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SYNTHESIS AND CORROSION STUDY OF BOROPHOSPHATE GLASSES

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ABSTRACT

Borophosphate glasses of composition 30Na2O - (60-y) B203 - yP205 -10 Al203 were prepared with the help of melt quench technique and studied the effect of corrosion on it. Polished samples of the borophosphate glass of various compositions were used for experiment. The glasses were characterized using XRD for their structural study. The polished samples of the borophosphate glass samples of various compositions 30NaO - (60-y) B2O3 - yP2O5 – 10 Al2O3 were exposed to 10% HCI and 10% NaOH separately at room temperatures for 24, 48 and 72 hrs. The effect of glass composition and the environment (acidic or alkaline) on the degradation behavior of these glasses was studied and interpreted. Weight loss was observed accordingly.

INTRODUCTION

A Borophosphate glass shows different useful properties, so that borophosphate glass becomes one of the important glasses of compounds. We find borate and phosphate in many glass systems. Calcium doped borophosphate found application as low Melton glass solders (Sanranti *et al.,* 2006). Several borophosphate glasses exhibit high chemical durability. Keeping in view of the fact that borophosphate glasses have attractive applications chemically more durable compared to both pure borate glasses (Kumar *et al.,* 2009). Glass is a powerful corrosion resistant than most of the substances. We can call glass as corrosion proof. In identifying several borate groups IR studies and NMR investigation were important (Veeranna Gowda and Anavekar, 2004). Borates group consists of boron oxygen triangle and tetrahedral which forms the glass network at various modifications levels (Hadj *et al.,* 2000; Vladimir *et al.,* 2010-2011). Up to 33.3% of Na_2O is found in alkali modified borate glasses. Where there is continuous formation of BO_3- BO_4 units and further increase in alkali which leads to the reconversion of BO_4 - BO_3 with non bridging oxygen. Other oxides can enter the glass network as a network former and also as a network modifier (Brow, 2000). Because of this structure of glass is expected to be different from that of alkali borate glasses (Brow, 1996).

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Experimental

To prepare the glass system, chemicals which are used are of A-1 grade i.e. of analytical grade. Method used for preparation of glass was conventional melt quench technique. Chemicals were taken in a mortar. Where they are thoroughly mixed and grinded for about 30-45 min. 30 gm charged was taken in alumina crucible. This charge contain in alumina crucible, it kept in a muffle furnace for about 4-5 hours. Temperature was ranged up to 900-1000^{oC}. When these charges attain a desirable viscosity and become homogeneous. Then it was poured on a metal plate. Glass was annealed at 330^{oC} in an annealed furnace. After 2-3 hours we can take it out at room temperature. Resultant glass was characterized by characterization method.

Glasses of the system,

$30Na_2O$ - (60-y) B_2O_3 - yP_2O_5 – 10 Al_2O_3

(y=5, 10, 15,20,25,30 mol. %)

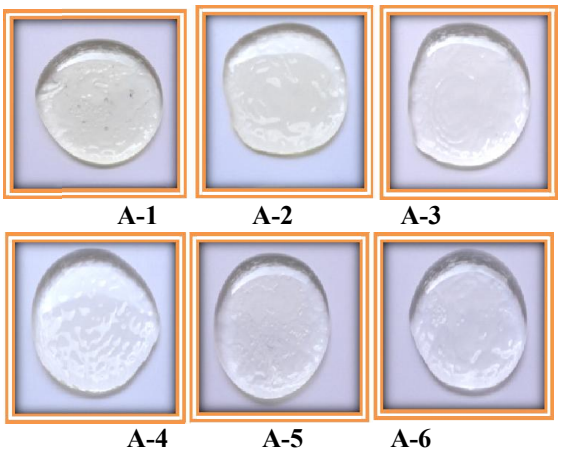

Fig. 1.1. Photographs of investigated Borophosphate glasses

Table 1.1. Weight loss observed after 72 hrs of exposure

Glass Code	Glass Composition		Na_2O/B_2O_3	B_2O_3/P_2O_5	Wt. loss in 10% HCl (g/cm^2).	Wt. loss in 10% NaOH (g/cm^2)
	X	Y				
A-1	30	5	0.54	11	1.32	0.63
A-2	30	10	0.60	05	1.23	0.62
A-3	30	15	0.66	03	0.97	0.61
A-4	30	20	0.75	02	0.83	0.42
A-5	30	25	0.85	1.4	0.75	0.39
A-6	30	30	1.00	1.0	0.69	0.43

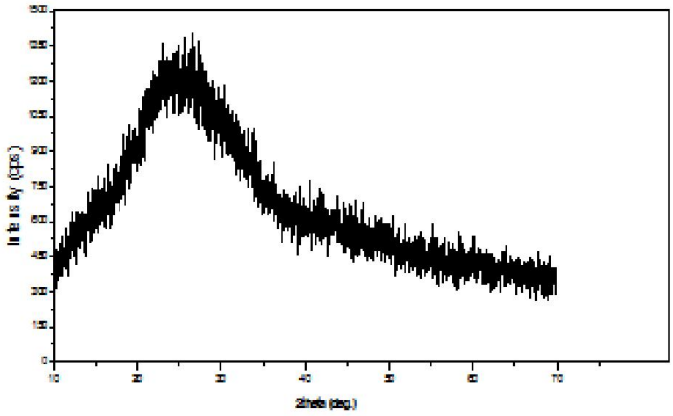

Fig. 1.2. XRD pattern of a glass having compositions of 30NaO - (60-y) B_2O_3 - yP_2O_5 – 10 Al_2O_3

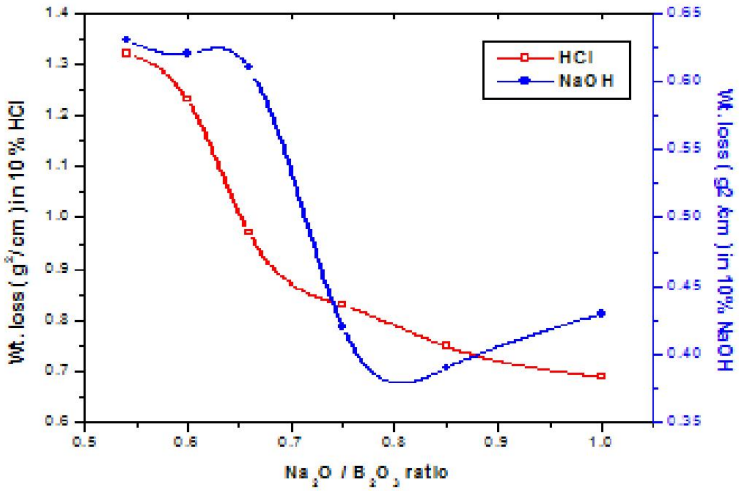

Fig. 1.3. Plot of weight loss against Na_2O/B_2O_3 ratio in 10% HCI & 10% NaOH

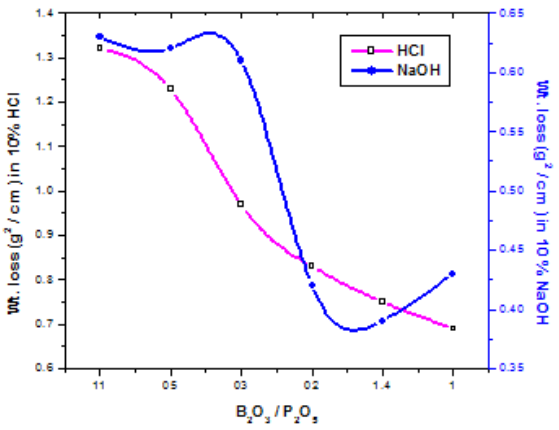

Fig. 1.4. Plot of weight loss against B_2O_3/P_2O_5 ratio in 10% HCI & 10% NaOH

1. A- I $30Na_2O$-$55B_2O_3$-$5P_2O_5$-$10Al_2O_3$
2. A- II $30Na_2O$-$50B_2O_3$-$10P_2O_5$-$10Al_2O_3$
3. A-III $30Na_2O$-$45B_2O_3$-$15P_2O_3$-$10Al_2O_3$
4. A-IV $30Na_2O$-$40B_2O_3$-$20P_2O_5$-$10Al_2O_3$
5. A-V $30Na_2O$-$35B_2O_3$-$25P_2O_5$-$10Al_2O_3$
6. A-VI $30Na_2O$-$30B_2O_3$-$30P_2O_5$-$10Al_2O_3$

MATERIALS AND METHODS

The borophosphate glasses of various compositions were prepared by melt quench technique, using analytical grade chemicals. First we chose acid and alkali medium. Afterwards sample of known weight and known surface area were held in the bottles of known medium i.e. acid and alkali. PVC bottles are used for this experiment. Samples of known weight and calculated surface area were held in the sample holder such that both sides of the sample were exposed uniformly to the medium. The holder assembly was then immersed in the PVC bottle containing the medium. Bottles should be kept in constant temperature i.e. room temperature. Weight of the glass samples were observed after successive time interval. Weight loss was observed at the same time surface area of glass sample also observed under microscope.

Wt. loss per unit area was calculated by following formula,

$$D = \frac{(Wo - Wt)}{A}\ g/cm^2$$

Where,

W_o= It is initial wt. of glass sample in air.
Wt= It is weight of glass sample after time t.
A= It is surface area.

The XRD pattern of various Sodium borophosphate glasses confirms the amorphous nature of glasses.

Corrosion Study

Polished samples of the borophosphate glass samples of various compositions 30NaO - (60-y) B_2O_3 - yP_2O_5 – 10 Al_2O_3 Where (y=5, 10, 15,20,25,30 mol. %) were exposed to 10% HCI and 10% NaOH separately at room temperatures for 24, 48 and 72 hrs. The effect of glass composition and the environment (acidic or alkaline) on the degradation behavior of these glasses was studied and interpreted. The weight losses observed are plotted as a function of ratio of sodium oxide to boron oxide (Na_2O / B_2O_3) content and are given in the table 1.1 and fig. 1.3 and fig.1.4. The dissolution was seen to be higher in alkaline medium as compared to acidic medium. This can be explained on the basis of chemical reaction involved in respective media. The dissolution rate was seen to decrease with increase in sodium oxide content this strengthening the structure of the glass.

RESULTS AND DISCUSSION

X-Ray Diffraction Study

The glasses were characterized using XRD for their structural study. Powder X-ray diffraction of the 30NaO - (60-y) B_2O_3 - yP_2O_5 – 10 Al_2O_3. Glass samples showed broad peaks as shown in fig 1.2 the pyrophosphate glass samples showed broad peaks characteristics of glass structure. Representative XRD pattern is shown in fig 1.2 confirms the amorphous or glassy nature of the investigated glass samples.

Conclusion

The dissolution was seen to be higher in alkaline medium as compared to acidic medium. This can be explained on the basis of chemical reaction involved in respective media. The dissolution rate was seen to decrease with increase in sodium oxide content this strengthening the structure of the glass. Results are matches with S.M. Budds experiment [10]. Hence the dissolution rate in 10% HCI and 10% NaOH goes on decreasing with increasing sodium oxide content.

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