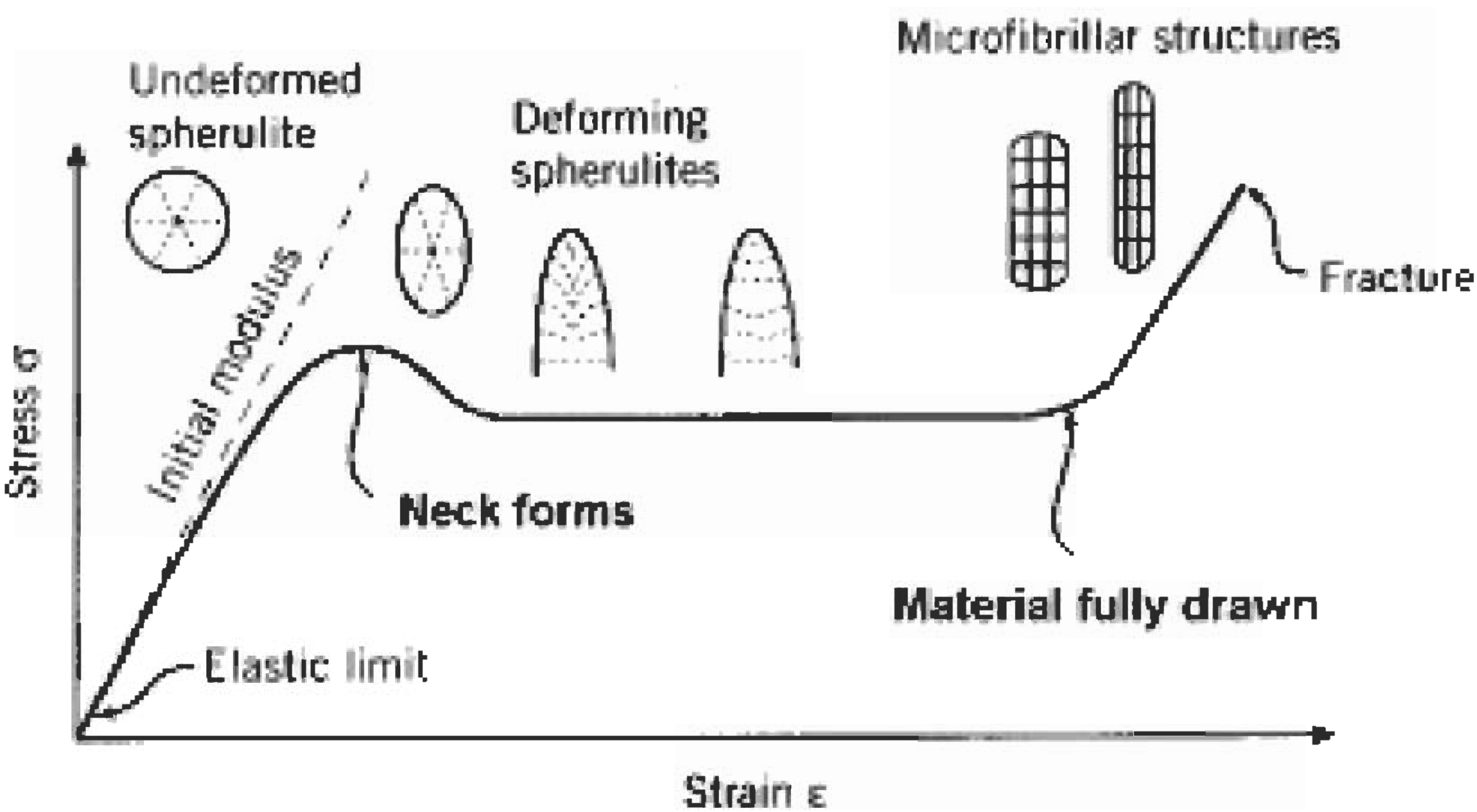
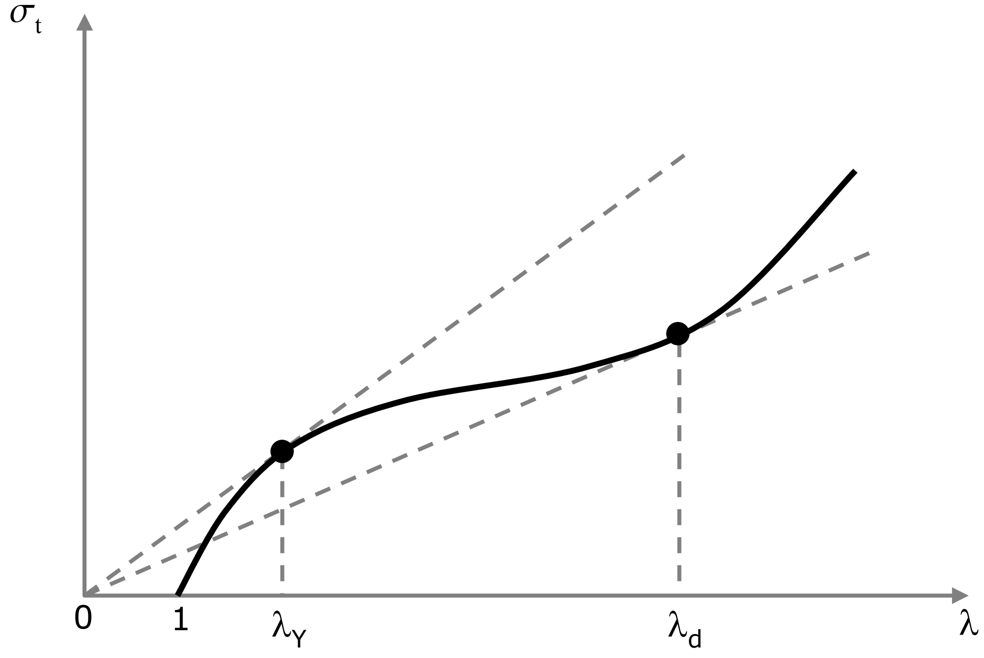


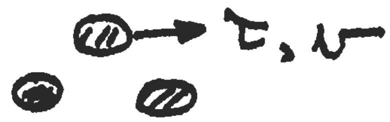
From Samuels, R.J. Structured Polymer Properties. New York: Wiley-Interscience, 1974.



σ_t
0
1
λ_Y
λ_d
λ

Creep: Bauwens/Eyring analysis

flow:



$$\nu = \nu_0 \exp \frac{-(\Delta H - V^* \tau)}{RT}$$

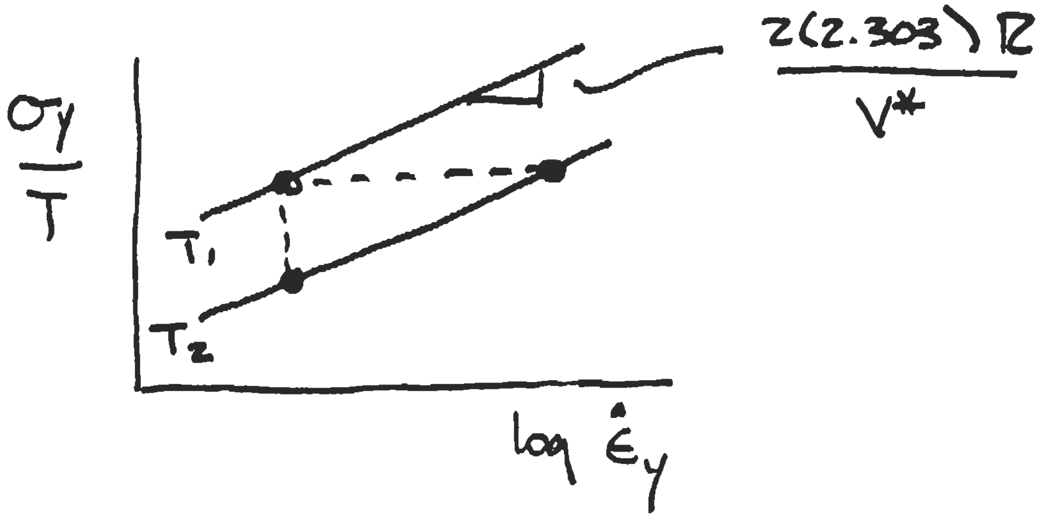
@ yield: $\nu \propto \dot{\epsilon}_y$, $\tau = \sigma_y / 2$

$$\dot{\epsilon}_y = \dot{\epsilon}_0 \exp\left(\frac{-\Delta H}{RT}\right) \exp\left(\frac{V^* \sigma_y}{2RT}\right)$$

$$\frac{\sigma_y}{T} = \frac{2}{V^*}\left[\frac{\Delta H}{T} + 2.303 R \log \frac{\dot{\epsilon}_y}{\dot{\epsilon}_0}\right]$$

See Figure 6.15, "Eyring plot for polycarbonate," in Roylance, D. *Mechanics of Materials.* Hoboken NJ: Wiley, 1995.

McCrum example (polycarbonate)



$$V^* = \frac{2(2.303)(8.314)}{9.8 \times 10^3} = 3.9 \times 10^{-3}\ m^3/mol$$

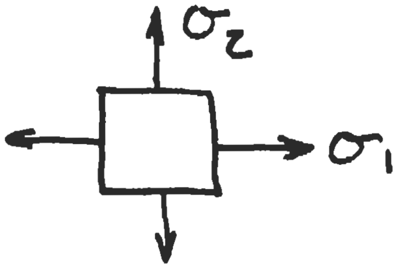
$$= 6.5\ nm^3 \quad (\sim 260\ \text{C atoms})$$

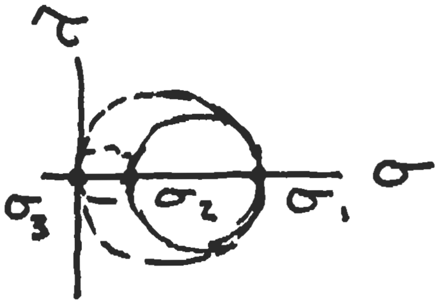
$$\Delta H = \frac{2.303R\left(\log \dot{\epsilon}_y^{T_2} - \log \dot{\epsilon}_y^{T_1}\right)}{\left(\frac{1}{T_1} - \frac{1}{T_2}\right)}$$

$$= \frac{2.303(8.314)(5.2)}{\frac{1}{333} - \frac{1}{373}}$$

$$= 309\ kJ/mol$$

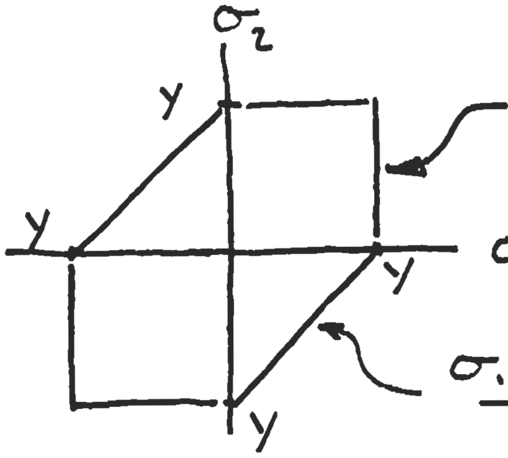
- Multiaxial stresses





- Tresca criterion (max τ)

$$\tau_{max} = \frac{\sigma_1 - \sigma_3}{2} \qquad \text{for } \sigma_1 > \sigma_2 > \sigma_3$$

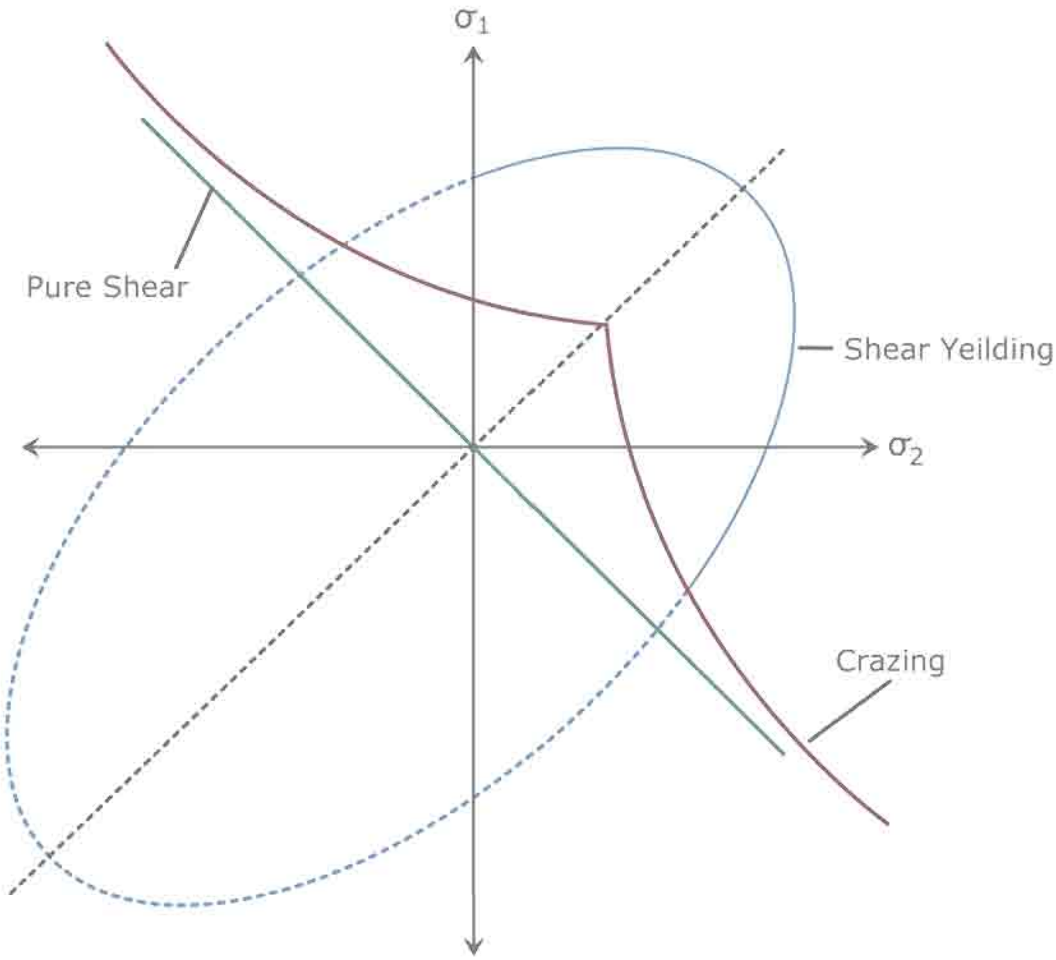


$$\frac{\sigma_1 - \sigma_3}{2} = \tau_{max} = \frac{Y}{2}$$

$$\frac{\sigma_1 - \sigma_2}{2} = \tau_{max} = \frac{Y}{2}$$

- von Mises (distortional strain energy)

$$\sqrt{\frac{1}{3}\left[(\sigma_1-\sigma_2)^2 + (\sigma_1-\sigma_3)^2 + (\sigma_2-\sigma_3)^2\right]} = \sqrt{\frac{2}{3}}\, Y$$



σ_1
Pure Shear
Shear Yeilding
σ_2
Crazing