UNIVERSITI TEKNOLOGI MARA

# STRUCTURAL, ELASTIC AND OPTICAL PROPERTIES OF $(80\text{-}x)B_2O_3\text{-}xTeO_2\text{-}10Li_2O\text{-}10Al_2O_3$ MIXED NETWORK FORMER GLASS SYSTEM

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# AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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# ABSTRACT

Mixed glass former of composition (80−$x$)$B_2O_3$-$x$$TeO_2$-10$Li_2O$-10$Al_2O_3$ ($x$ = 10 mol% to 60 mol%) glasses were prepared by melt-quenching technique to investigate the effects of mixing $B_2O_3$ and $TeO_2$ glass formers on structural, elastic and optical properties of the glass system. Structural analysis using FTIR spectroscopy revealed competition between $TeO_2$ and $B_2O_3$ formers where $TeO_4$ functional group indicates bridging oxygen, BO decreased with increasing $TeO_2$ content, while $BO_4$ units indicates bridging oxygen, BO fluctuated below 40 mol% before finally increasing suggesting $BO_4$ units become dominant above 40 mol% $TeO_2$. At $x$ = 40 mol% $TeO_2$ content, the observed minima in independent elastic moduli (longitudinal, $C_L$ (45.6 GPa) and shear, $\mu$ (15.2 GPa)) together with Bulk, $K$ (25.4 GPa) and Young's, $Y$ (38.0 GPa) modulus were due to presence of high concentration of $TeO_3$ and $BO_3$ units which indicates that non-bridging oxygen, NBO deteriorates the rigidity of the glass. This suggest that competition between $TeO_2$ and $B_2O_3$ glass formers at 40 mol% is most intense and destructive to the glass structure. DC conductivity also showed a minimum (-7.4 $\Omega^{-1}cm^{-1}$) at $x$ = 40 mol% which suggests presence of MGFE contributing to the minima in elastic properties. Meanwhile, in the same region, quantitative analysis of ultrasonic data using bulk compression model showed maximum in $K_{bc}/K_e$ ratio (2.74) at $x$ = 40 mol%, which indicates minimum isotropic compression. On the other hand, the computed maximum in average ring size, $l$ (0.54 nm) at similar region indicates maximum ring deformation. On the other hand, the optical energy gap, $E_{opt}$ for both transitions showed minimum values (3.23 eV and 4.18 eV) at $x$ = 40 mol%, while refractive index, $n$ (2.338 and 2.136) and Urbach energy, $E_u$ (0.66 eV) showed maximum values at the same concentration due to presence of high concentration of $TeO_3$ and $BO_3$ units indicating non-bridging oxygen, NBO which cause less energy to induce electron excitation. On the other hand, slight slope change in $\alpha_{O^{2-}}$ and $\Lambda$ was observed at $x$ = 40 mol% which suggested to be due to the large formation of NBO via $TeO_3$ and $BO_3$ units which possess high polarizability and low covalency that increase the electron donor power.

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