

UNIVERSITI TEKNOLOGI MARA

**EFFECT OF Bi_2O_3 - BaO OXIDE PAIR
ON ELASTIC, OPTICAL AND
DIELECTRIC PROPERTIES IN THE
BORATE ANOMALY REGION OF
 $5\text{Bi}_2\text{O}_3$ - $x\text{BaO}$ - $(85-x)\text{B}_2\text{O}_3$ - 10SiO_2
BORATE GLASS**

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ABSTRACT

A series of glasses with composition of $5\text{Bi}_2\text{O}_3-x\text{BaO}-(85-x)\text{B}_2\text{O}_3-10\text{SiO}_2$ were prepared using conventional solid state melt-quenching techniques. Density, ultrasonic, UV-Vis, FTIR, XRD and Impedance spectroscopy measurements have been carried out to investigate the effect of Bi_2O_3 and BaO pair in the borate anomaly region. Density (ρ) and structural data with increasing BaO showed initial drop in density at $x=25$ mol % before a large increase in ρ at $x > 25$ mol %. Longitudinal modulus (C_L), Shear modulus (μ), Young's modulus (Y), Bulk modulus (K_e) and Debye temperature (θ_D), showed weak changes for $x < 25$ mol % followed by large increase for $x \geq 25$ mol % indicating non-linear changes in stiffness and rigidity. The results indicate suppression of the borate anomaly at $x \leq 25$ mol % which was initially expected with the partial replacement of B_2O_3 by BaO . Presence of unconventional former Bi_2O_3 seems to effectively suppress the modifying role of BaO in the region of $x \leq 27$ mol % . Optical energy gap (E_{opt}) was found to decrease with increasing BaO content except for $x = 32$ mol % where slight increase in E_{opt} was observed. Dielectric properties (ϵ') and AC conductivity (σ) measurement showed a minimum at the turning point where borate anomaly was suppressed ($x = 25$ mol %) indicating non-linear changes which is in good agreement in the previous report on elastic and structural behaviour which suggest that the borate anomaly was suppressed at $x \leq 25$ mol % BaO . The gradual decreased in ϵ' for $x \leq 25$ mol % was suggested to be due to the reduction in polarity of B_2O_3 structure which arise from the limitation of sp^3 hybridization. The drop in σ in the same region is attributed to the blocking effect of Bi^{3+} and Coulomb repulsion which arised from effect of Bi_2O_3 - BaO pair that blocks the migration of Ba^{2+} ions. However, both ϵ' and σ increased at $x > 25$ mol % due to higher relative amount of Ba^{2+} ions which are mobile and contribute to formation of dipoles and improves AC conductivity. The minima in $\tan \delta$ alongside with the lowest value of ϵ' at $x = 25$ mol % BaO was suggested to be due to the formation of smaller space charge dipoles which in turn reduces the loss of energy in the samples. The dielectric relaxation behaviour showed that the elementary particles become more interacting to each other at $x \leq 25$ mol % BaO and become less interacting with further BaO substitution.

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