

**E1-08: Electronic to ionic conductivity in glasses based on  
Na<sub>2</sub>O-V<sub>2</sub>O<sub>5</sub>-TeO<sub>3</sub>**

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Tellurium oxide is a good network former and a large number of binary and ternary tellurate systems easily form glasses. Alkali oxides as network modifiers should give rise to an ionic conductivity by alkali cations. When transition metals are associated with tellurium oxide, the electrical conductivity is electronic with a hopping mechanism. The objective of the present work was to study the electronic to ionic conductivity variation in the 2TeO<sub>2</sub>xNa<sub>2</sub>O(1-x)V<sub>2</sub>O<sub>5</sub> glassy system. For each composition, conductivity data in the 25 - 200°C temperature range is expected to obey the Arrhenius equation:

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

Pre-exponential term A and activation energy E will be analysed and interpreted on the basis of available models for conductivity.

V<sub>2</sub>O<sub>5</sub> (Aldrich 99.6%), TeO<sub>2</sub> (Janssen Chimica 99%) and Na<sub>2</sub>CO<sub>3</sub> (Janssen Chimica 99%) were dried at 200°C for 12 h. Appropriate quantities were calculated and mixed thoroughly using an agate mortar. Mixtures were melted in a platinum crucible at 900°C for one hour and the melts were stirred well to remove CO<sub>2</sub>. The melts were quenched in an aluminium mould in air at room temperature. Ten cylindrical glass pellets of 12 mm diameter and 1 mm thickness were synthesized for various composition 0 ≤ x ≤ 1

Both flat surfaces of glass pellets were painted with a solution of colloidal graphite in isopropanol (DAG 154 Achenson). The ac conductivity measurements were carried out using impedance spectroscopy technique in the frequency range 500 mHz to 10 MHz using a Schlumberge 1260 impedance analyser. Impedance plots were obtained in the temperature range 25 to 250°C.

The composition(x) dependence of the pre-exponential factor A and activation energy E are given below.

x	0.0	0.1	0.2	0.3	0.4	0.6	0.7	0.8	0.9	1.0
logA ( $\text{Scm}^{-1}\text{K}$ )	2.7	3.1	2.4	2.2	1.9	4.3	4.3	5.0	4.8	5.0
E (eV)	0.35	0.41	0.42	0.49	0.58	0.96	0.93	0.93	0.87	0.84

The activation energy values and pre-exponential terms of compositions from  $x = 0$  to 0.4 are very low compared to those from  $x = 0.6$  to 1.0

Analysis of the activation energies and conductivity values suggest that for compositions  $x = 0$  to 0.4, the material behaves as an electronically conducting glass, whereas for compositions from  $x = 0.6$  to 1.0 the material behaves as an ionically conducting glass.

Results show that in the electronically conducting regime ( $x=0$  to 0.4) the glass obeys the conductivity model proposed for semiconductive glasses based on small polaron theory. In the ionically conducting regime ( $x = 0.6$  to 1.0), the conductivity parameters of the glass are consistent with Arrhenius type cation migration expected for an ionic solid.

The nature of conduction can be varied from electronic to ionic by varying the composition of the ternary glass system. This type of mixed conductive glasses are potential candidates for cathode materials in solid state batteries.