

[4] Steve W. Martin, "Ionic Conduction in Phosphate Glasses," *J. Am. Ceram. Soc.*, *74, 1767-84* (1991).

[5] V. Nazabal, E. Fargin, C. Labrugere, and G. Le. Flem, "Second Harmonic Generation Optimisation in Thermally Poled Borophosphate Characterisation by XANES and XPS,"*J. Non-Cryst. Solids, 270, 223-33* (2000).

[6] M. G. Masko, and D. E. Day, "Immobilisation of spent Nuclear Fuel in Iron Phosphate Glass," *J. of Nuclear Materials, 273, 27-36* (1999).

[7] L. L. Hench, "The Story of Bioglass," *J. Mater Sci: Mater Med., 967-78* (2006).

[8] J. C. Knowles, "Phosphate Based Glasses for Biomedical Applications," *J. Mater. Chem., 13, 2395-401* (2003).

[9] S. Y. Marzouk, N. A. Elalaily, F. M. Ezz-Eldin, and W. M. Abd-Allah, "Optical absorption of gamma irradiated lithium- borate glasses doped with different transition metal oxides," *Physica B 382, 340-51*, (2008).

[10] H. A. ElBatal, Z. E. ElMandouh, H. A. Zayed, S. Y. Marzouk, G. M. Elkomy, A. Hosny, "Gamma rays interaction with copper doped lithium phosphate glasses," *J. Molecular Structure, 1054-1055, 57-64*, (2013).

[11] Ibrahim, A.M. Abdelghany, "Optical and FTIR spectra of NdF_3-doped Borophosphate glasses and effect of gamma irradiation," *J. Molecular Structure, 1030 107-12*, (2012).