An Introduction to Tellurite Glasses

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Module 3 - Elastic & Thermal Properties

From the above Introduction

Tellurite glasses *are of interest from both the scientific and technological viewpoints,*

Part I : Elastic Properties of Telluirte Glasses,

Part 2 : Thermal Properties of Telluirte Glasses,

Part 3 : Electrical Properties of Telluirte Glasses,

Part 4 : Optical Properties of Telluirte Glasses,

Part 1: Elastic moduli determination by measuring ultrasonic velocity& Ultrasonic attenuation

Elastic properties are very informative about the structure of solids because they are directly related to the interatomic potentials,

Glasses being isotropic and have only two independent elastic moduli which are longitudinal & shear moduli,

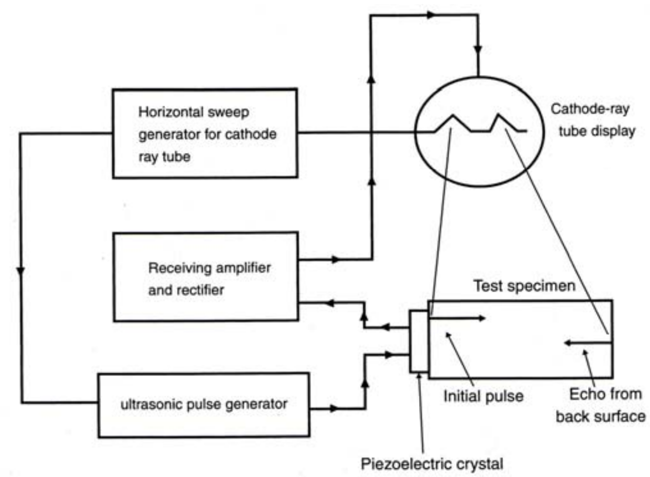
The two parameters have been obtained from the longitudinal & shear sound velocity and density of the glass,

The rest of other elastic moduli (Bulk, Young's and Poisson/s ration , Debye temperature) could be deduced,

Measurements of the ultrasonic attenuation at different temperatures and the relaxation strength in glasses.

Ultrasound velocity measurements calculations of elastic moduli of glasses

- Longitudinal modulus: L= ρ (vl x vl)
- Shear modulus: G = ρ (vs x vs)
- Bulk modulus : B= ρ{ (3vl x vl) - 4(vsxvs)}/3
- Young's modulus :
- E = ρ { (3vl x vl) - 4(vsxvs)}/
- {(vlxvl)-(vsxvs)}
- Poissson's ration = Σ = { (vl x vl) - 2(vsxvs)}/
- 2{(vlxvl)-(vsxvs)}



- Debye temperature =

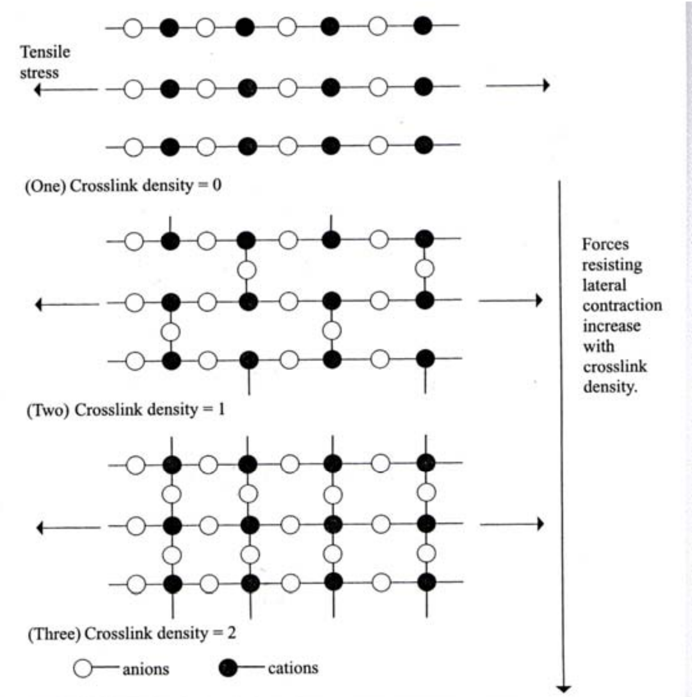
$$\theta_D = \left(\frac{h}{K_B}\right)\left(\frac{3\rho N_A P}{4\pi M}\right)\left[\left(\frac{1}{V_L^3}\right)+\left(\frac{2}{V_S^3}\right)\right]^{1/3}$$

Theoretical Considerations:

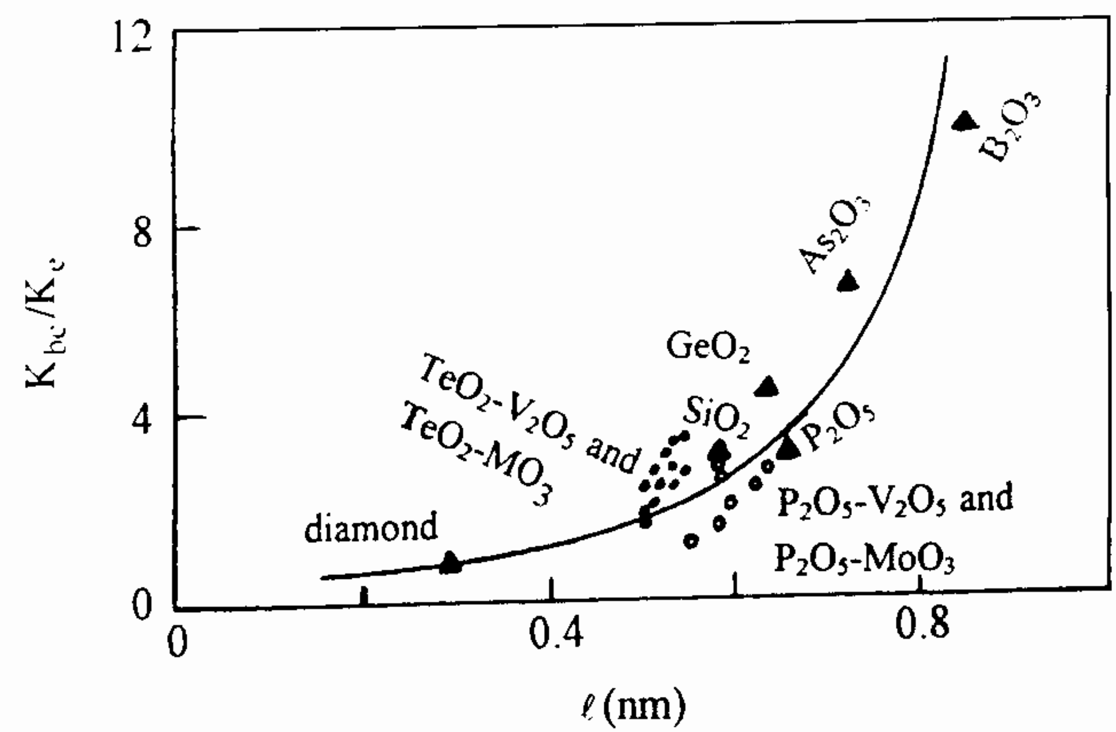
Information about the structure of the glass can b deduced after calculating:

- **Crosslink Density**

  n_c = Coordination number – 2,
- **Number of network bonds per unit volume,**
- **Value of the average stretching force constan**
- **Average ring size,**
- **Structure sensitivity factor and**
- **Mean crosslink density.**



Comparisons between the calculated and experimental elastic moduli & Poisson's ration wil carried out, Quantitative analysis of the Elastic moduli by ElMallawany et al (1998) using the bulk compression model by Bridge et al, 1983

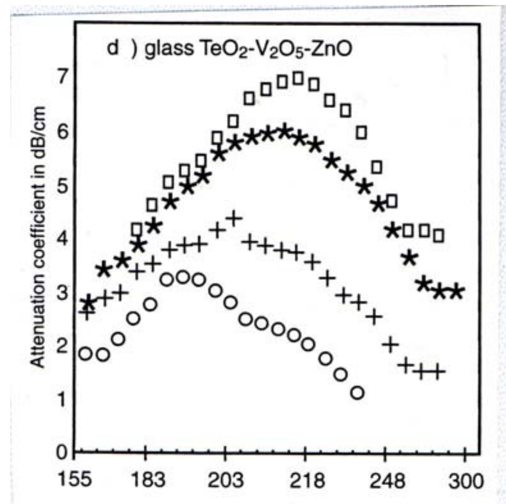


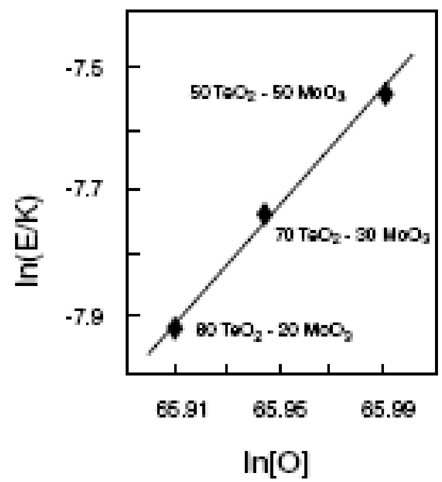
$$K_{bc} = \frac{n_b r^2 f}{9}$$

Ultrasonic Attenuation in Tellurite Glasses

$$\alpha_{acoustic} = \left(\frac{20}{2x}\right)\log\left[\frac{A_n}{A_{n+1}}\right]$$

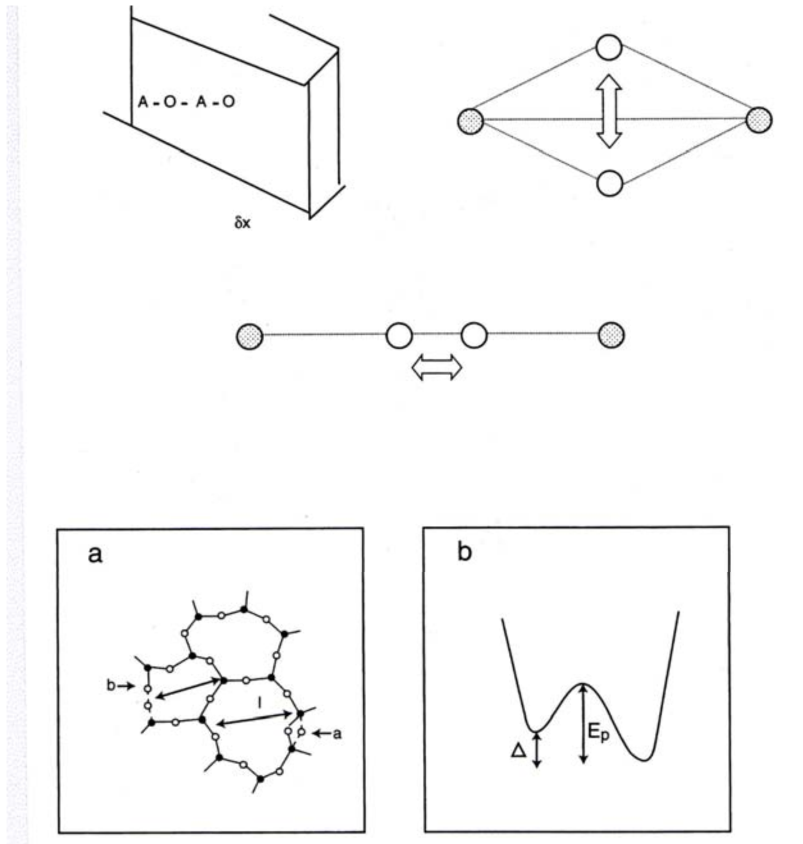
$$f = f_o \exp\left(\frac{-E}{kT}\right)$$



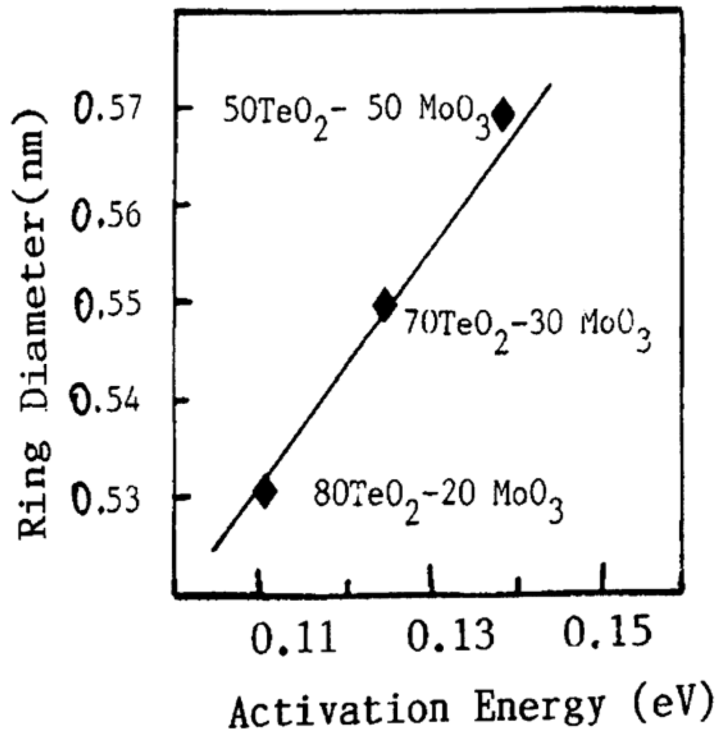


Relaxation Strength A and The mutual potential in tellurite glasses

$$A = \left(\frac{2\alpha_{MRL} \mathrm{v}}{2\pi f} \right)$$



Relation between ring diameter and acoustic activation energy in tellurite glasses   by ElMallawany (1994)



All of the quantitative values of the quantitative analysis of elastic moduli and relaxation process in telluirte glasses telurite glasses are in reference http://www.crcpress.com/engineering/Chemical/T , (2002)

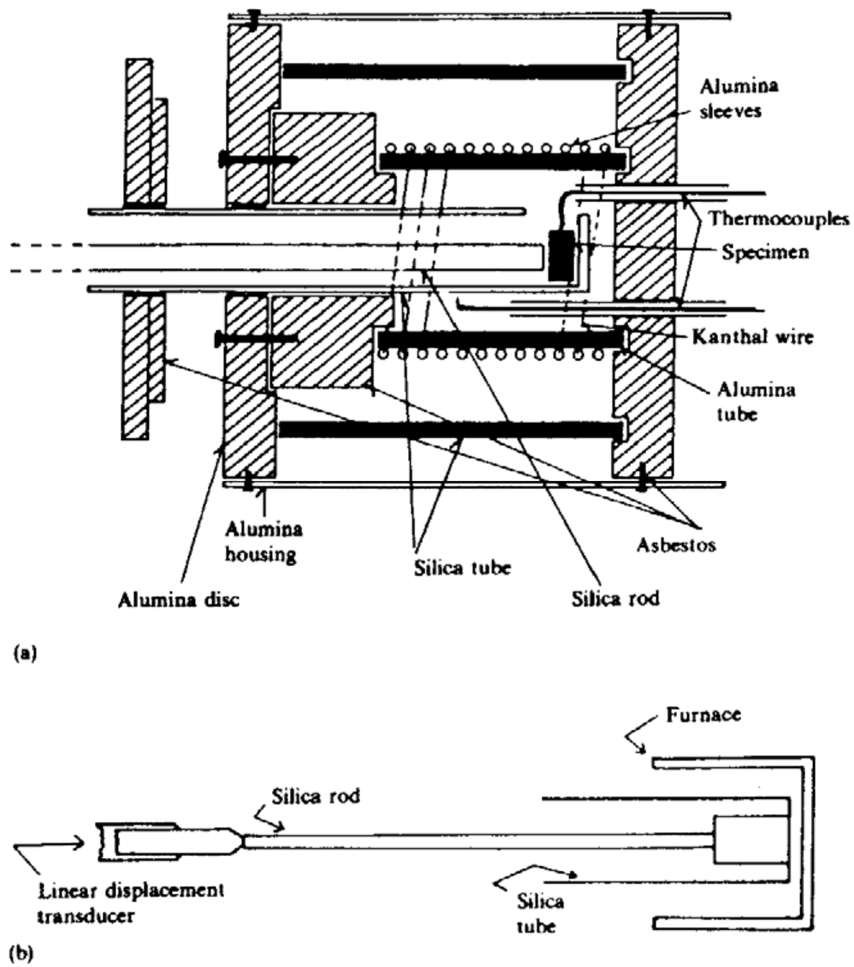
Part 2 Thermal Properties of Telluirte Glasses

The experimental thermal properties:
glass transformation temperature (T_g),
glass crystallization temperature (T_c),
glass melting temperature (T_m) and
thermal expansion coefficient (α_{th}) data for tellurite glasses were represented.

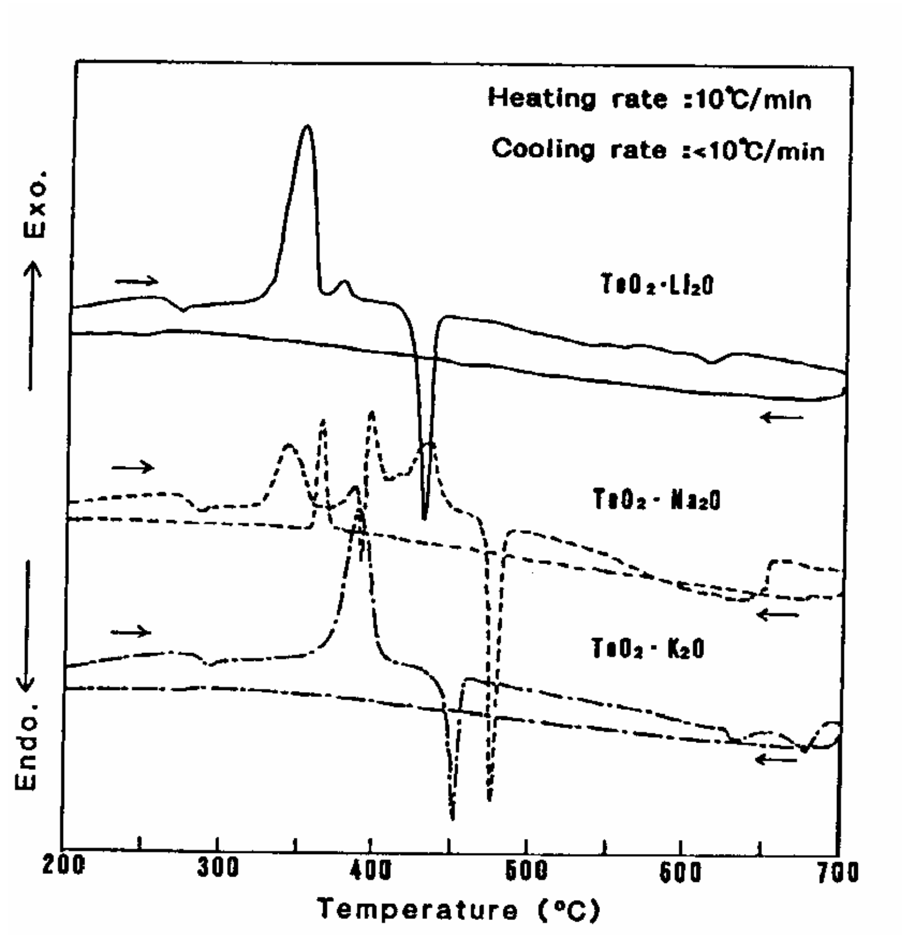
The correlations between the thermal properties (T_g) with the average crosslink density and average stretching force constant have been noticed.

Specific heat capacities of tellurite glasses were collected and the difference in specific heat capacities, (ΔC_p) of the glass (C_{pg}) and supercooled liquid (C_{pl}) at (T_g) was represented for tellurite glass.

Measurement of thermal expansion coefficient (α th)

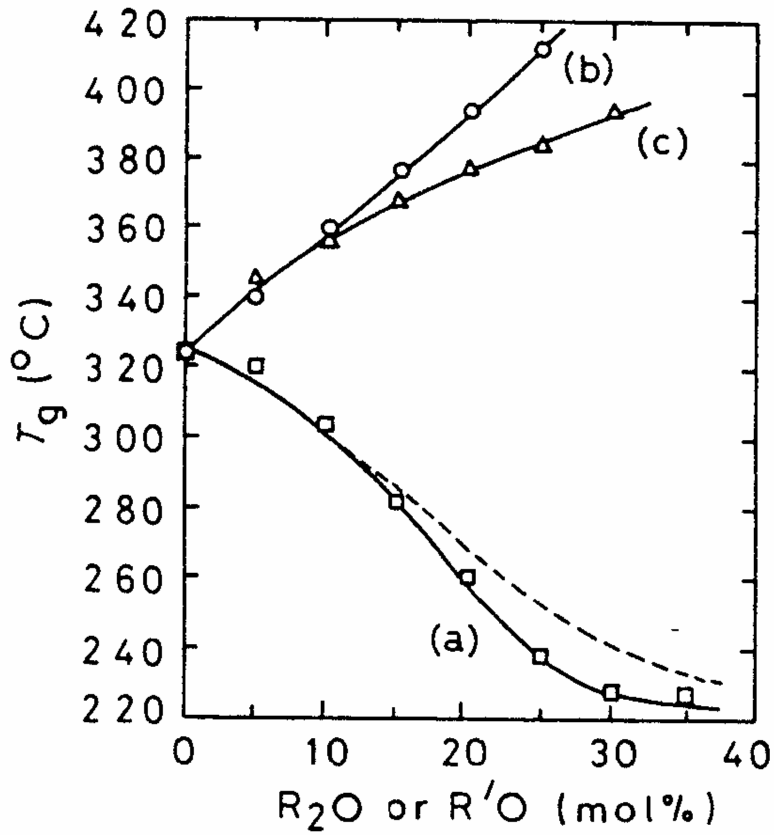


Glass transformation temperature (Tg) by Differential Thermal Analysis (DTA) by S.Inou et al (1992)

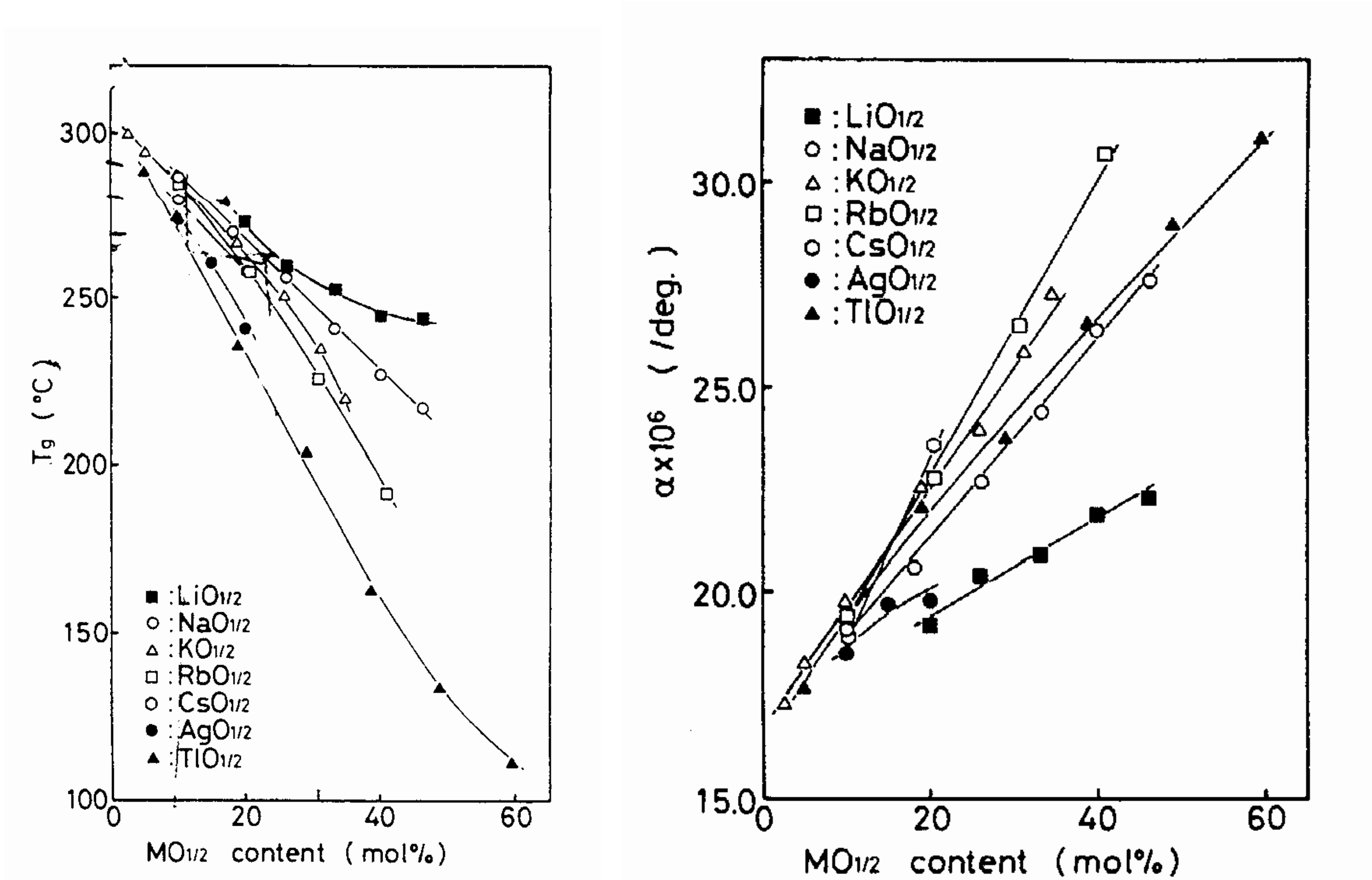


Glass transformation temperature (Tg) by Nichida et al (1992)

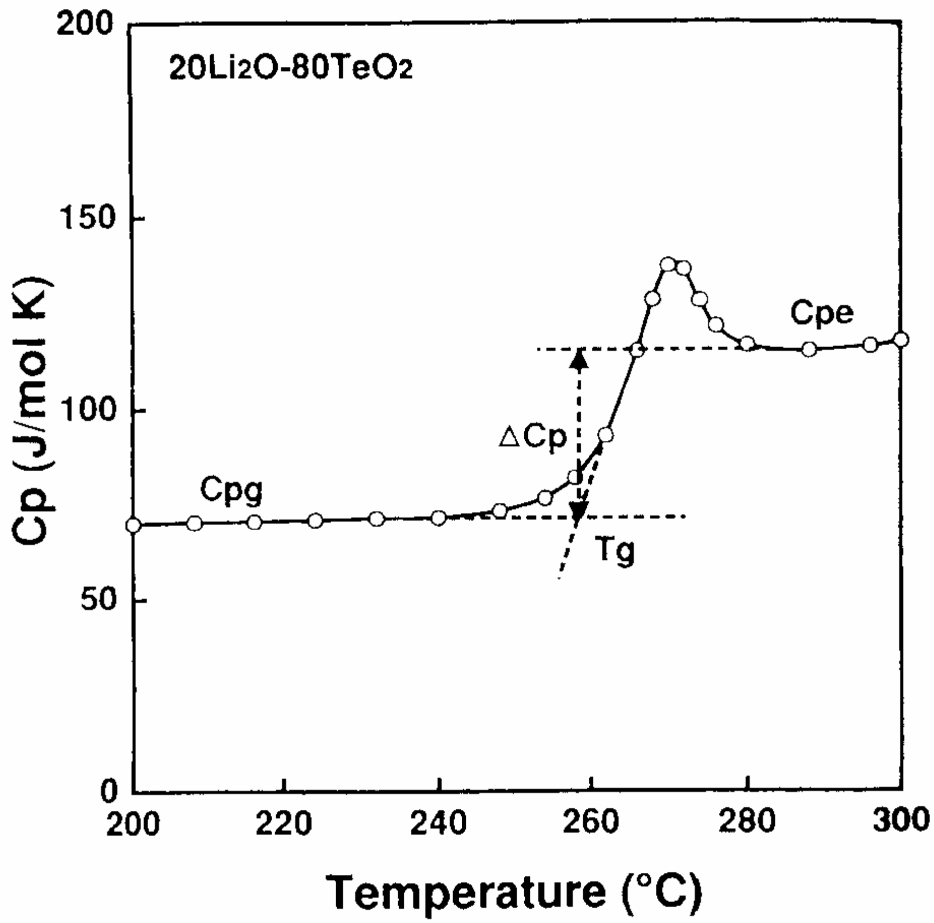
$$T_g = f(n_c^{'}, F^{'})$$



The quantitative values of the quantitative analysis of he thermal properties in telluirte glasses are in reference http://www.crcpress.com/engineering/Chemical/T , (2002) The opposite behavior of the glass transformation temperature and thermal expansion coefficient in tellurite glasses by Sekiya et al (1992)

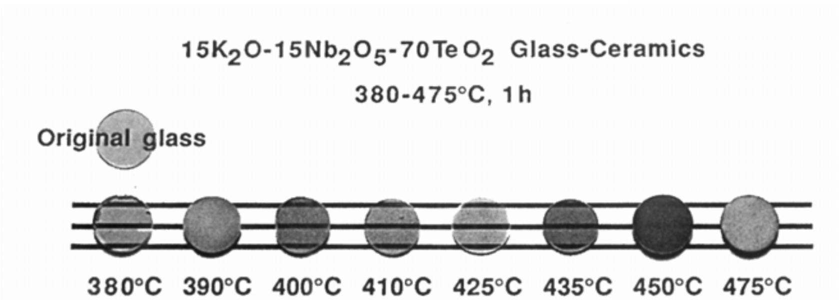


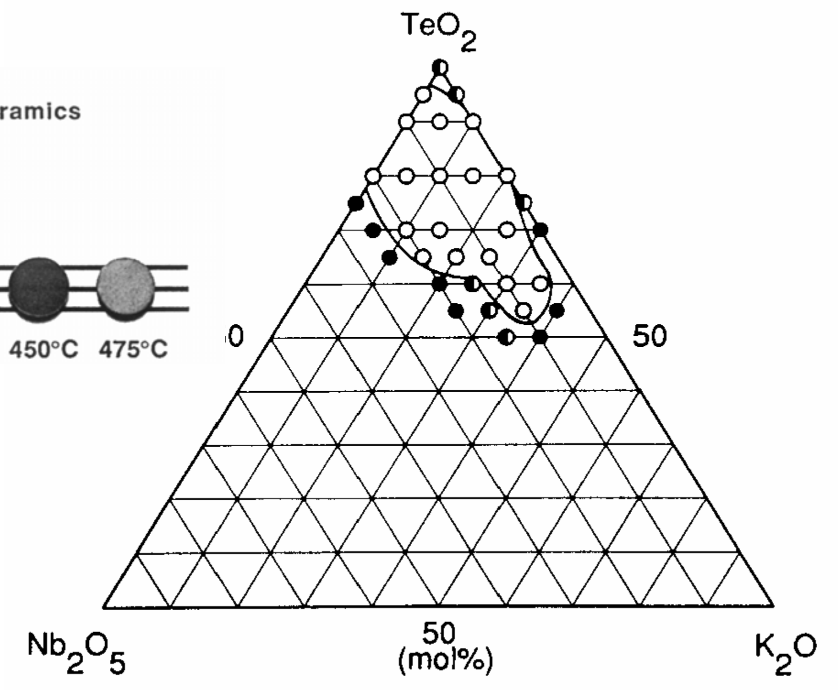
Heat capacity changes at glass transition temperature for tellurite glasses by Kosuge et al (1998)



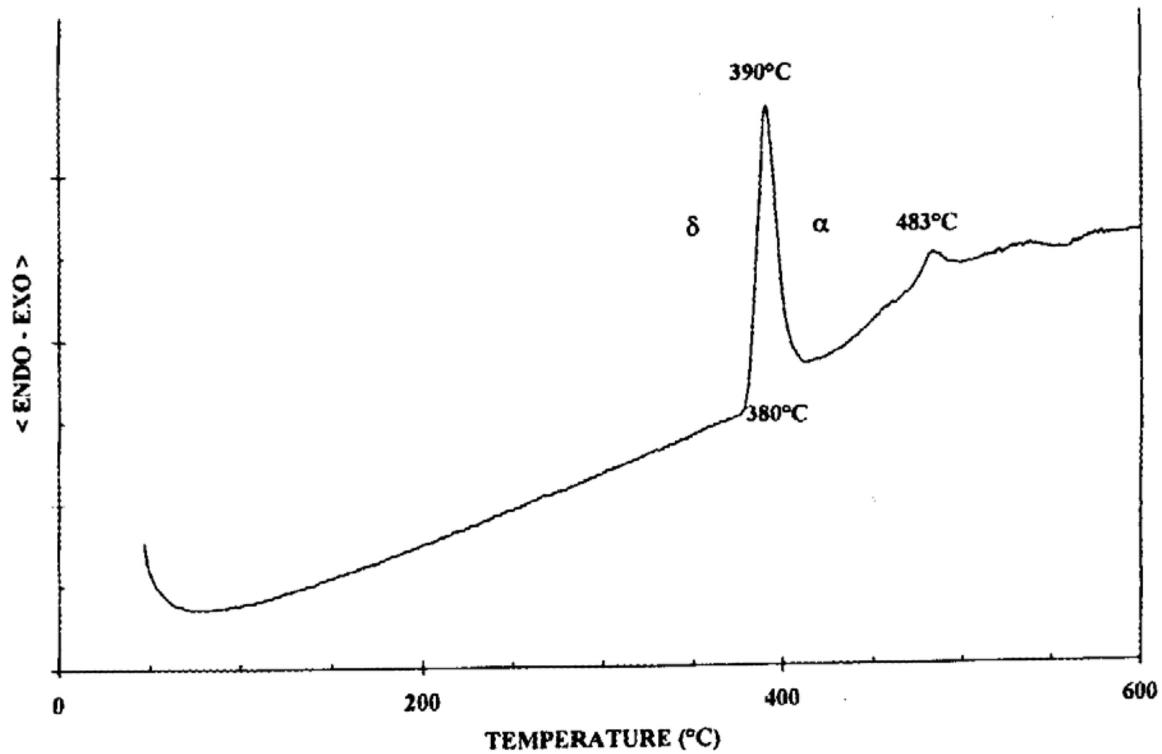
Optical properties of transparent tellurite glasses and opaque tellurite glass ceramic

by K. Shioya et al (1995)





Two new metastable compounds α & δ have been detected by S.Blanchandin, et al, 1999



To Be Followed by

Module 4: Electrical and Dielectric Properties