"Stress Relaxation of B$_2$O$_3$ Glass"

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The stress relaxation mechanism of B$_2$O$_3$ glass having three dimensional network structure has been investigated in a temperature range from $T_g$ up to 500°C. Young's moduli, $E(t)$, of the glass in vacuum ranging from $10^{11}$ to $10^{9}$ dyn/cm$^2$ were measured as a function of time for period not longer than $10^3$ seconds at fixed temperatures by bending-stress and tensile-stress methods.

From some experimental results obtained it was indicated that the glass is of linear viscoelasticity within the experimental error. The stress relaxation curves for the glass are shown in Fig. 1. An attempt to apply time-temperature superposition to the glass was successful: a master curve can be constructed by shifting each experimental curves horizontally until overlap is obtained. The $E_g$ value, the modulus of the glass at $T_g$, is laid between usual organic polymers and inorganic glasses. The distribution of relaxation times, $H_1(\tau)$, for the first approximation is shown in Fig. 2. The half-width of $H_1(\tau)$ curve, $\Delta \log \tau$, is about 0.74, and therefore B$_2$O$_3$ glass belongs to the group in which the bond interchange seems to be only possible relaxation mechanism. The shift factor deviates considerably from that of the "universal" WLF equation which is derived from the free volume concept on physical relaxation behavior. B$_2$O$_3$ glass shows an Arrhenius behavior near $T_g$, and an activation energy at $T_g$ is about 68 kcal/mol. A pronounced inflection point was observed around $10^5$ dyn/cm$^2$. The cause of this phenomena is unknown, but it seems to be different from the rubbery plateau of organic polymers.
Reference

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