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PII: S0264-1275(16)30018-1
DOI: doi: 10.1016/j.matdes.2016.01.018
Reference: JMADE 1219

To appear in:

Received date: 17 August 2015
Revised date: 3 January 2016
Accepted date: 6 January 2016

Please cite this article as: K. Hayder, H. Obayes, R. Wagiran, M.A. Saeed, Structural and optical properties of strontium/copper co-doped lithium borate glass system, (2016), doi: 10.1016/j.matdes.2016.01.018

Structural and optical properties of strontium/copper co-doped lithium borate glass system

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Abstract

There is continuous search for materials having superior optical and structural properties in glass photonics, thermoluminescencedosimetry and phosphorsfields. A new series of copper (Cu)/strontium (Sr) co-doped lithium borate glasses (LB:Sr, Cu) of composition (85-*x*)H_3BO_3-15Li_2CO_3-2$SrCO_3$-*x*Cu_2O, where x = 0.005 to 0.1 mol% were prepared using melt quenching method. Synthesized glasses are characterized to determine the concentration's effect of copper ions (Cu^{2+}) on modification of the structural and optical properties. XRD patterns confirmed theamorphous nature and FESEM verified the homogeneous surface morphology. EDX spectra authenticated the accurate elemental traces. Glasses are thermally stable with Hurby parameter ~ 0.5. Glass density decreases with the increasing Cu^{2+} concentration.FTIR peaks in the range of 698-1070 cm^{-1} attribute totrigonal and tetrahedral stretching vibrations of BO_3 and BO_4 units. The direct/indirect band gap and Urbach energy vary from 3.1-2.8 eV/2.94-2.84 eV and 1.2-2.18 eV, respectively. The observed increase in refractive index ascribed to the conversion of BO_4 into BO_3 units. PL spectra under 280 nm excitations display two peaks centered at 482 and 526 nm accompanied by slight peak shift towards the lower wavelength. Excellent structural and spectroscopic characteristics of the present glass compositions indicate prospects for various photonic devices.

Keywords: Co-dopant concentration; Optical properties; Infrared spectra; Absorption; Photoluminescence.

1-Introduction

Semiconducting copper oxides are potentialmaterials due to their natural abundance of starting material copper (Cu), easiness of production by Cu oxidation, non-toxicity and reasonably superior electrical and optical properties [1]. Copper forms two well-known oxides such astenorite (CuO) and cuprite (Cu_2O). Both tenorite and cuprite are p-type semiconductors having band gap energy in the range of 1.21-1.51 eV and 2.10-2.60 eV,respectively[2, 3]. The conductivity arises from the presence of holes in the valence band (VB) due to doping [1]. CuO is attractive as a selective solar absorber due to significantly high solar absorbency and low thermal emittance[4]. Cu_2O is avery promising candidate for photovoltaic energy conversion [5, 6].Luminescent glass