



Density, refraction and thermal expansion of alkali borate and borosilicate glasses and crystals

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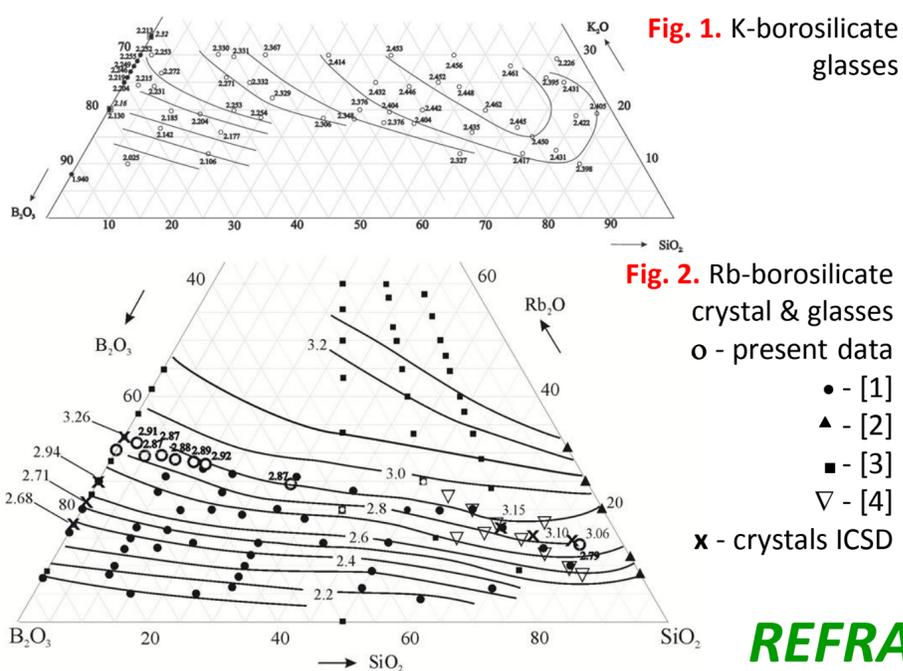
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The study is aimed to the comparative analysis of some structure-sensitive properties of alkali borate and borosilicate glasses and crystals. Among the properties under consideration there are density, refraction and thermal expansion. The comparison of physical properties is done between crystals and glasses depending on alkali cation. New experimental data on refraction indexes and density for about a hundred samples of K- and Rb-borate and borosilicate glasses are presented. Mass density measurements have been performed employing the method of hydrostatic weighing. Refractive index measurements have been carried out on a polarization microscope with the series of immersion liquids using the Becke line method. The data on crystals density calculated from crystal structures are used for comparison.

DENSITY of crystals and glasses



Density diagram of Rb-borosilicate glasses differs from that of K (Fig. 1, 2), particularly it has no maxima. If we look at the data on borate glass density (Fig. 3), the dramatic change is observed between Li,Na,K and Rb,Cs figures. The explanation could be as follows. Until a glass is formed by light (Li, Na) or middle (K) alkali metal, some details, like maxima could appear. When Rb or Cs contribute, the density depends on the quantity of the heavy atom only.

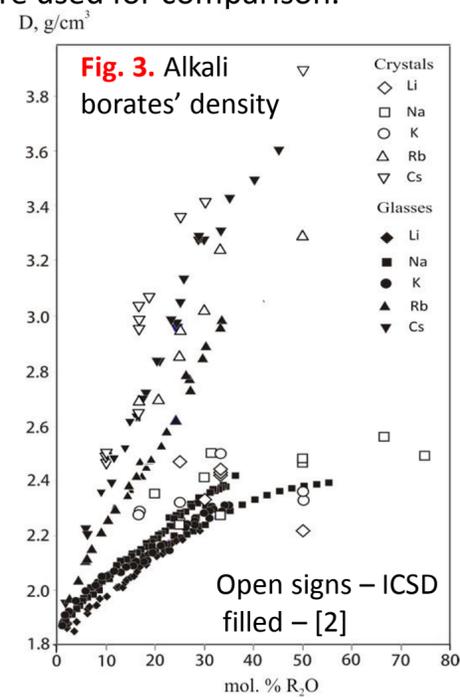
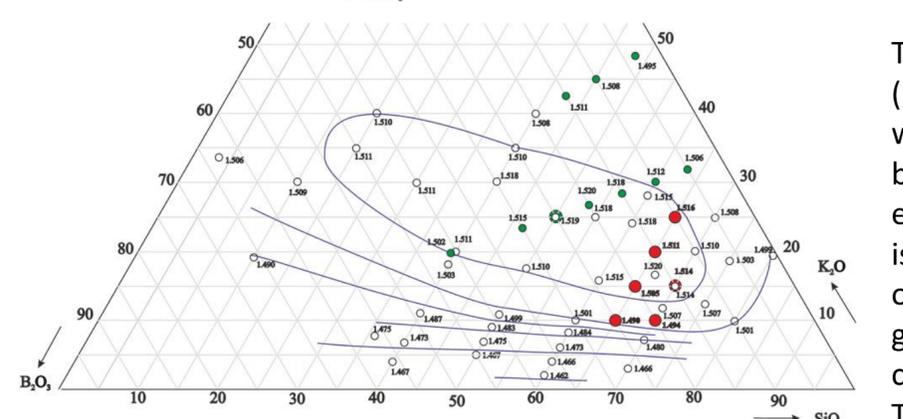
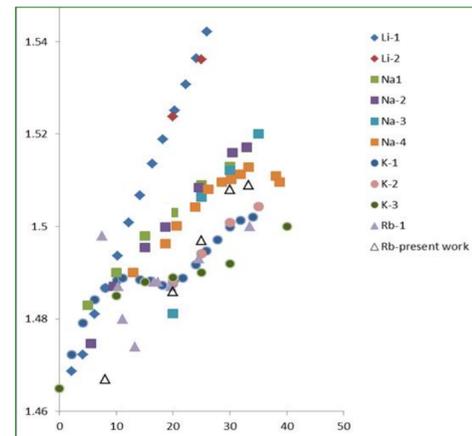


Fig. 3 shows that density of borate glasses are generally lower than that of crystals. That is also true for the borosilicates although the statistics here should be approved.



REFRACTION of alkali borate and borosilicate glasses

The refraction indexes of K-borosilicate glasses (Fig. 4) vary in narrow range $n=1.462-1.520$ with maxima near the composition of boroleucite $KBSi_2O_6$ [6], coinciding to the extremum in density diagram (Fig. 1). This fact is in agreement with the data on the extremum of structure-sensitive properties of crystals and glasses observed in area of $KBSi_2O_6$ crystallisation in [7].

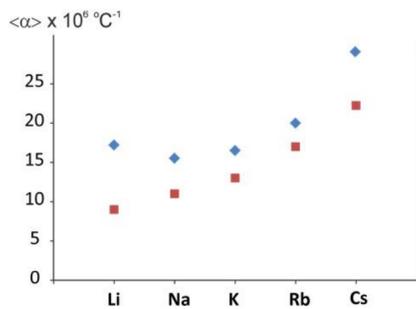


The refractive indexes of alkali borate glasses (Fig. 5) increase with increase alkali content.

Fig. 5. Refractive indexes of alkali borate glasses. Open signs – present data, filled – [2]

THERMAL EXPANSION of crystals and glasses

The values of thermal expansion coefficients of crystals (Fig. 6) are calculated from high- or low-temperature powder X-ray diffraction data (Fig. 7), the data for glasses are taken from [2]. Fig. 8 demonstrates that the average thermal expansion coefficient of alkali borate crystals is higher than that of glasses, that looks reasonable, because the density of crystals is higher (Fig. 5). In contrast thermal expansion of alkali borosilicate crystals is lower than that of glasses. For example: $\langle\alpha\rangle$ for Na glasses is 12, for $NaBSi_3O_8$ - 9.



Literature

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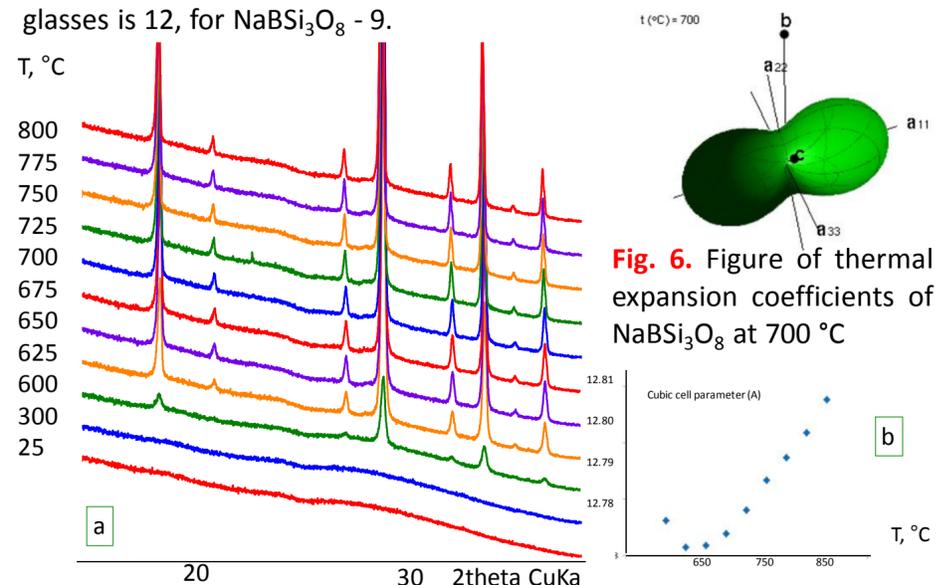


Fig. 7. Crystallisation of $KBSi_2O_6$ from stoichiometric glass: a – XRD patterns, b – cell parameter

