Ionic conductivity of binary alkali borate melts

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Abstract

While electrical conductivity of borate glasses has been extensively studied, only few works were devoted to the charge transport in molten state of these oxides. In order to reach accurate conductivity data in the molten state, we used an experimental setup based on the four-electrode method which reduces polarization effects usually observed in the classical two-electrode method especially at high temperatures and low frequencies. Our device was successfully applied to study ionic transport of two series of binary alkali borate melts: XLi2O-(100-X)B2O3 and YNa2O-(100-Y)B2O3 (X = 5 - 45 mol% and Y = 5 - 40 mol in the frequency range 1Hz -1 MHz. The data acquisition was performed during cooling from about 1050◦C to 300◦C, thus from the molten to the solid states. It is well known that below the glass transition temperature (Tg) the conductivity follows an Arrhenius law which is characteristic of thermally activated transport while above Tg and in the molten state, the conductivity is well described by the phenomenological VTF (Vogel-Tamann-Fulcher) law. The VFT law suggests a cooperative nature in the transport mechanism where the deformation of the network enhances the mobility of the ionic charge carriers. Our results suggest that the well-known boron anomaly observed on several properties of borate glasses persists in the molten state, but takes place at lower alkali contents than in the solid state.

Keywords: alkali borate glasses and melts, ionic conductivity

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