An Introduction to Tellurite Glasses

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Module 4 – Electrical and Dielectric Properties

Part 4:
Electrical Properties of Telluirte Glasses

I-Electrical Conductivity

II- Dielectric Properties

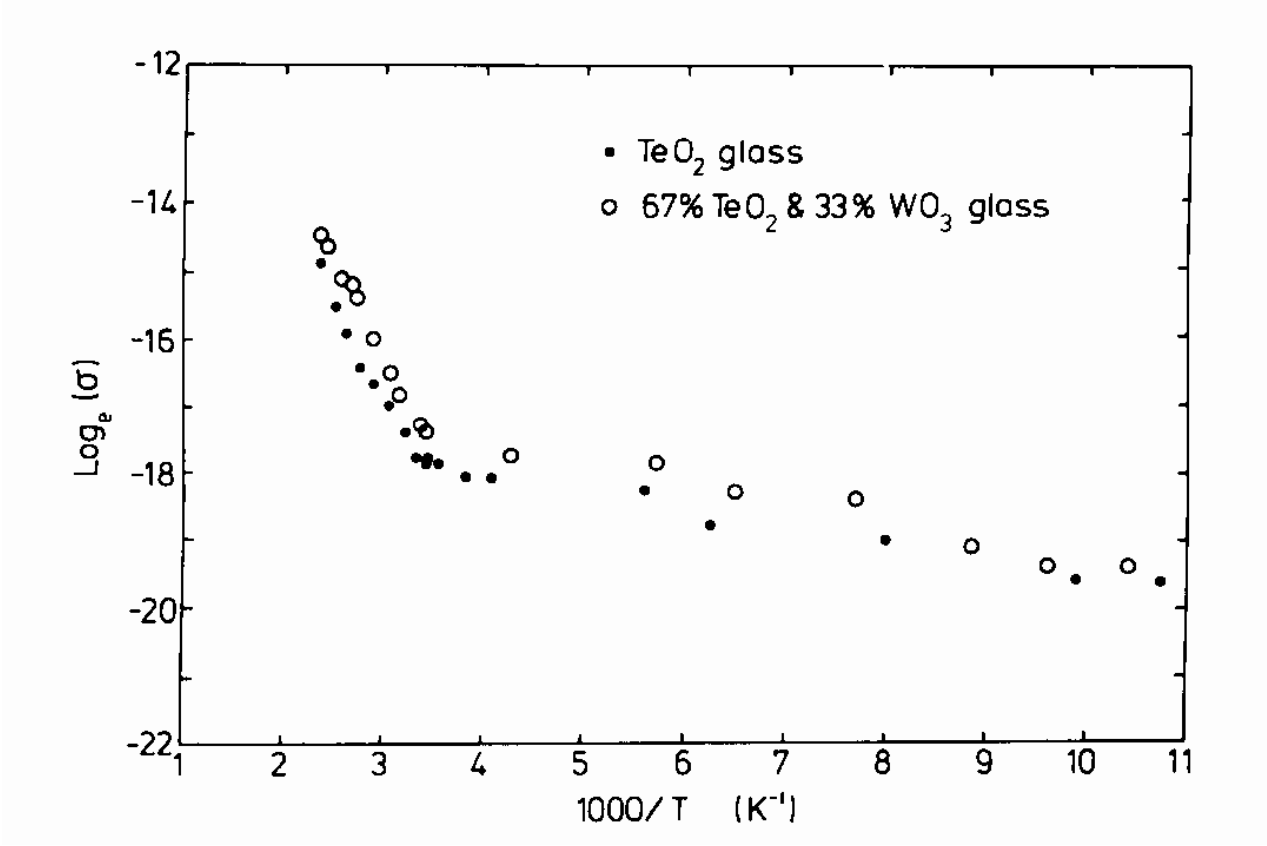
I-Electrical Conductivity

The objective of the present is part to understand the conduction mechanisms of tellurite glasses in its pure form and also when it contains transition metal (T.M.), rare-earth (R.E.) oxides,

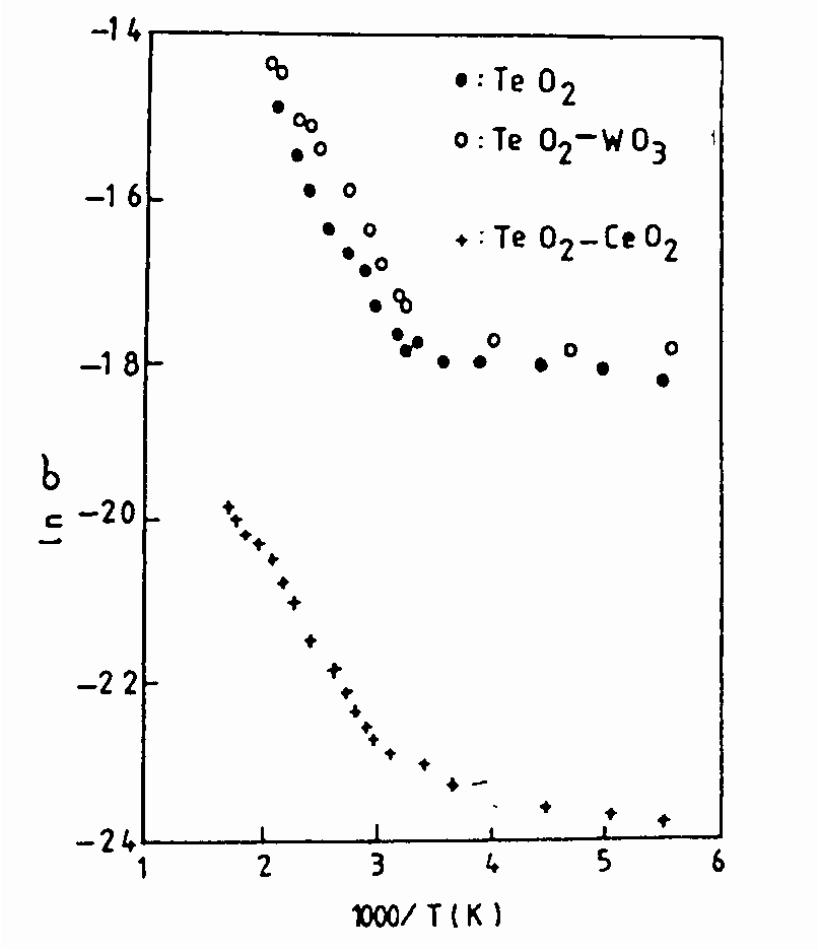
- The D.C. electrical conductivity for the glassy systems were represented in different temperature ranges, pressures and modifiers,
- The A.C. conductivity for the glass systems were collected in different temperature ranges and frequencies,
- Theoretical considerations and analysis of the electrical properties of telluirte glasses according to hopping mechanism for the conductivity at high, room and low temperature,

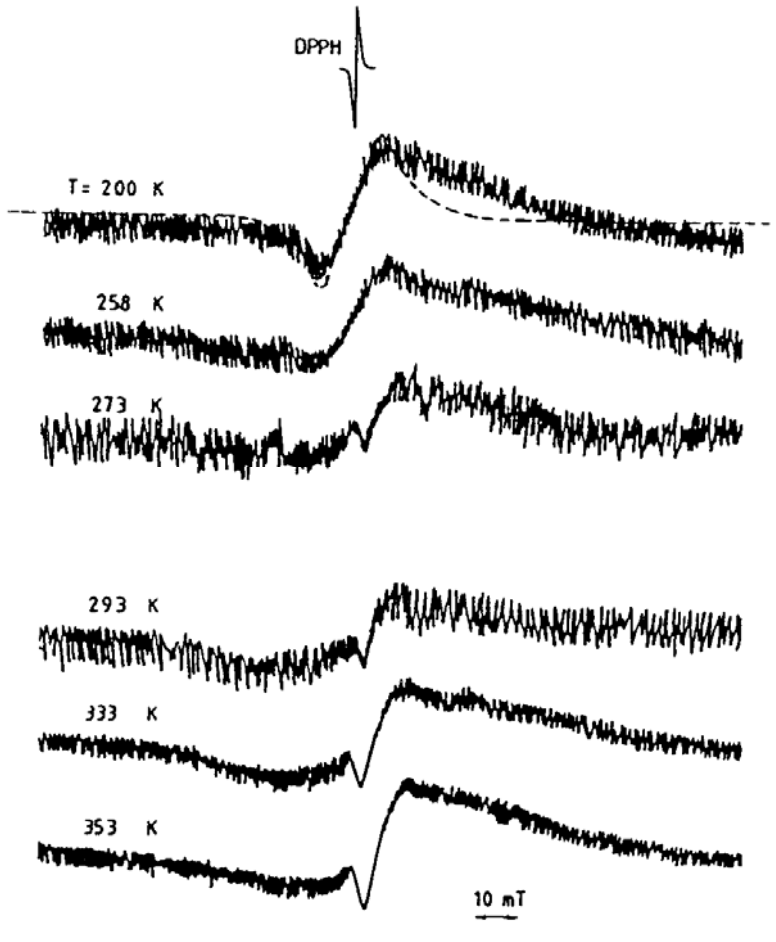
- The semiconducting behavior of tellurite glasses were found to be dependent on the ratio of low valance to high valance state of the modifier, activation energy, electron phonon coupling,
- The behavior of the electrical conduction parameters were found to be dependent upon the temperature, the frequency, the pressure, kind and percentage of the modifier.

The D.C. electrical conductivity for the glassy systems in different temperature ranges and modifiers (T.M.O).
Tellurite tungsten glasses by Hampton et al, (1987)



The D.C. electrical conductivity for the glassy systems in different temperature ranges and modifiers, by El-Mallawany at al, (1995)





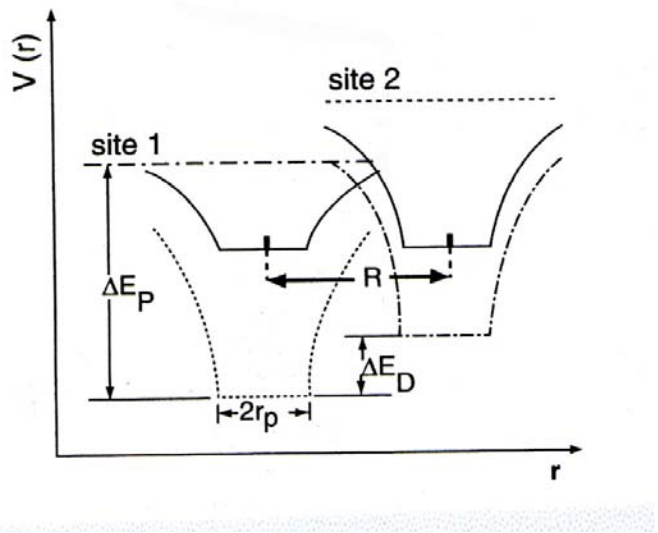
The quantitative analysis of D.C. electrical conductivity for the glassy systems in different temperature ranges and modifiers.

$$\sigma(T) = \frac{\nu_{phonon} e^2 c(1-c)}{KTR}\left[\exp(-2\alpha R)\right]\left[\exp(-\Delta E / kT)\right]$$

$$N = \frac{\rho P N_A}{(100\ AW)}$$

$$r = (0.5)\left(\frac{\Pi}{6N}\right)^{1/3}$$

$$\Delta E = \Delta E_H + 0.5\Delta E_D$$



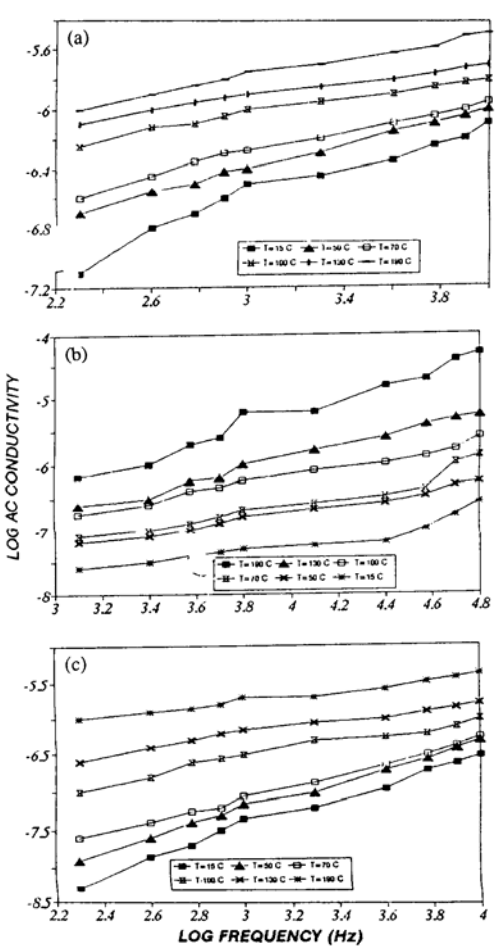
At low temperature $\sigma = A\exp(-B/T^{1/4}),$ $T \le (\Theta_D / 4)$

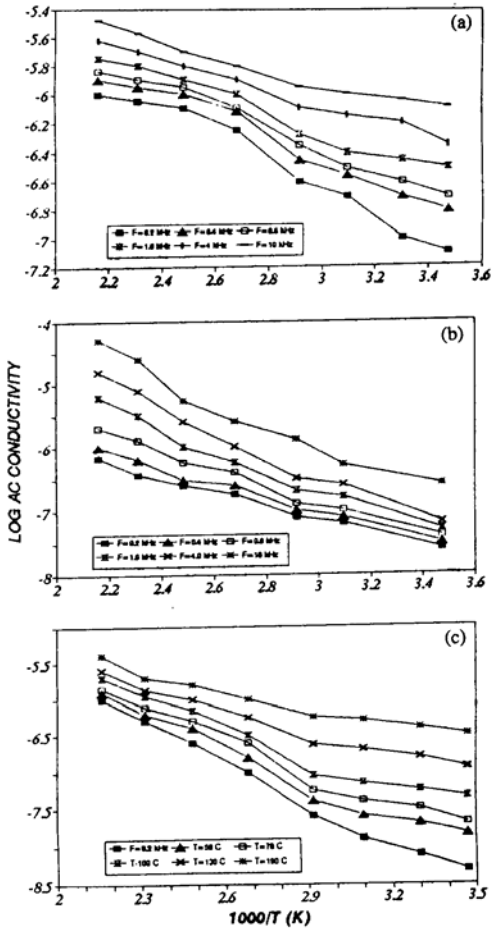
where A and B are constants. The constant (B) is given by

$$B = 2.1\left[\frac{\alpha^3}{kN(E_F)}\right]^{1/4}$$

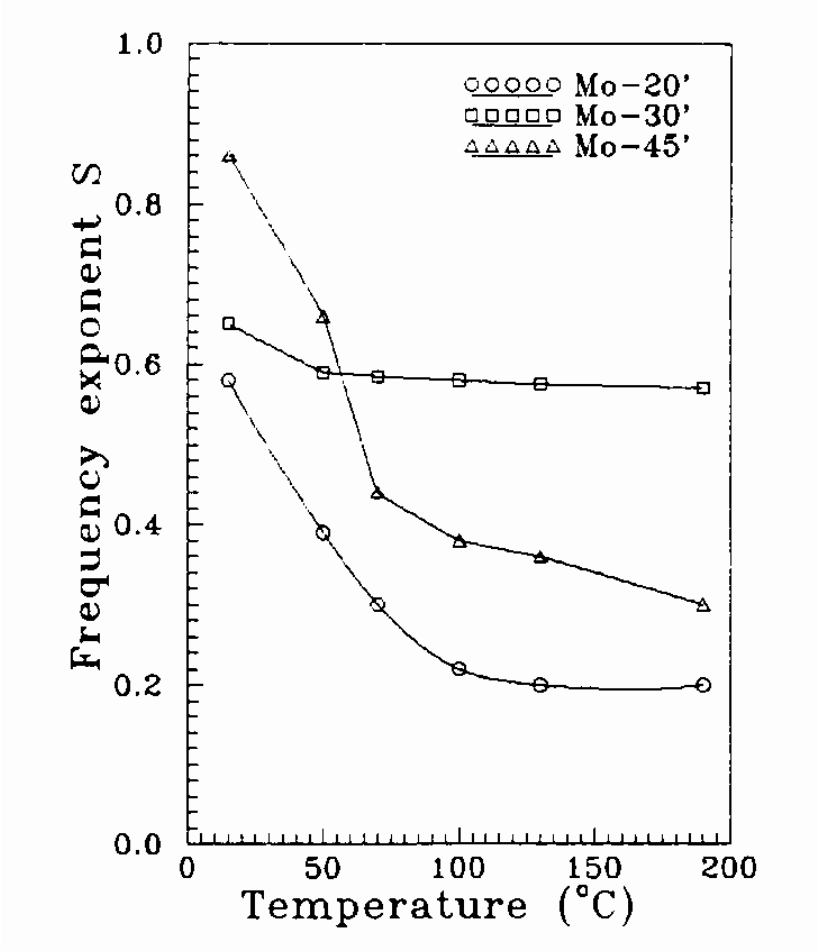
A.C. Electrical Conductivity Data of Tellurite Glasses containing MoO3 with different percentage by Elkholy and ElMallawany (1995)

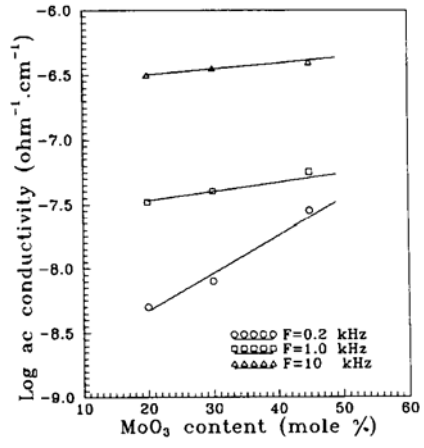
$$\sigma(\omega) = A\omega^{s}$$

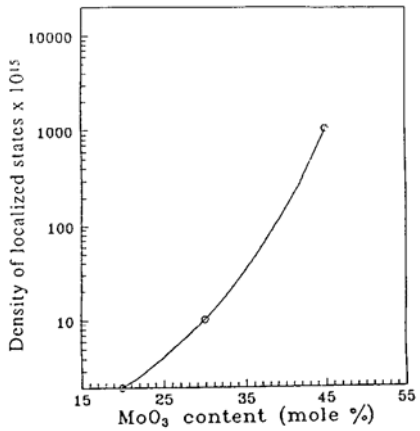




A.C .Electrical Conductivity Data of Tellurite Glasses containing MoO3 by ElKholy and ElMallawany (1995)



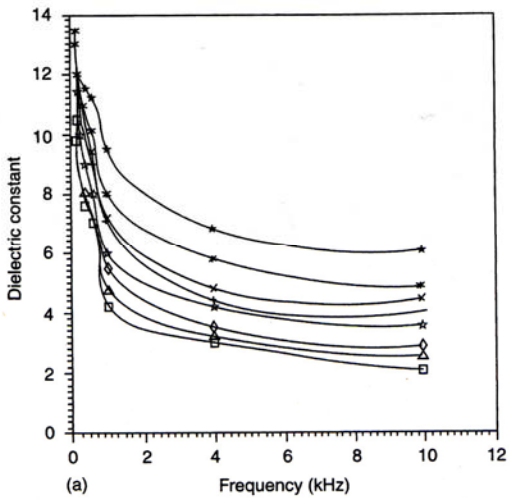


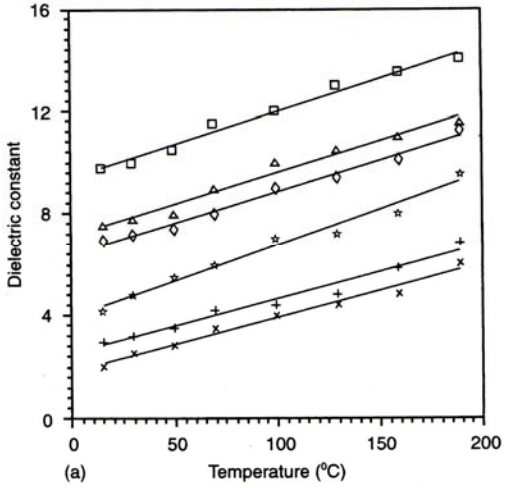


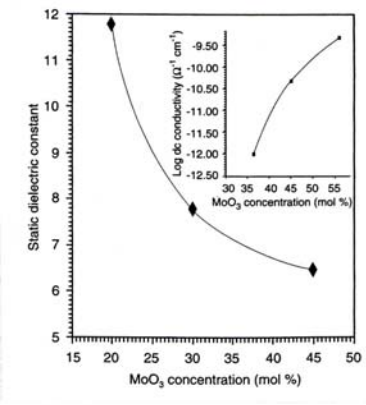
Dielectric Properties of Telluirte Glasses

- *The dielectric constant and loss factor were collected for tellurite glasses in both forms : oxide form and non-oxide form.*
- *The dielectric constant and loss factor has been decreased as frequency increased. While both of them has been increased as temperature increased. Also, the values of the rate of change of dielectric with frequency and temperature (dε/df) , (dε/dT) and the complex dielectric (ε*) and polarizability (α) have been* represented *and discussed.*
- *These values depend on the type and percentage of the modifier present in telluirte glasses. The electric modulus and relaxation behavior of tellurite glasses were collected and discussed according to the stretching exponent parameter. Also, the pressure dependence of the dielectric constant* (ln ε / P) *has been* represented.
- *The quantitative analysis of the dielectric constant has been discussed number of polarizable atoms per unit volume (N/V), and the polarizability of these atoms α factors to explain the electrical properties.*

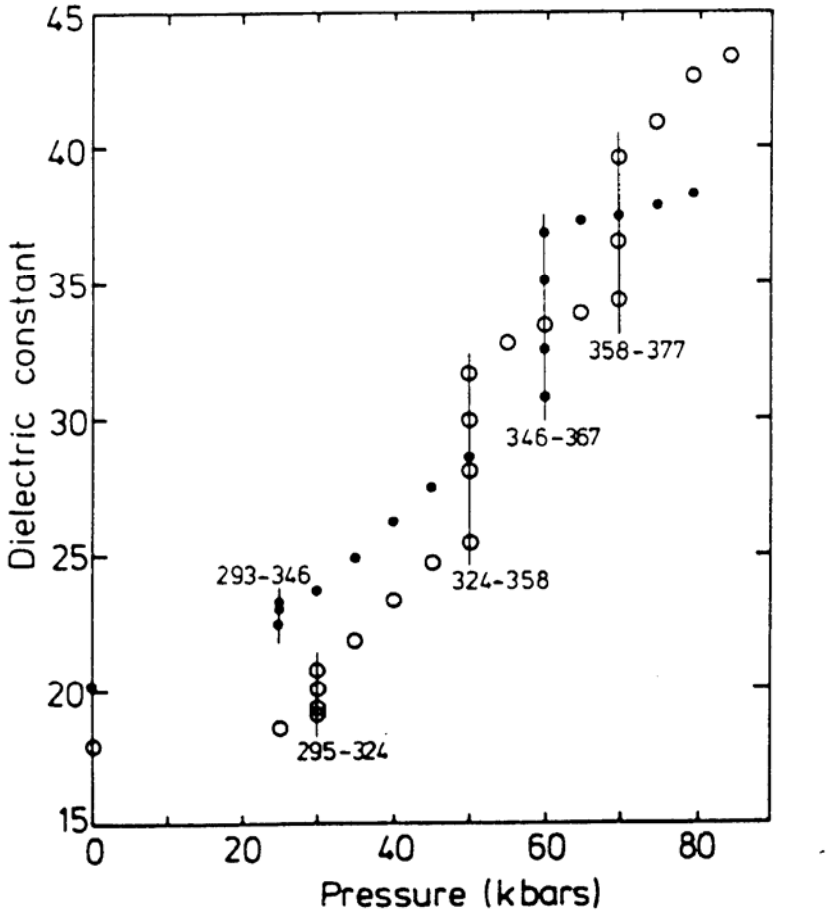
Dielectric constant frequencies and temperatures TeO2-MoO3 glasses with different percentage of MoO3 by ElMallawany et al, (1996)



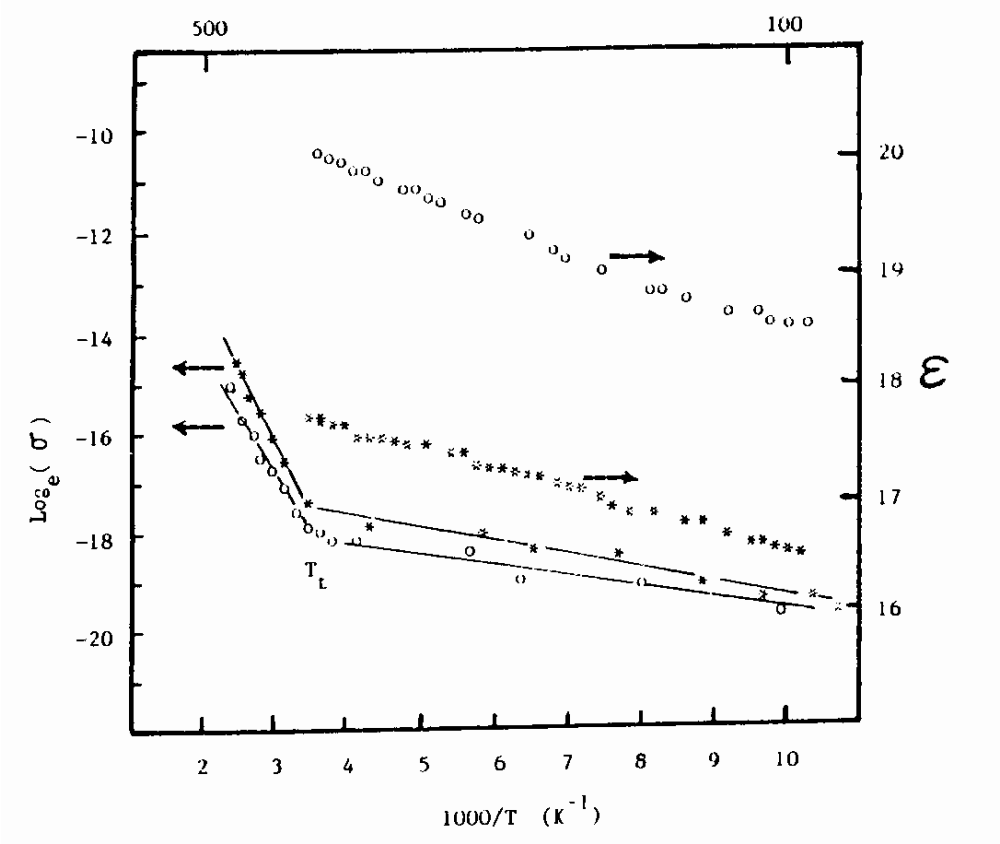




Dielectric constant under hydrostatic pressure TeO2-WO3 by Hampton et al (1989)



The quantitative analysis of electrical conductivity & dielectric constant by ElMallawany (1994)



All of the quantitative values of electrical process like; polaron radius, hopping distance and disorder energies, and density of states near Firmi level together with the quantitative analysis of dielectric constant data for telurite glasses are in reference
http://www.crcpress.com/engineering/Chemical/T , (2002)

To Be Followed by

Module 5: Optical Properties