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Spectroscopic Analysis of a Simple Bandpass Absorption Filter Based On Copper Zinc Sodium Phosphate Glass.

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ABSTRACT

The phosphate glass system of chemical composition $(80-x) [(Na_2O)(P_2O_5)] - [20ZnO] - x [CuO]$ (where $x = 0, 1, 2, 3, 4$ and 5 mol%) has been prepared by the conventional glass melt technique. The X-ray diffraction technique has been used to investigate the structure of the prepared glass samples. Optical properties of the glasses were measured in the wavelength range. $190 - 2700$ nm. Absorption coefficient, energy band gap were calculated. The results reveal the importance of such glass composition in optical filter applications.

Keywords: spectroscopic, bandpass, glass.

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INTRODUCTION

Glasses containing alkaline earth oxides along with glass modifiers as ZnO, PbO, TeO₂ and Bi₂O₃ are promising materials for their applications in the fields of optical communications optical fibers, (laser hosts, optical filter, γ-ray absorbers, photonic devices etc. [1–5]. various alkaline earth oxide glasses have a variations in structural, physical, optical and electrical properties which were reported by many researchers[6-8]. Heavy metal oxides doped glasses have a good chemical durability and larger refractive indices than conventional borosilicate glasses [9–12]. The glasses containing glass modifiers like ZnO, PbO and Bi₂O₃ give rise to good non-linear optical properties. The metal oxides like PbO and ZnO behave as glass network formers and also as glass network modifiers (GNM).The glasses with good optical properties are needed in many important technological applications.

EXPERIMENTAL TECHNIQUES

The preset copper doped Phosphate glass system with a chemical composition (80-x)[(Na₂O)(P₂O₅)]–20[ZnO]– x [CuO] where x = 0,1,2,3,4 and 5mol%was prepared by conventional melting method. The oxide components were carefully weighted and well mixed and Grinded in an agate mortar. The mixed powders were heated in 1000° C for 1 hour with clockwise shaking to ensure high homogeneity. The melts were casted in steel molding. The casted glasses were quenched at room temperature out of the furnace. The glass systems were examined by X-ray diffraction (XRD) Bruker AXS D8 Advance XRD diffractometer. The glass samples were used in the form of fine powder. The density of the prepared glassy samples were determined at room temperature by simple Archimedes method using toluene as the immersing liquid (ρ₀=0.8869 g/cm³) and a single pan balance of 10⁻⁴ g sensitivity. The density of each composition was obtained by using the relation:

$$\rho = \left(\frac{\omega_{air}}{\omega_{air} - \omega_l} \right) \rho_0 \quad (1)$$

Where ρ₀ is the density of the liquid toluene, ω_{air} and ω_l are the weight of the glass in air and toluene respectively. The molar volume was calculated according to the relation:

$$V_m = \frac{M\omega_{glass}}{\rho_{glass}} \quad (2)$$

Where, Mω is the glass molecular weight according to the mol % and ρ_{glass} is the density of the investigated glasses. The optical absorption was recorded at room temperature; UV/Vis/NIR absorption and transmission spectra were obtained for the bulk glass sample sand were measured by using jasco (V – 670) spectrophotometer in the wavelength range 190 - 2700 nm.

RESULTS AND DISCUSSION

Figure 1 shows XRD pattern of the prepared glasses with different CuO concentration. It is obvious that there are no sharp peaks indicating the non-crystalline nature of the prepared glasses.

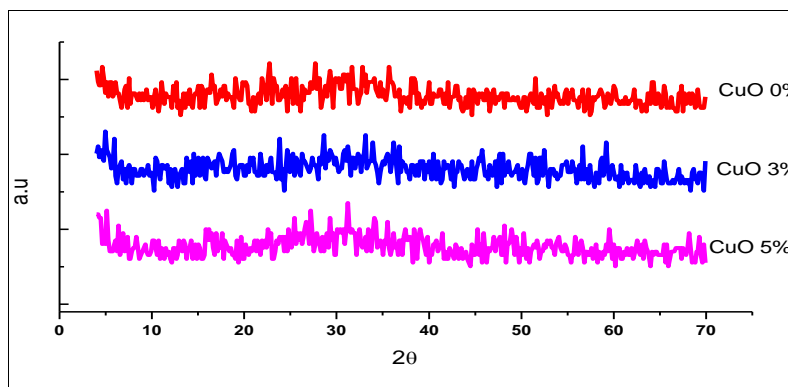


Fig 1: XRD analysis for glass samples

Fig. 2 shows the variation of density and molar volume with respect to composition. The density of these glasses first increases and then decreases with the content of CuO while corresponding molar volume first decreases and then increases. The density of these glasses should decrease due to replacement of high molecular weight P_2O_5 by low molecular weight CuO. But it is found that the density of these glasses increases with addition of CuO and correspondingly molar volume decreases, indicating that the copper polyhedra form some new interconnections within the structural network and thus stabilize the glass structure.

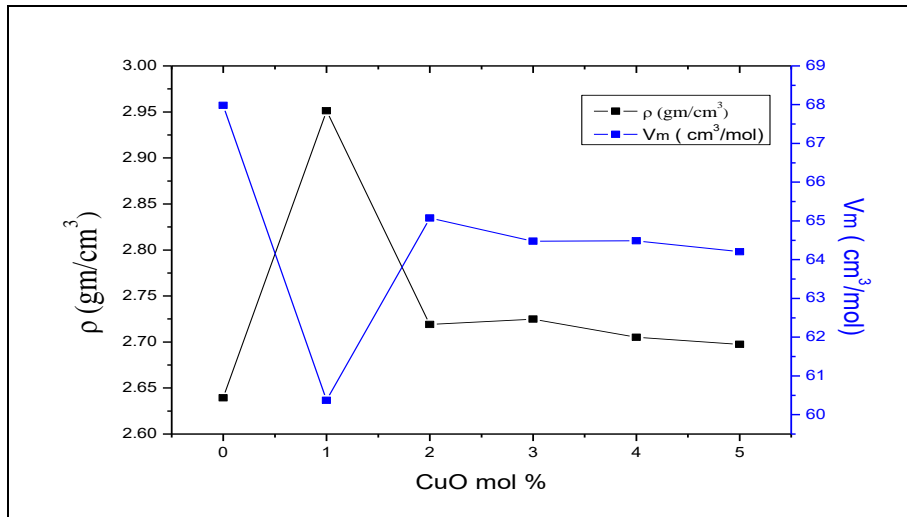


Fig 2: The density (ρ) and molar volume (V_m) as a function of CuO content for the investigated samples

In accordance with the measured Absorbance, the following values were calculated: absorption coefficient (α) as shown in figure 3, Energy band gap

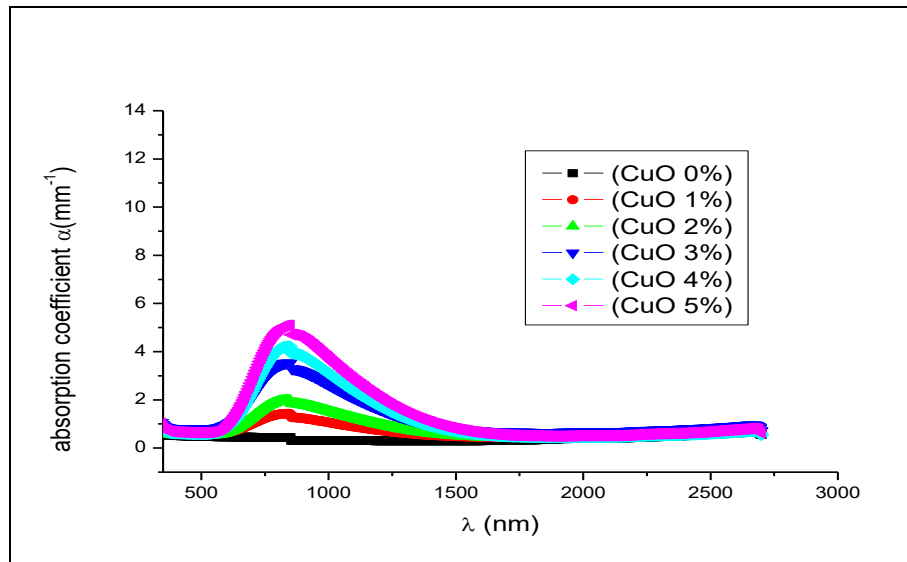


Fig 3: The absorption coefficient versus wavelength of the glass samples

The relation between $(\alpha h\nu)^{1/2}$ and the photon energy $h\nu$ was obtained, The extrapolation of the straight line to the zero absorption (the cut of the energy x-axis) in the $(\alpha h\nu)^{1/2}$ versus $h\nu$ plot gives the optical energy gap (E_g) as shown in Figure. 4.

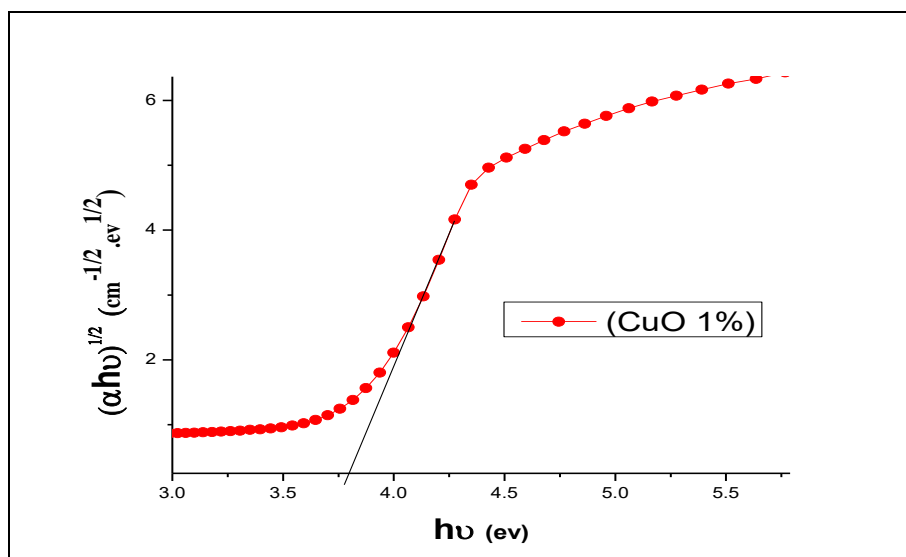


Fig 4: The optical energy gap

The obtained E_g values are 1.14, 3.79, 3.66, 3.75, 3.78, and 3.79 respectively for all samples.

It is clear that E_g values of the glass samples decreased with the increase in CuO content. In the present investigation, the change of E_g towards lower energies with increases in CuO content is probably related to the progressive increase in the concentration of non-bridging oxygen.

CONCLUSION

The glasses compositions were prepared by the conventional melting technique, the XRD patterns shows amorphous nature of all prepared samples. The trend of the density and molar volume curve due the sodium phosphate glass change its structure. The material is good to be semiconductor applications and band pass absorption glass filters.

REFERENCES

- [1] Yahia H. Elbashar, "Structural and spectroscopic analyses of copper doped P2O5-ZnO- K2O-Bi2O3 glasses", International Journal: Processing and application of ceramics, 9 [3] (2015) 169–173.
- [2] Y.H.Elbashar, Aly Saeed, "Computational spectroscopic analysis by using Clausius–Mossotti method for sodium borate glass doped neodymium oxide", Research Journal of Pharmaceutical, Biological and Chemical Sciences (RJPBCS), volume 6, issue 5, September – October, Pages 320-326.
- [3] Aly Saeed, Y. H. Elbashar, S. U. El Kameesy, "Study of Gamma Ray Attenuation of High-Density Bismuth Silicate Glass for shielding applications", Research Journal of Pharmaceutical, Biological and Chemical Sciences (RJPBCS), volume 6, issue 4, July – August 2015, pages 1830-1837.
- [4] Aly Saeed, Y. H. Elbashar, S. U. El Kameesy, "Towards modeling of copper-phosphate glass for optical bandpass absorption filter", Research Journal of Pharmaceutical, Biological and Chemical Sciences (RJPBCS), volume 6, issue 4, July – August 2015 , pages 1390- 1397.
- [5] D.A. Rayan, Y.H. Elbashar, A.B. El Basaty and M.M. Rashad, "Infrared spectroscopy of cupric oxide doped barium phosphate glass", Research Journal of Pharmaceutical, Biological and Chemical Sciences (RJPBCS), volume 6, issue 3, May – June 2015, pages 1026-1030.
- [6] H. Elhaes , M. Attallah , Y. Elbashar , M. Ibrahim , M. El-Okr, "Application of Cu2O-doped phosphate glasses for bandpass filter", Journal of Physica B: Condensed Matter, Volume 449, 15 September 2014, Pages 251–254.
- [7] Aly Saeed, R. M. El shazly, Y. H. Elbashar, A. M. Abou El-azm, M. M. El-Okr, M.N.H.Comsan, A. M. Osman, A. M. Abdal-monem, A. R. El-Sersy, "Gamma Ray Attenuation in Developed Borate Glassy", Journal of Radiation Physics and Chemistry, Volume 102, September 2014, Pages 167-170

- [8] Nehal Aboufotouh, Yahia Elbasha, Mohamed Ibrahim, Mohamed Elok, "Characterization of copper doped phosphate glasses for optical applications", *Journal of Ceramics International* ,Volume 40, Issue 7, Part B, August 2014, Pages 10395–10399.
- [9] Hanan Elhaes, Mohamed Attallah, Yahia Elbasha, Ayser Al-Alousi, Mohamed El-Okr, and Medhat Ibrahim , "Modeling and Optical Properties of P2O5-ZnO-CaO-Na2O Glasses Doped with Copper Oxide", *Journal of Computational and Theoretical Nanoscience* 11 (10), 2079-2084.
- [10] D. A. Rayan, Y.H.Elbashar , M.M. Rashad , and A. El-Korashy, " Spectroscopic analysis of phosphate barium glass doped cupric oxide for bandpass absorption filter ", *Journal of Non- crystalline solids*, Volume 382, 15 December 2013, Pages 52–56.
- [11] AlySaeed, Y. H. Elbasha, R. M. El shazly, "Optical Properties of High Density Barium Borate Glass for Gamma Ray Shielding Applications", *Journal of Optical and Quantum Electronics* (2016) 48:1.
- [12] A.M. Abdelghany, H.A. ElBatal, F.M. EzzElDin, "Influence of CuO content on the structure of lithium fluoroborate glasses: Spectral and gamma irradiation studies", *SpectrochimicaActa Part A: Molecular and Biomolecular Spectroscopy*, Volume 149, 5 October 2015, Pages 788-792.