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Optical analysis of Cu^{2+}: CdO - Li_2O - B_2O_3 -TeO_2 glass

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ABSTRACT
This article reports on the optical analysis of Cu^{2+} (0.5 mol %): $59.5B_2O_3$ – 20 TeO_2 – 10CdO – $10Li_2O$ glass. From XRD spectrum , amorphous nature of the glass has been studied. Absorption spectrum of the copper glass shows a broad absorption band ($^2B_{1g}\rightarrow{}^2B_{1g}$) at 829 nm has been observed. Emission spectrum of Cu^{2+} (0.5 mol %): $59.5B_2O_3$ – 20 TeO_2 – 10CdO – $10Li_2O$ glass has exhibits a blue emission at 439 nm with an excitation wavelength 379 nm.
***Keywords**:* absorption, Cu^{2+} : glass, emission, excitation, XRD

I. INTRODUCTION

In recent years, a great deal of work has been carried out on tellurium oxide (TeO_2) based glasses. TeO_2 based glasses are of great scientific and technological interest due to their unique properties such as good chemical durability, high dielectric constant, electrical conductivity, transmission capability, high refractive indices and low melting points [1, 2]. It is well known that a pure TeO_2 chemical does not form a glass under usual quenching rates but it does so when it is mixed with certain other oxides such as B_2O_3, Li_2O and CdO etc., TeO_2 based glasses doped with rare earth and transition metal ions have received significant attention because they can considerably change density, optical and thermal properties of these glasses [3-7]. The applications of tellurite glasses in industries such as electrical, optical, electronic and other fields are immense due to their good semiconducting properties [8]. Transition metal ions doped glasses are of great importance because of their applications in various fields. In glasses, copper can emit bluish green colour and exist as a monovalent (Cu^+) ion, or as a divalent (Cu^{2+}) ion. In the present work, we have studied the CLBT glasses with Cu^{2+}as the dopant transition metal ions to analyze their optical properties systematically.

II. EXPERIMENTAL

2.1 GLASS PREPARATION

The chemicals used were reagent grade of H_3BO_3, Li_2O, CdO, TeO_2, CuO. Transition metal ion (Cu^{2+}) doped CLBT glass is prepared by melt quenching method in the following composition.
20 TeO_2 – $59.5B_2O_3$ – 10CdO – $10Li_2O$ - $0.5Cu^{2+}$

All the weighed chemicals were finely powdered. Each batch of (10g) was melted in an alumina crucibles in an electric furnace at 950^0C, for an hour. These melts were quenched between two brass plates to get 2-3 cm diameter optical glasses with a uniform thickness of 0.2 cm. All the samples were annealed at 200^0C for an hour to remove the thermal strains.

Powder X-ray diffraction (XRD) spectrum was obtained on a Shimadzu XD3A diffractrometer with a Ni-filter and $CuK_\propto$ (=1.542 A^0) radiation with an applied voltage as 30kV and 20mA anode current, calibrated with Si at the rate of 2^0/min. The optical absorption spectrum of Cu^{2+} glass is obtained on a Varian-Cary Win Spectrophotometer. Both the excitation and emission spectra of the glass were obtained on a SPEX Fluorolog-2 Fluorimeter (Model II) with a datamax software to acquire the data with a Xe-arc lamp (150W) as the excitation source.

III. RESULTS AND DISCUSSION

The free ion term Cu^{2+} ($3d^9$) is ^2D. In octahedral crystal field, it splits into ^2E_g and $^2T_{2g}$ with being the lower level. ^2E_g generally splits due to Jahn - Teller effect. Therefore, Cu^{2+} is rarely found in regular octahedral site. Accordingly, in the present investigation, Cu^{2+} is taken to be octahedrally coordinated by six oxygen atoms and the octahedron is tetragonally distorted. Therefore in the tetragonally distorted octahedral environment, the ^2E_g level splits into $^2A_1$ and $^2B_1$ and $^2T_{2g}$ levels into ^2E and $^2B_2$, the ground state being $^2B_1$[10].

XRD pattern of (0.5 mol %) Cu^{2+}: CLBT glass is shown in Fig.1. From this pattern, the glass amorphous nature has been confirmed. The absorption spectrum of (0.5 mol %) Cu^{2+}: CLBT glass is shown in Fig.2. From this figure an absorption band centered at 829 nm is observed and is assigned to the transition $^2B_{1g}\rightarrow$ $^2B_{2g}$. The optical absorption studies confirm the presence of Cu^{2+} ions in the 20 TeO_2 – $59.5B_2O_3$ – 10CdO – $10Li_2O$: $0.5Cu^{2+}$ glass.

The excitation spectrum of (0.5 mol %) Cu^{2+}: CLBT glass is shown in Fig.3. with an excitation band at 379 nm. According to ligand field theory, oxide based glasses could show charge transfer bands in the UV region due to the absorption by the oxygen ligands around the cations. This band is due to charge transfer phenomena caused by O^{2-} with an UV radiation exposure.

Fig. 4, indicates the emission spectrum of (0.5 mol %) Cu^{2+}: CLBT glass, which shows two emission bands at 418 nm and 439 nm respectively with an excitation wavelength 379 nm. Among these two, the intense emission band at 439 nm indicates blue emission.However, according to an earlier report [9], emission at 439 nm arises due to localized excitation of isolated Cu^{2+} ions.

IV. CONCLUSION

It is concluded that, we have developed transparent, moisture resistant and more stable optical glass based on the chemical composition of (0.5 mol%) Cu^{2+}: 20 TeO_2 – 59.5B_2O_3 – 10CdO – 10Li_2O .Keeping in view of these encouraging optical properties, Cu^{2+} glasses have been selected to examine its amorphous nature through XRD spectrum. Absorption spectrum has revealed the presence of Cu^{2+} ions, in the glass investigated. Emission spectrum of Cu^{2+} (0.5 mol %): 20 TeO_2 – 59.5B_2O_3 – 10CdO – 10Li_2O: 0.5Cu^{2+} glass has revealed a blue emission at 439 nm with an excitation wavelength 389 nm. Based on the spectral results, we suggest that, the Cu^{2+} glasses have potential applications to carry on further research work with several other transition metal ions. Such novel glasses are considered as potential optical systems. It is strongly contemplated for further development in future as laser materials doping with suitable lasing ions.

V. ACKNOWLEDGEMENTS

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REFERENCES

[1.] S. Tanabe, K. Hirao, N. Soga J. Non-Cryst. Solids 122(1) (1990) 79-82.
[2.] H. Nasu, O. Matsusita, K. Kamiya, H. Kobayashi, K. Kubodera J. Non-Cryst. Solids 124 (1990) 275-277.
[3.] K. Kumar, S. B. Rai, D. K. Rai Spectrochim. Acta A 66 (2007)1052-1057.
[4.] Arshpreet Kaur, Atul Khanna, Carmen Pesquera, Fernando González, Vasant Sathe J. Non-Cryst Solids 356 (2010) 864–872.
[5.] L. M. Sharaf El-Deen, M. S. Alsalhi, M. M. Elkholy, J. Alloy. Compd. 465 (2008) 333-339.
[6.] El SayedYousef, A. El-Adaway, N. El-Koshkahany, E. R. Shaaban, J. Phys. Chem. Solids 67 (2006) 1649-1655.
[7.] J. Ozdanova, H. Jicha, I. Jichy, J. Non-Cryst. Solids 353 (2007) 2799-2802.
[8.] H. Burger, W. Vogel, V. Kozhukharov Infrared Phys. 25 (1985) 395-409.
[9.] B. Sudhakar Reddy, S. Buddhudu, Bull. Mater. Sci. 30 (2007) 481-486.
[10.] R.V.S.S.N Ravikumar, R. Komatsu, K. Ikeda, A V. Chandrasekhar, L. Ramamoorthy, B.J. Reddy, Y.P. Reddy, P.S. Rao Physica B, 334 (2003) 398.

Figures

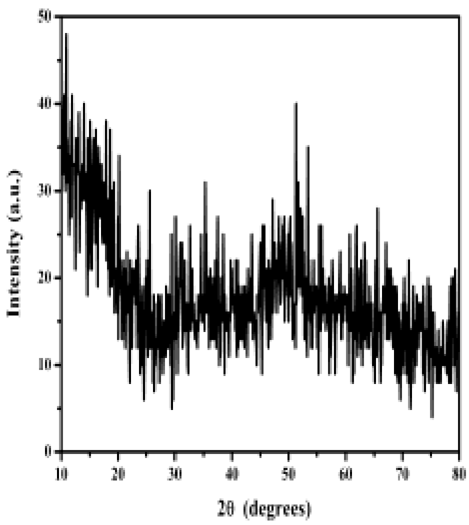

Fig.1. XRD spectrum of 20 TeO_2 – 59.5B_2O_3 – 10CdO – 10Li_2O - 0.5Cu^{2+} glass

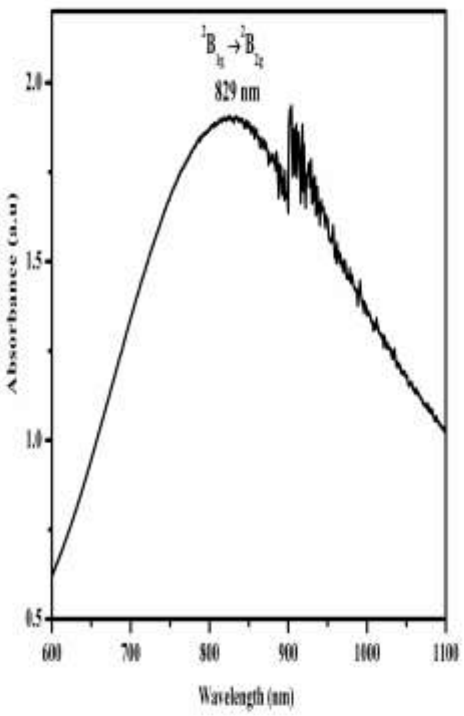

Fig.2.Absorption spectrum of 20 TeO_2 – 59.5B_2O_3 – 10CdO – 10Li_2O - 0.5Cu^{2+} glass

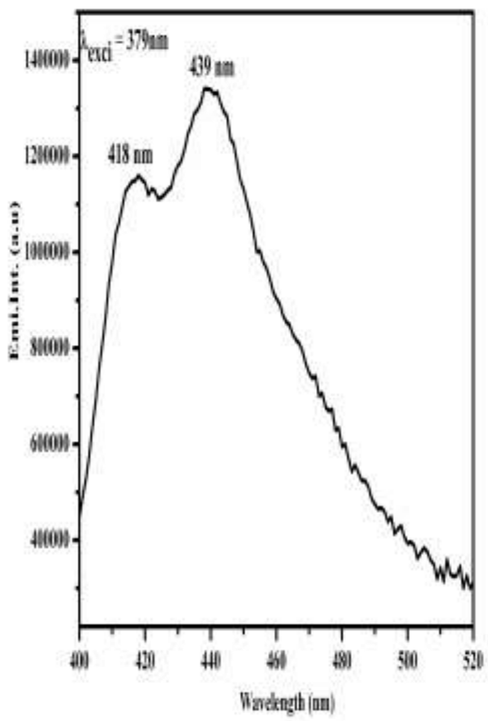

Fig.4.Emission spectrum of 20 TeO_2 – 59.5B_2O_3 – 10CdO – 10Li_2O - 0.5Cu^{2+} glass

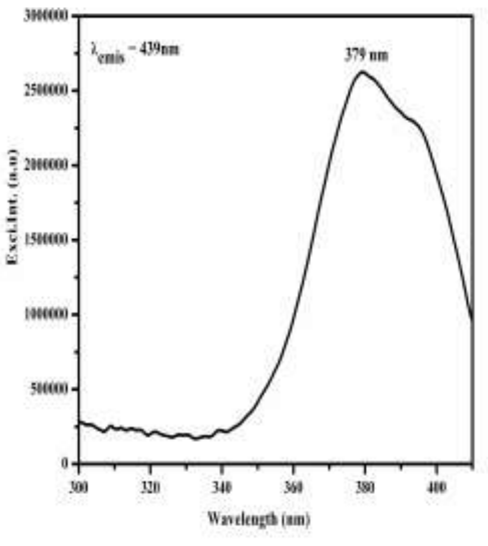

Fig.3.Excitation spectrum of 20 TeO_2 – 59.5B_2O_3 – 10CdO – 10Li_2O - 0.5Cu^{2+} glass