

Effects of concurrent TeO₂ reduction and ZnO addition on elastic and structural properties of (90 – x)TeO₂–10Nb₂O₅–(x)ZnO glass

ABSTRACT

Niobium-containing tellurite glass with starting composition of (90 – x)TeO₂–10Nb₂O₅–(x)ZnO (x = 0–15 mol%) have been prepared by melt-quenching method and the effect of reduction of TeO₂ with simultaneous increase in ZnO on elastic properties was studied. Ultrasonic longitudinal and shear velocity showed initial decrease of 3.52% and 2.37%, respectively, at x = 5 mol%. For x > 5 mol%, longitudinal velocity showed weak recovery but shear velocity showed steady recovery with ZnO and recorded 0.95% increase in value at x = 15 mol% compared to x = 0 sample. Shear and Young's moduli recorded similar drop at x = 5 mol% followed by strong recovery at x > 5 mol%, while longitudinal and Bulk modulus showed weak and no recovery, respectively, with x. Infrared (IR) absorption spectra showed increase in intensity of NbO₆-assigned peak accompanied by increase in intensity of ZnO₄ tetrahedra and TeO₄ trigonal bipyramid (tbp) assigned peaks indicating formation of both non-bridging oxygen, NBO and bridging oxygen, BO, respectively, with addition of ZnO. The initial drop in ultrasonic velocity and related elastic moduli observed at x = 5 mol% indicates weakening of network rigidity of the glass system due to structural modification as a direct effect of TeO₂ reduction and existence of NBO. However, further replacement of TeO₂ by ZnO at x > 5 mol% contributed to increase in BO causing rigidity of the glass network to improve. In addition, hardness, H, was observed to increase with ZnO indicating increase in connectivity of the glass network while Poisson's ratio, σ , decreased indicating increase in cross-link density of the glass system. The combined results of ultrasonic velocity and IR absorption spectra suggest that the role of TeO₂ is very critical in the ternary glass system as, although ZnO addition showed improved rigidity due to recovery of shear modulus, the weakening of longitudinal and Bulk moduli indicates ZnO is not fully effective as glass former in place of TeO₂.

Keyword: Tellurite glass; Ultrasonic velocity; Elastic moduli; FTIR