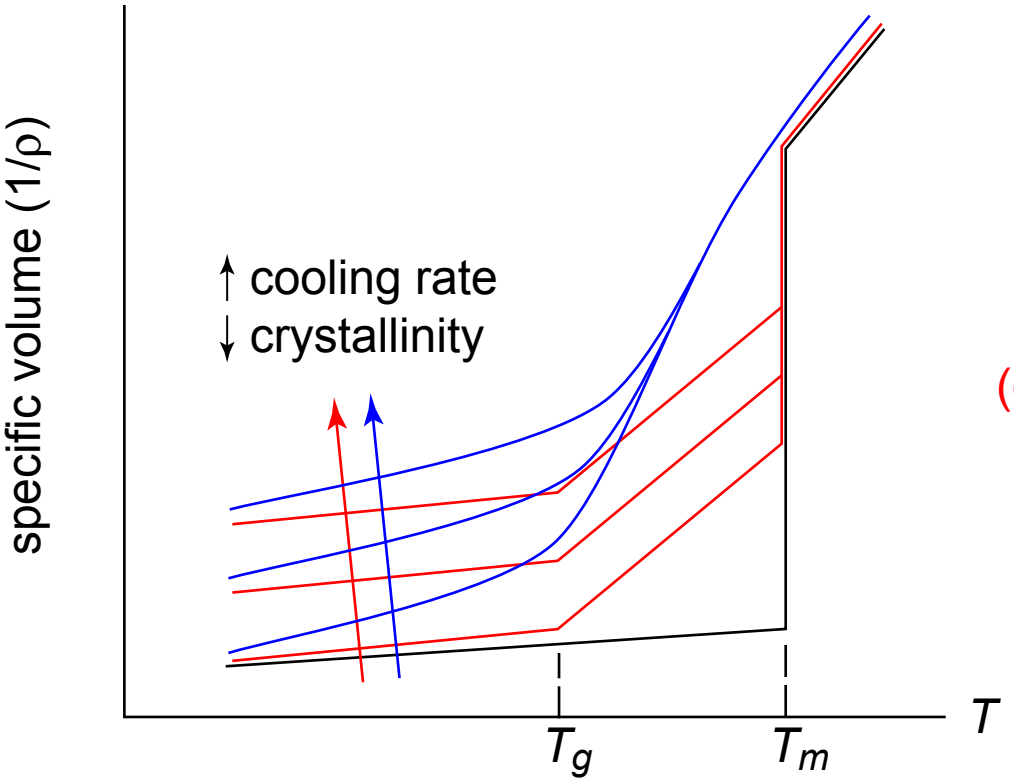
Molecular Structure: Crystallinity

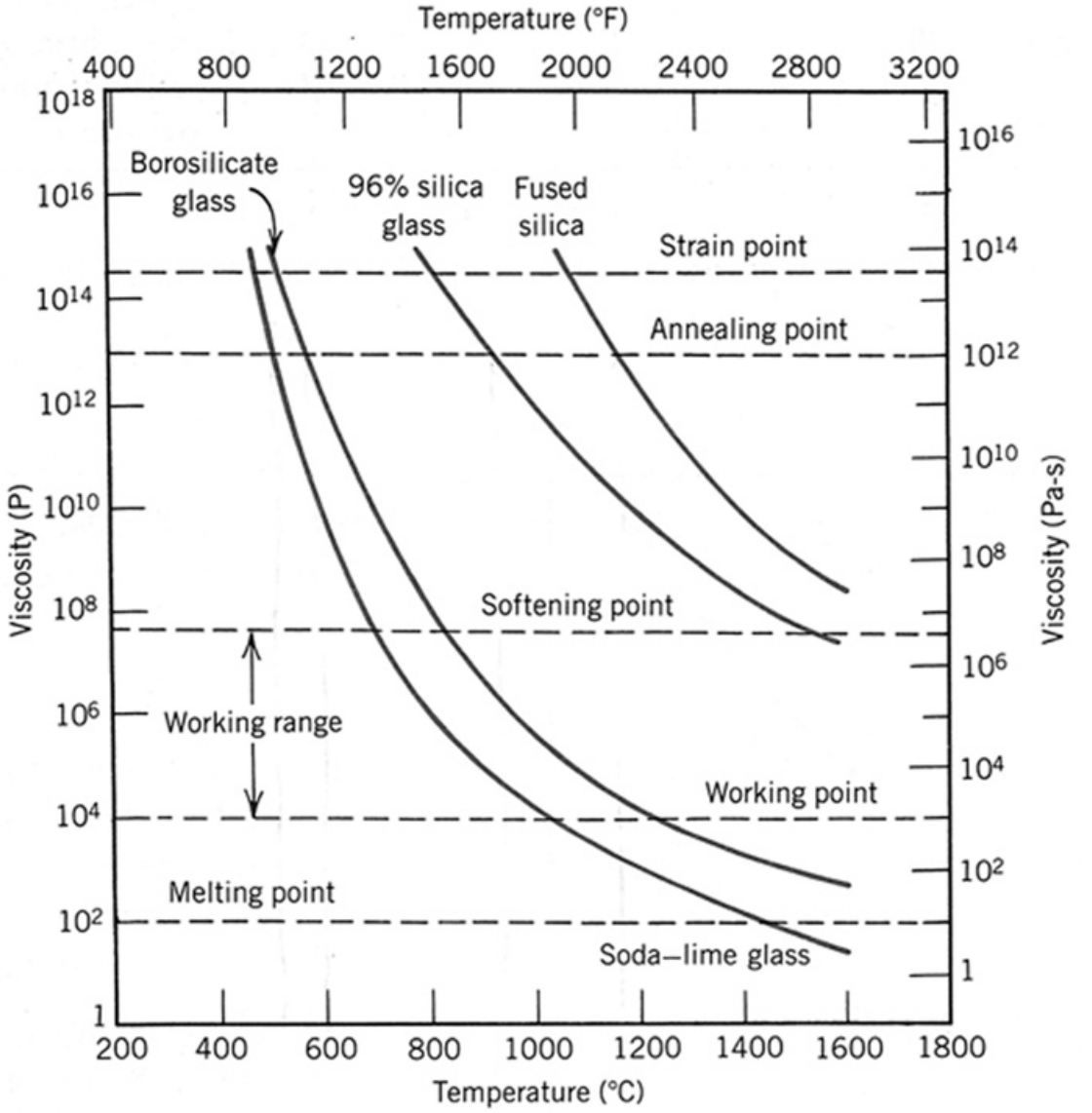


noncrystalline
(e.g., polystyrene
or silicate glass)

semicrystalline
(e.g., polyethylene)

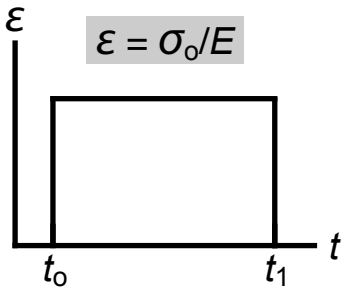
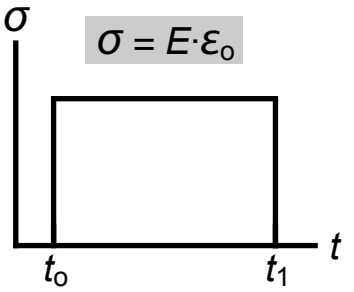
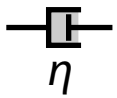
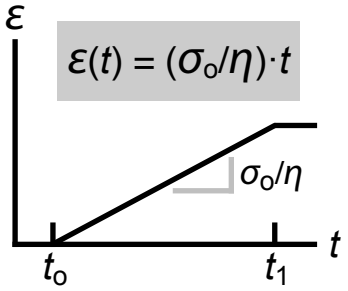
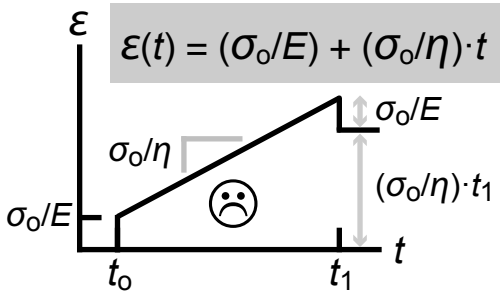
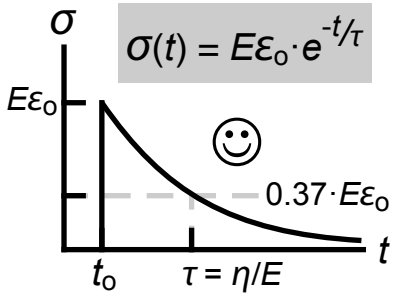
crystalline
(e.g., metals)

Glass Viscosity



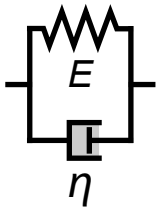
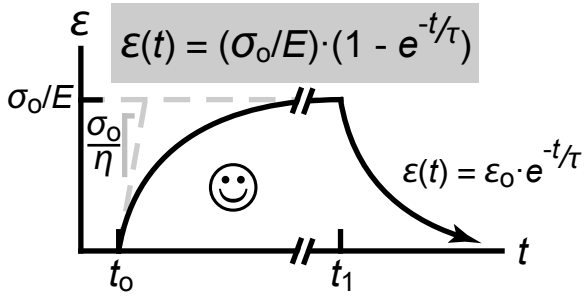
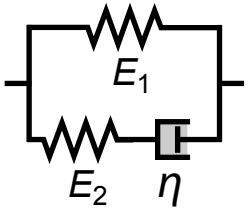
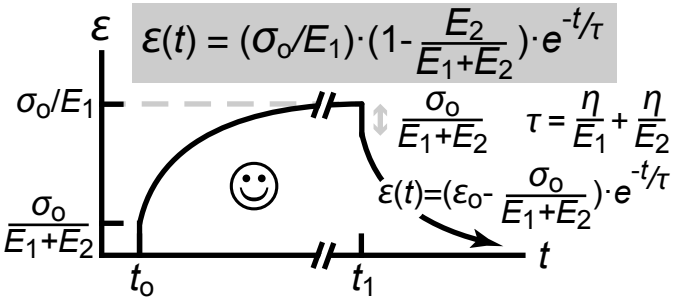
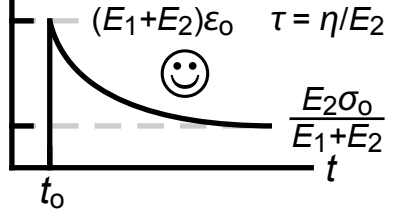
Adapted from: E.B. Shand, *Engineering Glass*, Modern Materials, Vol. 6, Academic Press, New York, NY, 1968.

Viscoelastic Constitutive Models

element/model	creep	stress relaxation
(a) spring (linear elastic) 	$\varepsilon = \sigma_o/E$ 	$\sigma = E\cdot\varepsilon_o$ 
(b) dashpot (viscous) 	$\varepsilon(t) = (\sigma_o/\eta)\cdot t$ 	$\sigma(t) = \eta\frac{d\varepsilon}{dt}$ instanteous strain not possible
(c) Maxwell 	$\varepsilon(t) = (\sigma_o/E) + (\sigma_o/\eta)\cdot t$ 	$\sigma(t) = E\varepsilon_o\cdot e^{-t/\tau}$ 

R.K. Roeder, “Mechanical Characterization of Biomaterials”; in *Characterization of Biomaterials*, Elsevier, 2013.

Viscoelastic Constitutive Models

element/model	creep	stress relaxation
(d) Kelvin/Voigt 	$\varepsilon(t) = (\sigma_o/E)\cdot(1 - e^{-t/\tau})$ 	$\sigma(t) = E\cdot\varepsilon_o + \eta\frac{d\varepsilon}{dt}$ instanteous strain not possible ☹
(e) standard linear solid 	$\varepsilon(t) = (\sigma_o/E_1)\cdot(1-\frac{E_2}{E_1+E_2})\cdot e^{-t/\tau}$ 	$\sigma(t) = \varepsilon_o\cdot(E_1+E_2\cdot e^{-t/\tau})$ 

R.K. Roeder, “Mechanical Characterization of Biomaterials”; in *Characterization of Biomaterials*, Elsevier, 2013.