

Synthesis and Characterization of New Amorphous Phases in Bi₂O₃-P₂O₅-SrO System

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Abstract— In the present work Bi₂O₃-P₂O₅-SrO glasses have been prepared via melt quenching method. A glass-forming domain is found and studied within Bi₂O₃-P₂O₅-SrO system. The glasses obtained in the system P₂O₅-SrO was investigated by Infrared Spectroscopy. FTIR studies have been performed in these glasses to examine the distribution of different phosphate structural groups. The effect of strontium on these distributions has been examined.

Index Terms— IR Spectroscopy, phosphates, glasses, Bi₂O₃-P₂O₅-SrO System

1. INTRODUCTION

In recent years, glasses are increasingly used as host material for solid state lasers based on rare earth and transition metal ionic transitions [1]. The advantages with glasses are the ease with which large homogeneous pieces can be produced. The nonlinear refractive indices can be made low and the doping concentration can be large [2]. It has been shown that the fluorescence intensity of rare earth ion are enhanced several fold when glass hosts with low phonon energies as example in germinate and telluride are used [2].

Phosphate glasses have received considerable attention in the past few years due to the synthesis of new glass compositions with high chemical stability. The improvement of chemical stability [3–5] stimulated the application of phosphate glasses in several fields of materials science, For example, zinc-calcium borophosphate glasses were investigated for application as glass seals or glass solders due to their low melting temperatures and low viscosities.[6] Alkali and silver borophosphates have been developed for fast-ionconducting applications such as for preparing electrolytes in solid-state electrochemical cells,[7] and the addition of niobium or calcium to borophosphate glasses was studied for applications in non-linear optical devices [8].

The present paper reports a preliminary investigation of new phosphate glasses in Bi₂O₃-P₂O₅-SrO system. Elaboration

process, vitreous domain, and infrared spectroscopy (IR) will be described successively.

2. EXPERIMENTAL PROCEDURE

The amorphous samples were prepared using high purity commercial materials Bi₂O₃, SrCO₃; NH₄H₂PO₄ of analytical grade (Aldrich 99.9%). The batches of suitable proportions of starting products were mixed in an agate mortar and then heated in air at 1100°C (2H) for vitreous phases. All of them are quenched to room temperature and identified by infrared spectroscopy.

3. RESULTS AND DISCUSSION

3.1. Glass formation region

A wide range glass system based on the Bi₂O₃-P₂O₅-SrO system was prepared at 1100°C after a series of composition. The vitreous was determined by X-ray diffraction .The glass formation region of the Bi₂O₃-P₂O₅-SrO system is illustrated in the figure 1 indicating a compositional range for glass formation: 50 < P₂O₅ < 100 mol%, 0 < Bi₂O₃ < 30 mol% and 0 < SrO < 50 mol%.

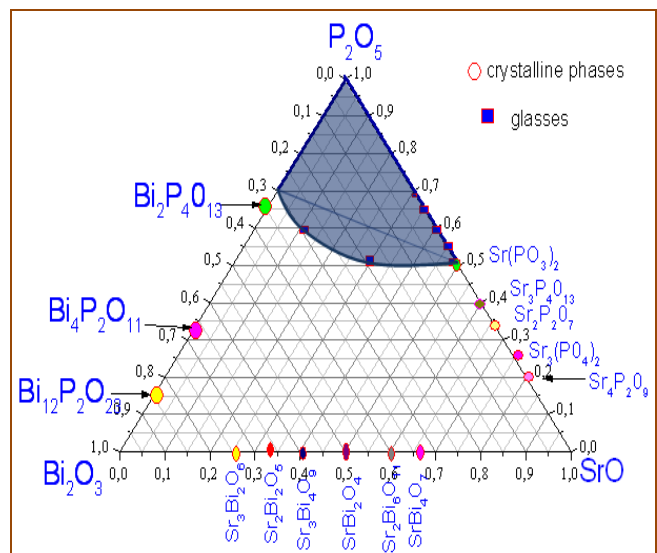


Figure 1: Vitreous domain diagram for the Bi₂O₃-P₂O₅-SrO system and the localized of crystallized phases and glassy phases

The phosphate glass samples obtained were transparent and showed no sign of devitrification. The photograph image of the studied glass have shown in Figure 2,

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Figure 2: Photograph image of glasses P₂O₅-SrO

3.2. Infrared Spectra Analysis

Figures 3–5 show FTIR spectra of glasses 70%P₂O₅–30%SrO, 65%P₂O₅–35%SrO, 60%P₂O₅–40%SrO, 55%P₂O₅–45%SrO, respectively, in the wave-number range from 400 cm⁻¹ to 4000 cm⁻¹.

The absorption band at 1270–1280 cm⁻¹ corresponds to the bonding O–P–O of the type ‘asymmetric stretching vibration mode’, denoted by ν_{as}(PO₂)⁻ [9,11].

The absorption band at around 1100 cm⁻¹ arises from asymmetric stretching vibration of P–O– bonding [12]

The absorption band at 920 cm⁻¹ is due to asymmetric stretching vibration of P–O–P bonding [12,13]; while those within 725–770 cm⁻¹ arises from symmetric stretching vibration of P–O–P bonding [12,13]. The two bands of P–O–P stretching vibration shift to higher wavenumbers while lower intensity with increasing SrO content.

Figures 3–6 demonstrate that with increasing SrO content, the P=O bonding intensity in the glasses decreases; O–P–O bonding is diminishing, while PO⁻ bond strength increases. That is to say, contents of Q³, Q² decrease while contents of Q¹ and Q⁰ increase. The reason is that as the ratio [P₂O₅]/[SrO] decreases, P–O–P bonding is more affected

by the modifier thus to leading to deterioration of the long phosphate chain and the subsequently to the formation of Q¹, Q⁰ bonding. Formations of P-O-H bonds express the hygroscopic nature of the phosphate glass.

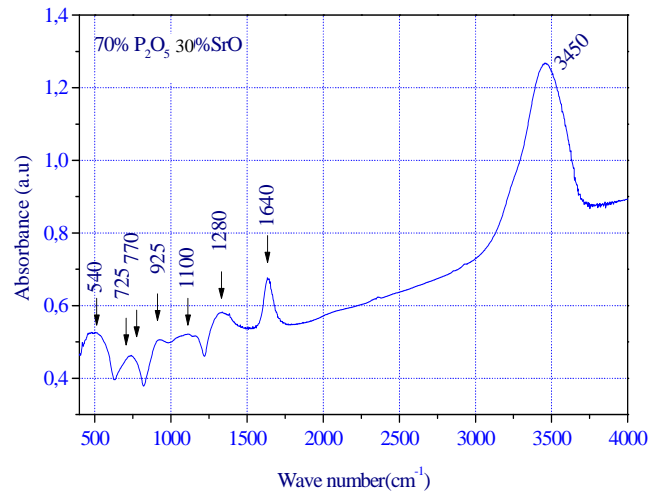


Figure 3 :Infrared spectra of 70% P₂O₅-30%SrO glass system

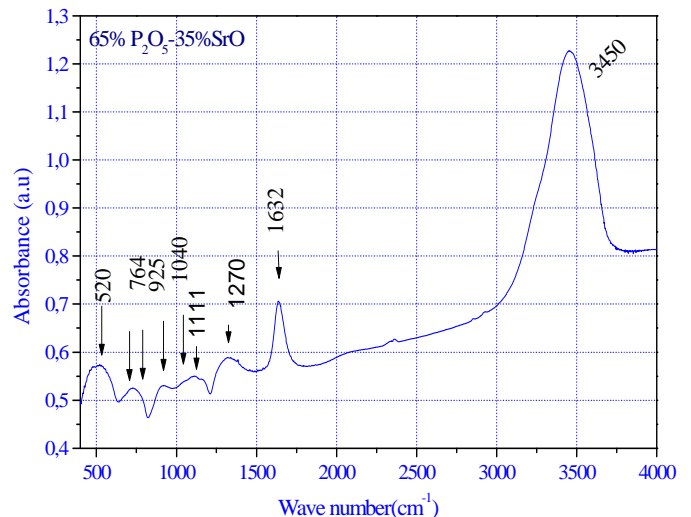


Figure 4 :Infrared spectra of 65% P₂O₅-35%SrO glass system

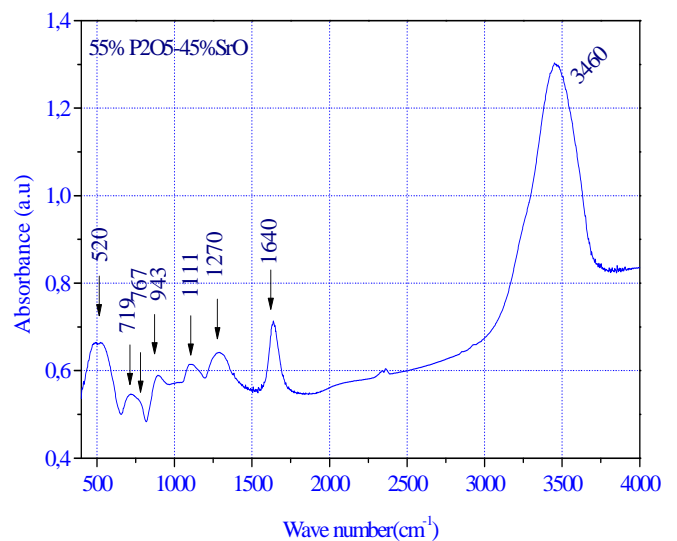


Figure 5 :Infrared spectra of 60% P₂O₅-40%SrO glass system

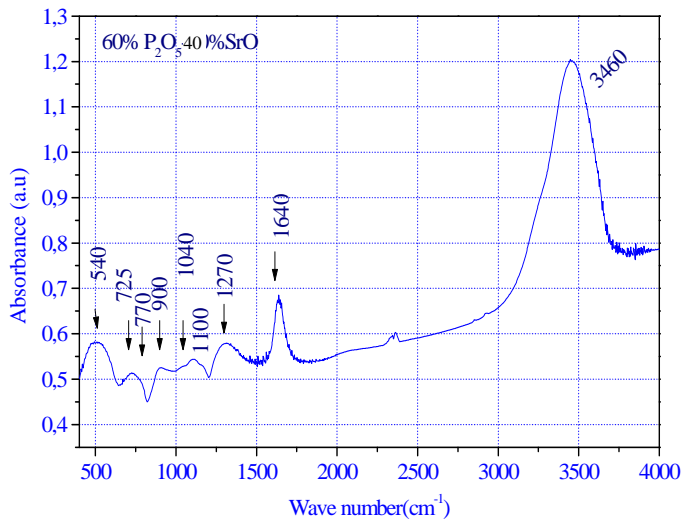


Figure 6 :Infrared spectra of 55% P₂O₅-45%SrO glass system

4. CONCLUSIONS

P=O bonding in the glasses disappears with increasing SrO content, while the O—P—O bonding diminishes with PO⁻ bond strength increases. That is to say, contents of Q³, Q² decrease while contents of Q¹ and Q⁰ increase

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