GLASS FORMATION IN Li_2O-Pr_2O_3-B_2O_3 SYSTEM

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ABSTRACT: By methods of physical-chemical analysis (DTA, X-ray diffraction, IR-spectroscopy) phase- and glass formation in Li_2O-Pr_2O_3-B_2O_3 system was researched in zone, which is enriched with boric anhydride. According to the results of three quasi binary sections: Li2O·3B_2O_3– Pr_2O_3·3B_2O_3; Li_2O·2B_2O_3-Pr_2O_3·3B_2O_3; Li_2O·2B_2O_3- Pr_2O_3·B_2O_3, as well as materials about glass formation in binary Li_2O–B_2O_3- and Pr_2O_3–B_2O_3 systems the zone of glass formation and glass transition diagram of Li_2O-Pr_2O_3-B_2O_3 was defined.

Key Words: Class formation, physical-chemical analysis, Li_2O-Pr_2O_3-B_2O_3 system

INTRODUCTION

In borate systems glass formation is connected with the quantity of polymer –B-B-B- ties and that's why glass formation zones joins to that part of system, which is rich with boric anhydride. In systems, which include oxides of alkali and rare earth elements, the zone volume of glass formation only in a small degree depends on the nature of rare earth element. The definite dependence of zone sizes on the nature of rare earth elements was determined. First of all it concerns to the systems with the participation of oxides La, Pr, Nd, Sm, Eu and others. According to structural composition (Levin E.M, 1966; Poycon K, 1969; .Hamidova Sh.A. 2005) each mol of enumerated oxide can contain 3,65; 2,9; 2,8; 2,5 mol of B_2O_3.

Earlier we have investigated glass formation zone of systems Li_2O-Ln_2O_3-B_2O_3 (Hamidova, Sh.A., 1995; Hamidova Sh.A. and Kuli-zade E.S., 2004, Hamidova Sh.A. and Kuli-zade E.S., 2003 ; Hamidova,Sh.A., Novruzova, F.A., and .Aliyev, I.I., 2006; .Hamidova,Sh.A., and Novruzova, F.A., 2007) and general analogy of them in glass formation was defined.

MATERIALS AND METHODS

Investigations were carried out by methods of physical-chemical analysis DTA (derivatograph MOM), X-ray diffraction and IR-spectroscopy (SPE CORD).

Reactive Pr_6O_{11} (99, 99 %), Li_2CO_3- "special pure", H_3BO_3 "chemically pure" were used.

Hinge of oxides Pr_6O_{11} were taken with calculations to Pr_2O_3, lithium carbonate and boric acid according to volatility of components. The synthesis was carried out in 900-1100^{0}C temperature regime in platinum crucible.

Alloys were poured on titanium plate and hardened on air. Glass shape alloys and glass crystals were crystallized at temperatures, corresponding to the crystallization effects on curve heating (DTA).

RESULTS AND DISCUSSION

Glasses of Li_2O-Pr_2O_3-B_2O_3 system were synthesized by three internal sections: Li_2O·3B_2O_3-Pr_2O_3·3B_2O_3; Li_2O·2B_2O_3-Pr_2O_3·3B_2O_3; Li_2O·2B_2O_3-Pr_2O_3·B_2O_3. Other compositions were also synthesized and investigated with the aim to define the borders of glass formation. According to investigations and materials about binary borate systems the tentative zone of glass formation in triple system Li_2O-Pr_2O_3-B_2O_3 was plotted (Fig.1).

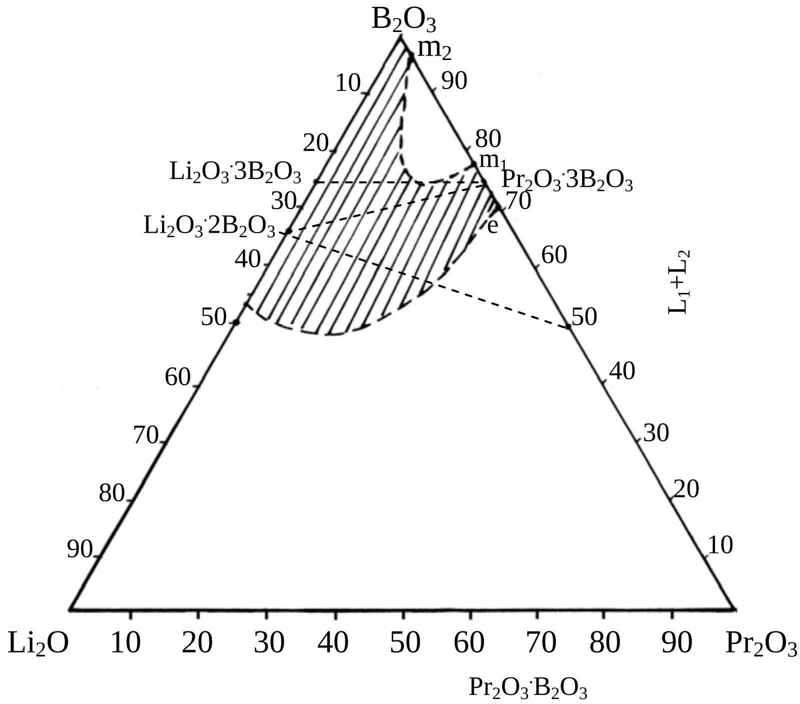

Figure 1. Diagram of glass formation in triple system Li_2O-Pr_2O_3-B_2O_3.

Border of glass formation in system Li_2O-Pr_2O_3-B_2O_3 begins from the points of compositions 47 mol % Li_2O on the side Li_2O-B_2O_3, 2.9 mol % Pr_2O_3 on the side Pr_2O_3-B_2O_3. There is wide exfoliation zone in the zone of compositions, which join to B_2O_3 in Pr_2O_3-B_2O_3 system. All alloys of this zone exfoliate into liquid practically pure boric anhydride, which gives transparent glass and liquid while cooling, the composition that is in other border of exfoliation. By this way one border of homogeneous glass transition passes from the point of composition 57 mol % B_2O_3 on side of Li_2O-B_2O_3, then turns round the left border of exfoliation, and reaches 2.9 mol % Pr_2O_3 on side of Pr_2O_3-B_2O_3 of triangle Li_2O-Pr_2O_3-B_2O_3.

While heating the obtained transparent green glasses easily crystallize.

Results of differential thermal analysis show, that glass formation and crystallization temperatures of glasses are 450-550^0 and 610-645^0.

The chemical composition and thermal indications of glasses were given in Table 1.

Table 1. Contents and physical-chemical data of glasses of Li_2O-Pr_2O_3-B_2O_3 system.

№	Content in mol %			Glass transition temperature, ^0C	Crystallization temperature, ^0C	Synthesis regime, ^0C
	Pr_2O_3	B_2O_3	Li_2O	450-550	610-645	900-1100
1	1,34	74,08	24,68	«-»	«-»	«-»
2	1,73	65,42	32,85	«-»	«-»	«-»
3	2,70	72,97	24,33	«-»	«-»	«-»
4	3,58	64,19	32,23	«-»	«-»	«-»
5	4,22	71,83	23,95	«-»	«-»	«-»
6	5,56	62,95	31,49	«-»	«-»	«-»
7	5,88	70,58	23,53	«-»	«-»	«-»
8	7,69	69,23	23,08	«-»	«-»	«-»
9	8,66	61,54	30,08	«-»	«-»	«-»
10	9,68	67,73	22,58	«-»	«-»	«-»
11	10.00	60,00	30,00	«-»	«-»	«-»
12	12,51	58,36	29,13	«-»	«-»	«-»

Table 2. IR-spectra of adsorption of glasses of Li_2O-Pr_2O_3-B_2O_3 system.

Dependent systems	Content, mol %			Adsorption zone, cm^{-1}
	Li_2O	Pr_2O_3	B_2O_3	
$Li_2O·2B_2O_3$- $Pr_2O_3·3B_2O_3$	26,5	5	68,5	444,464,488,524,568,720,760, 976,1084,1144,1416,1560,1568
$Li_2O·2B_2O_3$- $Pr_2O_3·3B_2O_3$	20	10	70	416,464,492,600,624,720,748, 968,976,1092,1092,1196,1376, 1420,1460,1696
$Li_2O·2B_2O_3$- $Pr_2O_3·3B_2O_3$	13,5	15	71,5	416,464,492,600,624,720,748,968, 976, 1080, 1200, 1376, 1424,1456, 1576, 1584,1616,1632,1696
$Li_2O·2B_2O_3$- $Pr_2O_3·3B_2O_3$	7	20	73	444,472,504,528,560,620,632,696, 704,720,760,796,840,932,976,1052, 1072,1104,1136,1180,1264,1456, 1576,1632
$Li_2O·2B_2O_3$	33,33	-	66,66	800-1100, 1100-1400
Pr_2O_3				434, 584, 596, 684
B_2O_3				610,630,700,780,890,950,1035, 1100,1300
Li_2O				685,968

IR-spectra of samples in Li_2O-Pr_2O_3-B_2O_3 were taken. The results were given in Table 2.

In IR-spectra of lithium diborate there are ~800-1100 cm^2 and 1100-1400 cm^2 zones, which correspond to trigonal and tetrahedral combinations B-O and B^{III}-O-B^{IV} bridges. In spectra of glasses adsorption zones were found at 1250 and 1360 cm^{-1}. These zones characterize separate links BO_3 and BO chains (Shegolova and Berkovskiy, 1980).

According to authors' opinion BO, B_2O_3, BO_3 and BO_2 molecules can exist in B-O_2 system. IR-spectroscopy data give important information at triangulation of triple system Li_2O-Pr_2O_3-B_2O_3.

The zones are more intensive at 1110-1660 cm^{-1} and 590-850 cm^{-1} intervals in B_2O_3 spectrum. B_2O_3 has strong zones in 805, 1190 and 1465 cm^{-1}intervals, but weak zones are in 870, 890 cm^{-1} intervals. Adsorption zones of higher than 800 cm^{-1} weren't found in spectra for oxides of rare earth elements.

CONCLUSION

The glass formation area was determined by Li_2O-Pr_2O_3-B_2O_3 system, and its glass-transition diagram was plotted. The investigation of system shows that glass formation area exists in a field of triangle, which is rich with boric anhydride. IR-spectra researches showed, that zones (1250-1360 cm^{-1}), which characterize separate links of BO_3 and BO chains, were found in glass spectra of system.

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