Boron effects on chemical strengthened glass

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Abstract

Chemical strengthened glass is produced by an ion-exchange stuffing process where small radius alkali ions within the base glass are replaced with larger radius alkali ions from a molten salt. To achieve a desirable strength in a reasonable process time, the base glass has to be carefully designed. In this study, we investigated the boron effects on the compressive stress (CS) and depth of layer (DOL) achieved from ion-exchange. A series of glass with compositions of 15Na2O·15Al2O3·xB2O3·(70-x)SiO2, where x=0, 5, 10 and 15, has been melted and ion-exchanged in potassium salt bath at 380 ∘C for 2, 4, 6, 8, and 10 hours. For each glass, DOL increases with ion-exchange time, but CS gradually decreases, which is due to force balance. Across the series, both DOL and CS decrease as the amount of boron is increasing. With boron content increasing, the atomic density (number of atoms in a unit volume) increases, therefore the packing density increases and free volume decreases. Interestingly, the number of Na ion in a unit volume is decreasing as boron content increases. As boron content is increasing, the atoms are more closely packed, which slows down the ion-exchange process. On the other hand, the number of Na+ in unit volume is decreasing as boron content increases, which also slows down the inter-diffusion of alkali ions. Both facts explain why smaller DOL and CS have been observed in high boron glasses.

Keywords: boron, ion, exchange, atomic packing density

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