Structural Investigations Studies of Antimony-Tungsten and Sodium MetaphosphateGlass Systems with $NaPO_3$ as Additive

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ABSTRACT

Sb_2O_3-based heavy metal oxide glasses in the Sb_2O_3– WO_3–$NaPO_3$ ternary system were prepared. The physical properties and structural properties of the glasses have been investigated. From Raman and FTIR spectroscopy, the average cross-link density and number of network bonds per unit volume have been increased and discussed according to the create P-O-W strong linkage. The optical and structural properties of these glasses were found to be generally affected by the chemical changes in the glass composition due to the formation of linear chain of phosphate, that increase the connectivity and rigidity of the glass network. This work demonstrates that our glasses can be used for produce optical fiber application.

KEYWORDS: Sb_2O_3– WO_3–$NaPO_3$ ternary system, FTIR and Raman spectroscopy.

INTRODUCTION

Antimony oxide based glass has attracted extensive investigation in recent years; Since these glasses possess a large nonlinear optical susceptibility (χ3) coefficient [1] making them suitable for potential applications in nonlinear optical devices[2]. Phosphate-based glasses are among the most researched for potential applications in optical fields because they exhibit unusual physical properties when compared to silicate glass. In order to improve the chemical durability of these $NaPO_3$ based bottles, the formulations should be improved by adding the selected elements [3, 4]. WO_3 are of particular interest and have undergone several studies since controlling the molar composition can lead to specific optical properties[5]. In this paper, we report on the physical and structural properties of glasses in the Sb_2O_3–WO_3–$NaPO_3$ ternary system.

RESULTS AND DISCUSSION

We calculated the $\bar{n}_c$ and n_b of our SWN glasses by using the formula in[6]. The mean cross-link density, $\bar{n}_c$, is rise from 1.26 to 2, while the number of links per unit volume, n_b, is increased from 40,37 to 64.01× $10^{21}cm^{-3}$. Since Antimony oxide is substituted with another glass former ($NaPO_3$), which has a higher cationic coordination number than Sb_2O_3 ($n_{f(NaPO3)}$ = 4) and therefore creates a BO sites, the network has become stiffer and more linked in SWN glasses. With the increase in $NaPO_3$ concentration, both $\bar{n}_c$ and n_b values an improve enhancement (Table 1).

DOI: 10.21467/abstracts.122 ISBN: 978-81-954993-3-5

Table 1: Values of density (ρ), molar volume (V_m), average cross-link density ($\bar{n}_c$) and number of bonds per unit volume (n_b) of glasses in the SWN systems.

S.n°	ρ (g/cm^3)	V_m(cm^3/mol)	$\bar{n}_c$	n_b(×10^{21}cm^{-3})
SWN10	5.256	50,722	1,26	40,37
SWN20	4.975	49,777	1,37	42,35
SWN30	4.827	47,376	1,47	45,77
SWN40	4.580	45,792	1,58	48,67
SWN50	4.325	44,109	1,68	51,89
SWN60	4.068	42,236	1,79	55,62
SWN70	3.725	41,037	1,89	58,71
SWN80	3.471	38,578	2,00	64,01

The Raman spectra of the vitreous samples of system (90- x) Sb_2O_3-10WO_3-x$NaPO_3$ with x varying from 10 to 80, is shown in Fig.1.

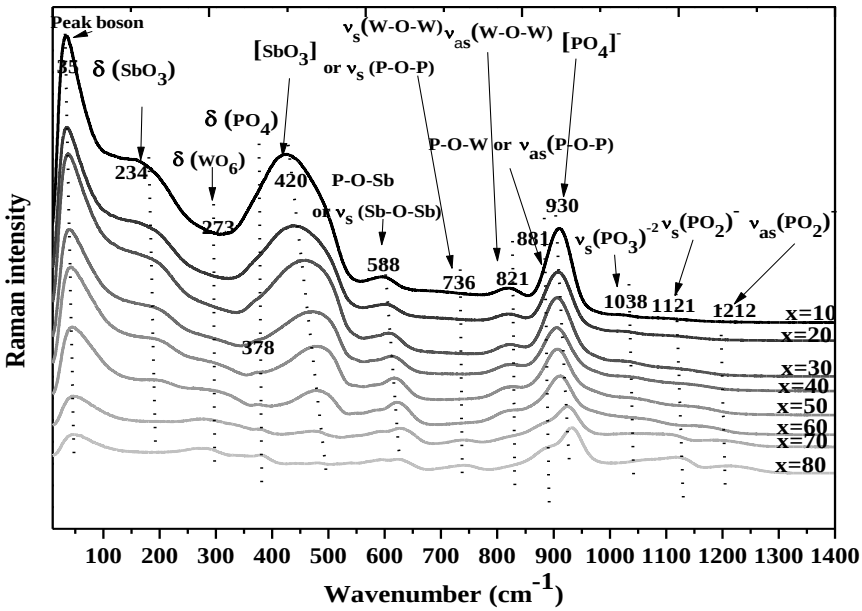

Fig.1: Raman absorption spectra of SWN glasses.

In conclusion, the stiff vitreous of the SWN samples is responsible for the formation of W-O-W, P-O-W, and P-O-Sb bonds. As a result of the increased $NaPO_3$ and the glass transition temperature rising, the NBO atoms are reduced[7].

CONCLUSION

In conclusion, the introduction of $NaPO_3$ into the SWN glass led to the formation of more linear chains, which reduced the number of NBOs and an increase in the structural compactness of these glasses. The structural studies of SWN glass supported this hypothesis by the formation of phosphate obeyed Q^2 with some modes of Q^1 and P-O-W linkage with the addition of $NaPO_3$. In general, these new glasses showed good behavior for producing optical fibers applications.

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DOI: 10.21467/abstracts.122
Series: AIJR Abstracts

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