

CHAPTER 5 CONCLUSION

Virtually any materials can be formed as a glass under the proper experimental conditions. The property of glass depends on chemical compounds, elements or heat treatment. Glass affords considerable flexibility in size and shape, and can be doped or activated to excellent uniformity. The possibility to control physical and luminescence properties of glasses by a proper variation of glass composition suggests the feasibility of a chemical control of the materials according to the needs of respective applications. The objectives of this research were to investigate physical, structural, optical and luminescence properties of prepared zinc bismuth borate glasses. The aim of this research was to study and characterize the properties of zinc bismuth borate (ZBB) glasses and investigate Eu^{3+} ion doped in zinc bismuth borate (ZBB) glasses.

5.1 Zinc Bismuth Borate Glass Samples

5.1.1 General Characteristic of Glass Samples

This research, zinc bismuth borate glass doped with different bismuth concentrations (Bi^{3+}) in the form of chemical compound oxides (Bi_2O_3), prepared using the glass composition formula $10\text{ZnO} : x\text{Bi}_2\text{O}_3 : (90 - x)\text{B}_2\text{O}_3$ (where $x = 15, 20, 25$ and 30 mol %) Zinc bismuth borate glass samples were prepared by the use of the melt quenching technique at the melting temperature of $1,100^\circ\text{C}$ at 3 hour time intervals. Glass samples were annealed at the temperature of 500°C at 3 hour time intervals to remove thermal strain. All glass samples shows yellow color. The results found that, from X - ray diffraction pattern was used to confirmed amorphous nature of glass samples.

5.1.2 Density, Molar Volume and Hardness

In this case, when add Bi_2O_3 in zinc bismuth borate glasses. The loose packing increases due to Bi_2O_3 act as modifier. Density and hardness were increased with an increase in Bi_2O_3 concentration. The behavior of molar volume mainly depends upon the density of glasses, it follows a trend opposite to density. The molar volumes of glasses were increased with increasing of Bi_2O_3 concentration, reflecting that the glass structure was compacted.

5.1.3 Gamma - Rays Shielding Properties

The zinc bismuth borate glasses (ZBB) were prepared at various Bi_2O_3 concentrations and characterized for their radiation shielding. The measured values of mass attenuation coefficients, effective atomic number and effective electron density of the glasses decrease toward higher energy of gamma - rays and are in good agreements with theoretical values. The ZBB glasses with Bi_2O_3 composition higher than 25 mol % (25 and 30 mol %) show lower values of MFP than all the standard shielding concretes in this studied. These results are good indications that the ZBB glasses in the present study can be used as radiation shielding materials. For the glasses containing Bi_2O_3 of 15 and 20 mol %, they exhibit better shielding properties than steel-magnetite concrete

at energies below 398 keV and 481 keV, respectively. The study results are useful for design a lead free radiation shielding glass in the appropriate energy range.

5.1.4 UV - VIS Absorption Study

From optical spectra of zinc bismuth borate glass doped with different bismuth concentrations, that shift of the absorption edge or cut - off wavelength to longer wavelength with increase in Bi_2O_3 content are related to the progressive increase in the concentration of non - bridging oxygen (NBO) atoms.

5.1.5 Luminescence Properties

The ground state of Bi^{3+} doped zinc bismuth borate glasses is $^1\text{S}_0$ and the excited states are $^3\text{P}_0$, $^3\text{P}_1$, $^3\text{P}_2$ and $^1\text{P}_1$ in a sequence of energy increasing. The transitions $^1\text{S}_0 \rightarrow ^3\text{P}_0$ or $^3\text{P}_2$ are spin forbidden and $^1\text{S}_0 \rightarrow ^3\text{P}_1$ or $^1\text{P}_1$ are lifted by spin-orbit coupling. So, the latter two have relatively higher absorption strength than the former two. A broad band can be seen from the excitation spectra in the near UV range, 300 - 357 nm with its centre at 302 nm and several weak peaks in the range 570 - 630 nm.

The lifetime curve exhibited single exponential nature in all the glasses and the measured lifetime increases with increase of Bi^{3+} concentration.

5.2 Eu^{3+} Ion Doped in Zinc Bismuth Borate (ZBB) Glass Samples

5.2.1 General Characteristic of Glass Samples

Zinc bismuth borate glass doped with different europium concentrations (Eu^{3+}) in the form of chemical compound oxides (Eu_2O_3), prepared using the glass composition formula $(60 - x)\text{B}_2\text{O}_3 : 30\text{Bi}_2\text{O}_3 : 10\text{ZnO} : x\text{Eu}_2\text{O}_3$ (where $x = 0.0, 0.2, 0.4, 0.6, 0.8$ and 1.0 mol %) ZBB glass samples with different concentrations of Eu^{3+} from 0.0 to 1.0 mol % were prepared by the use of the melt quenching technique at the melting temperature of $1,100^\circ\text{C}$ at 3 hour time intervals. Glass samples were annealed at the temperature of 500°C at 3 hour time intervals to remove thermal strain. All glass samples shows yellow color. The results found that, from X - ray diffraction pattern was used to confirmed amorphous nature of glass samples.

5.2.2 Density, Molar Volume and Hardness

Density and hardness were increased with an increase in Bi_2O_3 concentration. The behavior of molar volume mainly depends on the density of glasses and as expected in the present case, it follows a trend opposite to density. The molar volumes of glasses were decreased with increasing of Eu_2O_3 concentration, reflecting that the glass structure was compactness with higher concentration of Eu_2O_3 , which leads to decrease average atomic separation.

5.2.3 UV - VIS -NIR Absorption Study

The room - temperature ground-state absorption spectra of Eu^{3+} doped zinc bismuth borate glasses in the wavelength range from 1,800 to 2,400 nm. The bands are assigned as absorptions from the ${}^7\text{F}_0 \rightarrow {}^7\text{F}_6$ (2,076 nm) and ${}^7\text{F}_1 \rightarrow {}^7\text{F}_6$ (2,198 nm) transitions levels. When the sample was doped with high concentration of Eu^{3+} the intensities of all the UV - visible and NIR peaks slightly increase higher than low concentration of Eu^{3+} .

5.2.4 Luminescence Properties

From emission spectra of Eu^{3+} doped zinc bismuth borate glasses, five emission transitions were observed, which are assigned to ${}^5\text{D}_0 \rightarrow {}^7\text{F}_0$ (579 nm; yellow), ${}^5\text{D}_0 \rightarrow {}^7\text{F}_1$ (589 nm; orange), ${}^5\text{D}_0 \rightarrow {}^7\text{F}_2$ (613 nm; red), ${}^5\text{D}_0 \rightarrow {}^7\text{F}_3$ (651 nm; deep - red) and ${}^5\text{D}_0 \rightarrow {}^7\text{F}_4$ (696 nm; deep - red) transitions. For all the glasses studied, the strongest peak was found at 613 nm (red emission) and increases with increase of Eu^{3+} concentration.

From X - ray luminescence spectra, all samples emitted a luminescence with the emission peaks at 589 nm, 613 nm and 696 nm. The emission spectra peaks were due to the ${}^5\text{D}_0 \rightarrow {}^7\text{F}_0$ (589 nm), ${}^5\text{D}_0 \rightarrow {}^7\text{F}_2$ (613 nm) and ${}^5\text{D}_0 \rightarrow {}^7\text{F}_0$ (696 nm) respectively. The X - ray luminescence intensities of peak at 613 nm are slightly increased with increasing of Eu_2O_3 concentration and the strongest intensity peak at 613 nm was obtained, similar with photoluminescence result.

This glass samples can be used for luminescence materials application with strong red luminescence. In addition, the scintillation properties were confirmed and possible to develop glass scintillator in future.

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