GLASS FORMATION IN Li₂O-Pr₂O₃-B₂O₃ SYSTEM

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ABSTRACT: By methods of physical-chemical analysis (DTA, X-ray diffraction, IR-spectroscopy) phase- and glass formation in Li₂O-Pr₂O₃-B₂O₃ system was researched in zone, which is enriched with boric anhydride. According to the results of three quasi binary sections: Li₂O-3B₂O₃-Pr₂O₃-B₂O₃; Li₂O-2B₂O₃-Pr₂O₃-3B₂O₃; Li₂O-2B₂O₃-Pr₂O₃-B₂O₃, as well as materials about glass formation in binary Li₂O-B₂O₃- and Pr₂O₃-B₂O₃ systems the zone of glass formation and glass transition diagram of Li₂O-Pr₂O₃-B₂O₃ was defined.

Key Words: Class formation, physical-chemical analysis, Li₂O-Pr₂O₃-B₂O₃ system

INTRODUCTION

In borate systems glass formation is connected with the quantity of polymer -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 B₂O₃.


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 Pr₆O₁₁ (99, 99 %), Li₂CO₃ “special pure”, H₂BO₃ “chemically pure” were used.

Hinge of oxides Pr₆O₁₁ were taken with calculations to Pr₂O₃, lithium carbonate and boric acid according to volatility of components. The synthesis was carried out in 900-1100°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 Li₂O-Pr₂O₃-B₂O₃ system were synthesized by three internal sections: Li₂O-3B₂O₃-Pr₂O₃-B₂O₃; Li₂O-2B₂O₃-Pr₂O₃-B₂O₃; Li₂O-2B₂O₃-Pr₂O₃-B₂O₃. 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 Li₂O-Pr₂O₃-B₂O₃ was plotted (Fig.1).
Border of glass formation in system Li$_2$O-Pr$_2$O$_3$-B$_2$O$_3$ begins from the points of compositions 47 mol % Li$_2$O on the side Li$_2$O-B$_2$O$_3$, 2.9 mol % Pr$_2$O$_3$ on the side Pr$_2$O$_3$-B$_2$O$_3$. There is wide exfoliation zone in the zone of compositions, which join to B$_2$O$_3$ in Pr$_2$O$_3$-B$_2$O$_3$ 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$_2$O$_3$ on side of Li$_2$O-B$_2$O$_3$, then turns round the left border of exfoliation, and reaches 2.9 mol % Pr$_2$O$_3$ on side of Pr$_2$O$_3$-B$_2$O$_3$ of triangle Li$_2$O-Pr$_2$O$_3$-B$_2$O$_3$.

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$^\circ$C and 610-645$^\circ$C.

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

**Table 1.** Contents and physical-chemical data of glasses of Li$_2$O-Pr$_2$O$_3$-B$_2$O$_3$ system.

<table>
<thead>
<tr>
<th>№</th>
<th>Content in mol %</th>
<th>Glass transition temperature, $^\circ$C</th>
<th>Crystallization temperature, $^\circ$C</th>
<th>Synthesis regime, $^\circ$C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pr$_2$O$_3$</td>
<td>B$_2$O$_3$</td>
<td>Li$_2$O</td>
<td>450-550</td>
</tr>
<tr>
<td>1</td>
<td>1.34</td>
<td>74.08</td>
<td>24.68</td>
<td>$\approx$</td>
</tr>
<tr>
<td>2</td>
<td>1.73</td>
<td>65.42</td>
<td>32.85</td>
<td>$\approx$</td>
</tr>
<tr>
<td>3</td>
<td>2.70</td>
<td>72.97</td>
<td>24.33</td>
<td>$\approx$</td>
</tr>
<tr>
<td>4</td>
<td>3.58</td>
<td>64.19</td>
<td>32.23</td>
<td>$\approx$</td>
</tr>
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<td>5</td>
<td>4.22</td>
<td>71.83</td>
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</tr>
<tr>
<td>6</td>
<td>5.56</td>
<td>62.95</td>
<td>31.49</td>
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</tr>
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<td>7</td>
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<td>70.58</td>
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<tr>
<td>8</td>
<td>7.69</td>
<td>69.23</td>
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<tr>
<td>9</td>
<td>8.66</td>
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<td>9.68</td>
<td>67.73</td>
<td>22.58</td>
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<td>12</td>
<td>12.51</td>
<td>58.36</td>
<td>29.13</td>
<td>$\approx$</td>
</tr>
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</table>
IR-spectra of samples in Li2O-Pr2O3-B2O3 were taken. The results were given in Table 2.

In IR-spectra of lithium diborate there are ~800-1100 cm⁻¹ and 1100-1400 cm⁻¹ zones, which correspond to trigonal and tetrahedral combinations B-O and B\textsuperscript{III}-O-B\textsuperscript{IV} bridges. In spectra of glasses adsorption zones were found at 1250 and 1360 cm⁻¹. These zones characterize separate links BO\textsubscript{3} and BO chains (Shekolova and Berkovskiy, 1980).

According to authors' opinion BO, B\textsubscript{2}O\textsubscript{3}, BO\textsubscript{3} and BO\textsubscript{2} molecules can exist in B-O\textsubscript{2} system. IR-spectroscopy data give important information at triangulation of triple system Li2O-Pr2O3-B2O3.

The zones are more intensive at 1110-1660 cm⁻¹ and 590-850 cm⁻¹ intervals in B2O3 spectrum. B2O3 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 Li2O-Pr2O3-B2O3 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\textsubscript{3} and BO chains, were found in glass spectra of system.

REFERENCES

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