08-027

Electrical properties of 0.75Sb2O3·0.25P2O5 glasses

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Impedance spectroscopy and capacitance measurements were performed on a 0.75Sb2O3·0.25P2O5 glass at temperatures up to 320 oC. The glass was obtained by melting Sb2O3 and NH4H2PO4 in a glassy carbon crucible at 900 oC. The liquid was poured onto a preheated stainless steel plate and further annealed in an electrical furnace from 300 oC on in order to reduce mechanical stresses. Samples were polished up to thickness of about 0.8 mm. Gold electrodes were deposited on opposite surfaces by sputtering and the sample was placed in an electrical furnace with the control of the temperature better than ±2 oC. An impedance spectrometer (Solartron 1260A) and a capacitance bridge (General Radio 1615-A) were employed. Measurementes were performed at temperatures below the glass transition (320 oC, according to dilatometric measurements). In the low temperature range the resistivity of the sample is too high, so that only the capacitance bridge could give reliable results. The dielectric constant at room temperature is (epsilon)' = ~25 for frequencies between 500 Hz and 10 MHz. For the high temperature range, the impedance spectrometer gave better results. With increasing temperature one observed an increase in the dielectric constant and of the loss factor, tg (delta). This is due to an increase in the electrical conductivity, (sigma)' = (epsilon)' (epsilon)_{o} tg(delta)(omega). The high resistivity presented by the glass at the near room temperature range is attributed to the absence of charge carriers like electrons or mobile ions, since both Sb2O3 and P2O5 are glass former oxides. At high temperatures the thermal expansion coefficient is high, 17.4 x 10-6 oC-1, resulting in higher amplitudes of the atomic vibrations which, under the action of the alternating electric field, enhances the displacement of the atoms in directiom of the electrodes. Consequently, one observed an increase in the electrical conductivity. The activation energy for the electrical conductivity, calculated after plots of log sigma_{DC} x T-1 and using Arrhenius equation, is 1.1 eV, while for typical soda-lime-silica glasses this value is ~0.8 eV. Financial support: FAPESP (Grant no 2011/02128-9).