UNIVERSITI TEKNOLOGI MARA

ELASTIC AND STRUCTURAL PROPERTIES OF V_2O_5-PbO-ZnO AND V_2O_5-TeO_2-Li_2O GLASS SYSTEMS

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AUTHOR'S DECLARATION

I declare that the work in this thesis/dissertation was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the result 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 other degree or qualification.

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ABSTRACT

Ternary $(55\text{-}x)V_2O_5$-45PbO-(x)ZnO (x = 0-15 mol%) and $35V_2O_5$-$(65\text{-}x)TeO_2$-$(x)Li_2O$ (x = 10-50 mol%) glass series were prepared by the melt-quenching method. Elastic and structural properties of the glasses were investigated by measuring sound velocity using the pulse-echo-overlap technique and Fourier Transform Infrared (FTIR) spectroscopy, respectively. Properties such as density (ρ), molar volume (V_a), and glass transition temperature (T_g) were also reported. For $(55\text{-}x)V_2O_5$-45PbO-(x)ZnO glass series, results from the study showed that both longitudinal and shear velocities decreased at x = 5 mol% with the increase of ZnO concentration. The independent longitudinal and shear moduli, C_L and μ and Young's modulus (Y) also showed decreasing trend at x = 5 mol% as the fraction of ZnO increases. FTIR analysis showed an increase in non-bridging oxygen (NBO) as indicated by the increase in intensity of VO_4 assigned peaks at x = 5 mol% while the increase in intensity of VO_5 assigned peaks at x > 5 mol% indicates increasing bridging oxygen (BO). The glass transition temperature (T_g) showed a decrease at x = 0-5 mol% which implies increase in non-bridging oxygen (NBO) while an increase of T_g for x = 10-15 mol% indicates the decrease in NBO. Analysis of the experimental results using the bulk compression and ring deformation models showed that the calculated value of K_{bc} was higher than that of K_e but K_{bc}/K_e ratio drops from 2.16 (x = 5 mol%) to 1.94 (x = 10 mol%) indicating that bond bending or ring deformation was slightly reduced with addition of ZnO. For $35V_2O_5$-$(65\text{-}x)TeO_2$-$(x)Li_2O$ glass series, both longitudinal (v_L) and shear velocity (v_S) showed an increase of 6.57% and 16.52%, respectively, at x = 20 mol%. The initial increase in C_L and μ at x = 20 mol% was suggested to be attributed to the increase in number of bridging oxygen (BO) which caused stiffness and rigidity of the glass network to increase while the decrease in C_L and μ between x = 20 and x = 30 mol% was suggested to be due to the increase in number of non-bridging oxygen (NBO). FTIR analysis showed an increase in intensity of TeO_4 and VO_5 assigned peaks at x = 10-20 mol% which indicates increasing BO while at the same time the decrease in intensity of TeO_3 and VO_4 assigned peaks indicates decreasing NBO. The increase in intensity of TeO_3 and VO_4 assigned peaks between x = 30-50 mol% which was accompanied by the decrease in intensity of TeO_4 and VO_5 assigned peaks indicate increases in NBO and decrease in BO, respectively. Therefore in the present study, formation of more BO compared to NBO can be the reason for the increase in stiffness above and vice versa. Our suggestion above is further supported by the variation of glass transition temperature (T_g) results. The increase of glass transition temperature (T_g) at x = 10-20 mol% implies decrease in non-bridging oxygen (NBO) while the decrease of T_g for x = 30-50 mol% indicates the increase in NBO. Quantitative analysis based on bulk compression and ring deformation models showed that the K_{bc}/K_e ratio drops from 2.60 (x = 10 mol%) to 1.74 (x = 20 mol%) which indicates that bond bending or ring deformation was reduced with the increase of Li_2O. Meanwhile, the slight increase in value of K_{bc}/K_e ratio from 1.74 (x = 20 mol%) to 2.06 (x = 30 mol%) before dropping to 1.93 (x = 40 mol%) and later increasing slightly to 1.96 (x = 50 mol%) indicates variation in ring deformation.

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