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EPR, Optical and Physical Studies on Cr^{3+} doped $MgO-BaO-B_2O_3-TeO_2$ glasses

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Abstract:

Physical, optical and Electron Paramagnetic Resonance (EPR) studies on 15MgO-15BaO-(59.8-x) B_2O_3-(10+x) TeO_2-0.2Cr_2O_3 (x = 0,10,20,30 mole %) glass samples are reported. EPR spectra exhibited two resonance signals at g = 4.8 and g=1.98. The resonance signal with large zero field splitting parameter (D) and E/D ≤ 1/3 at g = 4.8 is attributed to isolated Cr^{3+} centers in strongly distorted octahedral sites, whereas the resonance signal at g = 1.98 is assigned to Cr^{3+} centers at axially distorted octahedral sites. The resonance signal at g = 4.26 is assigned to Fe^{3+} ions, which are present in the glass matrix as unwanted impurities. The resonance signal at g = 1.91 indicates the Cr^{3+}-Cr^{3+} exchange coupled pairs. The two observed broad optical bands in the optical absorption spectra 16025 cm^{-1} and 23474 cm^{-1} are assigned to $^4A_{2g}(F) \rightarrow {}^4T_{2g}(F)$ and $^4A_{2g}(F) \rightarrow {}^4T_{1g}(F)$ transitions respectively. The site symmetry of Cr^{3+} is C_{4v} or C_{3v}. Racah parameters, crystal field (D_q) parameters and energy gap are evaluated from the optical spectra. Various other physical parameters like density etc. have also been reported.

Key words: Borotellurite glasses; Electron Paramagnetic Resonance (EPR); optical absorption; physical properties.

1. Introduction

Now-a-days a great scientific revolution has been done by means of telecommunication, through mobile phones or via internet. People are connected to the entire world through internet and world has become a global village. The entire high speed telecommunication signal transmission basically depends on optical fiber network. The optical fiber network requires switches and routers. These electronic boxes particularly cannot meet the demands of communication industry [1] because their linear and non-linear properties play an important role to determine the features [2, 3]. For example linear properties like refractive index of transparent medium changes with intensity of light travels through it [4]. Thus glass industry plays a crucial role in glass fibers, whereas organic materials show very poor mechanical and thermal properties. Finally amorphous material like glass is a very good option for high intrinsic transparency, fast response time [5], excellent resistance to atmospheric conditions, mechanical and chemical durability. Hence glass is an important material in the field of optics [6] and optical communication systems.

Boric acid (H_3BO_3) is one of the important oxide for the glass formation. It exhibits a variety of structural changes when combined with different alkali and alkaline earth oxides. Linear and non-linear properties of borate glasses change with composition of oxides [7]. It is also used as dielectric and insulating medium as a shield against infra-red radiation [8]. TeO_2 based glasses are used in non-linear devices due to its property of forming glasses with higher refractive index (n>2), good thermal stability and low melting temperature [9]. The desired linear and non-linear optical susceptibility