

E1-07: Ionic conductivity of glasses in the Na₂O-TeO₂ system

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Ionic conductivity of mineral glasses generally proceeds by alkali cations displacement. These materials may be used in electrochemical devices like ion sensitive electrodes, solid state batteries or electrochromic displays.

Na⁺ conductive glasses were synthesized in the binary system

$x \text{ Na}_2\text{O}(1-x)\text{TeO}_2$. Stable glasses were obtained by melt quenching in air for $0.18 \leq x \leq 0.33$. Glasses are clear with slightly orange colour and have a high refractive index due to the lone electronic pair associated with tellurium. The glassy character of the samples was confirmed by XRD and SEM techniques. Their glass transition temperature (T_g) measured using DSC showed a monotonic decrease with sodium oxide content and was between 261 to 219°C.

The impedance spectroscopy technique was used to measure the ionic conductivity below T_g . The conductivity data are an activated function of temperature and obey an Arrhenius type equation:

$$\sigma T = A \exp\left(-\frac{E_g}{RT}\right)$$

The pre-exponential term $\log A$ had a mean value of 4.6 ± 0.5 which was in agreement with the estimated value from an interstitial type mechanism between two adjacent sites. According to this model value for A was given by the equation

$$A = \frac{N^{1/3} e^2 v_0}{6 R}$$

where N is the Na⁺ concentration per unit volume, v_0 the attempt frequency and other symbols have their usual meaning. A large isothermal variation of ionic conductivity, e.g. two orders of magnitude had been seen at 200°C and the maximum conductivity of the system was $2.5 \times 10^{-7} \text{ S cm}^{-1}$ for $x = 0.33$ at that temperature.

This conductivity increase was a result of correlative decrease in activation energy from 1.02 eV ($x = 0.18$) to 0.79 eV ($x = 0.33$).

SECTION E1

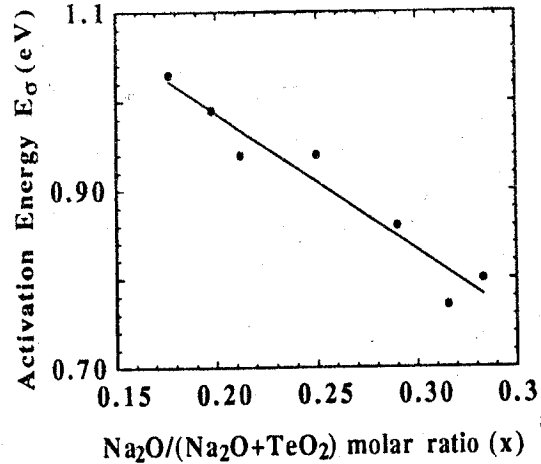
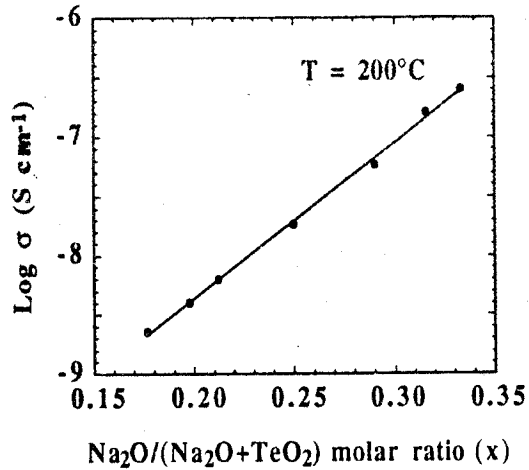


Fig. 1 Ionic conductivity and activation energy variations with the amount of Na₂O in the Na₂O-TeO₂ glass system.