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Effect of Gamma Irradiation on Optical Properties of Rare Earth Ions Incorporated with Borate

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KEYWORDS:*Sodium lead calcium borate glass, Pr^{3+} ions, UV/Visible Spectroscopy, X Ray Diffraction, Gamma irradiation*.

ABSTRACT:UV–Visible absorption spectra of glasses with molecular glass composition $20Na_2O$-$10PbO$-$10CaO$-$60B_2O_3$ and Pr^{3+}-doped glass samples have been investigated. After gamma irradiation repeated the spectral measurements and it is observed that decrease in intensities of adsorption bands. The XRD analysis sample confirms the glassy nature before and even after gamma irradiation. By irradiation of samples shows induced defects which were analyzed.

INTRODUCTION

The glass former, borate which has been extensively studied due to its various attractive features likeit is inexpensive, higher relative stability good host for alkali,rare-earth ions, alkaline earth, ease of preparation and high transparency.[1-4] When a glass is subjected to gamma radiation dose as result of induced defects glass becomes darkly colored. With progressive gamma irradiation, this radiations damage in glass may come under three categories such as photochemical effects, charge and ionization trapping and atomic displacement.The rare earth Pr^{3+} has been use since this is an excellent optical activator. It can be used in lasers, Up-converters, Optical amplification etc.[5-9]

The main aim of present work is to characterize and compare the optical absorption spectra the preset glasses after gamma irradiation discussed in detail and compared with existing results before irradiation which already published.[10]

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METHODS/EXERIMENTAL

The glass samples having composition 10CaO -20Na2O -10PbO -xPr_2O_3-$60B_2O_3$) (where, x=0, 0.1mol% of Pr^{3+}, 0.3mol% of Pr^{3+}, 0.5 mol% of Pr^{3+}) is which are named as C-G,C01_G,C03_G,C05_G were prepared by normal melt quenching technique. The mixture ofpraseodymium trioxide (99.99%), calcium carbonate, lead oxide, sodium carbonate and boric acid were mixed in agate and motor for around 20 minutes and these mixtures were transferred to crucible this kept in furnace. The batch was then melted at1000-1080°C for around 30 minrapidly poured on a brass mouldsto get pellet which werepreheated. The absorption spectra was recordedin the wavelength range 300nm -800nm using Pekin Elmer lambda-35 UV-Vis spectrometer.XRD measurements (RigakuUltima IV) usingλ = 1.54 Å (Cu-Ka radiations), the glassy nature was confirmed. With 1.5 Gy/s (150 rad/s) dose rate, ^{60}Co gamma cell (2000 Ci) asgamma ray source was used at a temperature of 30^0C. All the glass with 30 KGy of dosesubjectedfor 3hr 31minutes.

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RESULTS AND DISCUSSION

XRD measurements: XRD profiles of C-G are gamma Irradiated and C is Non-Irradiated glasses.

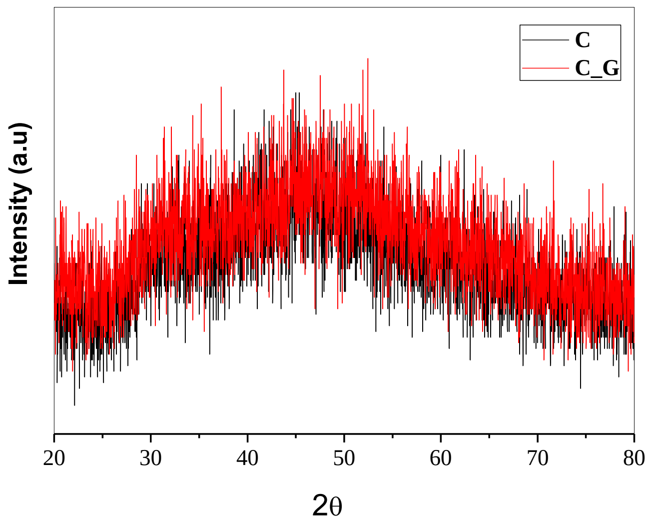

Figure 1. Typical XRD patterns of gamma Irradiated and Non-Irradiated base glass samples.

Optical absorption spectra:

We can clearly observe inhomogeneous prominent four peaks at592nm,482nm,470nm and 443nm are due to $^3P_2$,$^3P_1$, $^3P_0$ and $^1D_2$ respectively from ground state $^3H_4$ of Pr^{3+}ions. Peakintensity increasing as the Pr^{3+} ions concentration was increased. On gamma irradiation, it should be noted that no significant peak can be observed in the Fig 2 and the UV absorption decreases in intensity. It is assumed that this is due to radiolytic bleaching, optical absorption decrease which cause destruction of the nonbridging oxygen.[11]

As Pr^{3+} ions concentration is increased in host matrix of irradiated glasses, the Direct(E_D) and even indirect band gap (E_{In}) also shows decreasing in nature in Fig3(a) and (b) respectively. The Urbach energy (E_U) increases which is observed in Fig 4. Values of E_D, E_{In} and $E_U$of C_G, C01_G, C03_G, C05_G glasses are estimated and tabulated in Table.1.

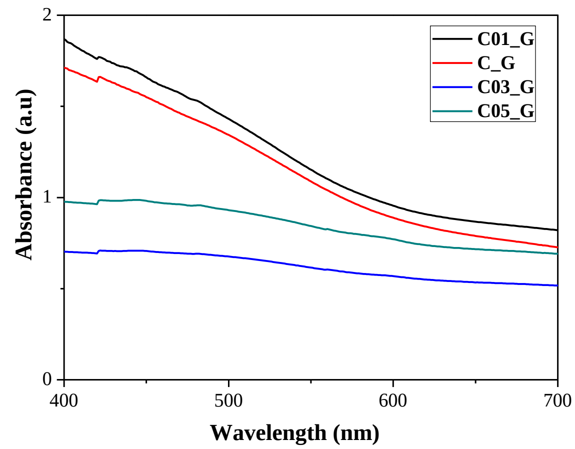

Fig2. Absorption spectra of gamma irradiated glasses.

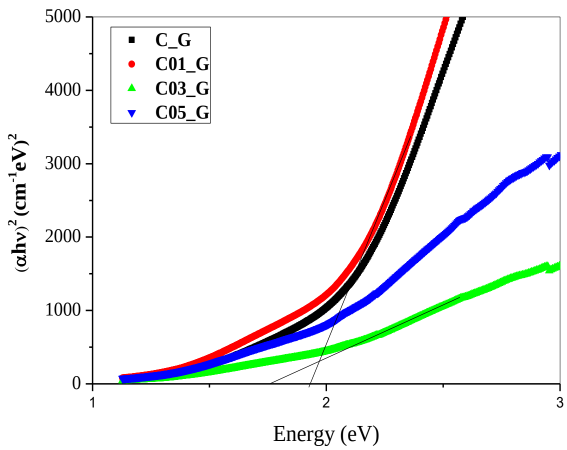

Fig3(a). Direct band gap of irradiated C series.

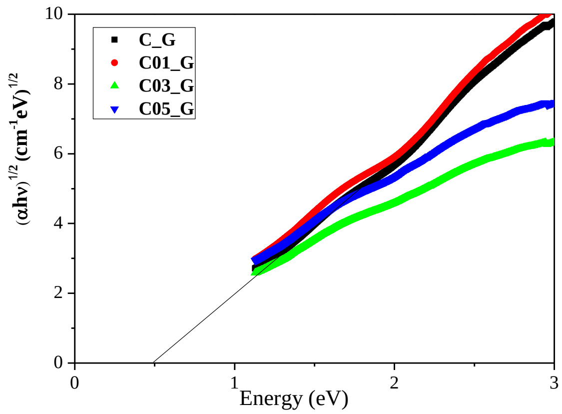

Fig3(b). Indirect band gap of irradiated C series.

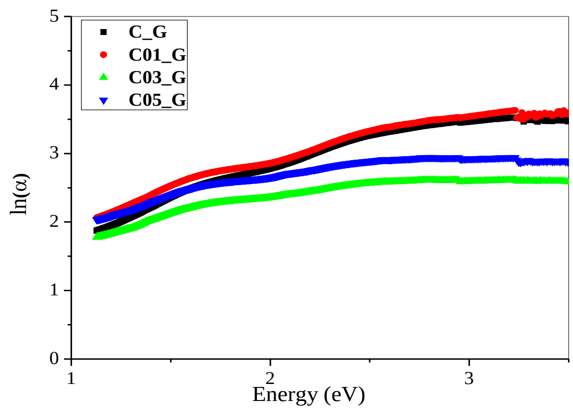

Fig.4. Urbach energy of irradiated C series.

Table1. Direct(E_D), Indirect(E_{In}) band gap and Urbach energy(E_U) for all gamma irradiated glasses sample doped Pr^{3+} oxide.

Glasses	Direct band gap (eV)	Indirect band gap (eV)	Urbach energy
C_G	1.94	0.95	0.97
C01_G	1.98	0.99	0.98
C03_G	1.77	0.35	2.4
C05_G	1.76	0.23	2.08

CONCLUSIONS

The effect of gamma irradiation is discussedin the present work, on the optical properties of calcium lead sodium borate glasses doped with Pr^{3+} were analyzed. The glassy nature of the samples is confirmed by XRD technique, before and even after gamma irradiation. Colors of the Pr^{3+} ions glasses before irradiation were light green in color and after irradiation; glasses exhibited deep brownish colors. The radiation induced activation of color center (color change) due to amorphous, non-crystalline structure of glasses. On gamma irradiation no significant peak can be observed and the UV absorption decreases in intensity.

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