Polymers Engineering
Group #5

INFOGRAPHY

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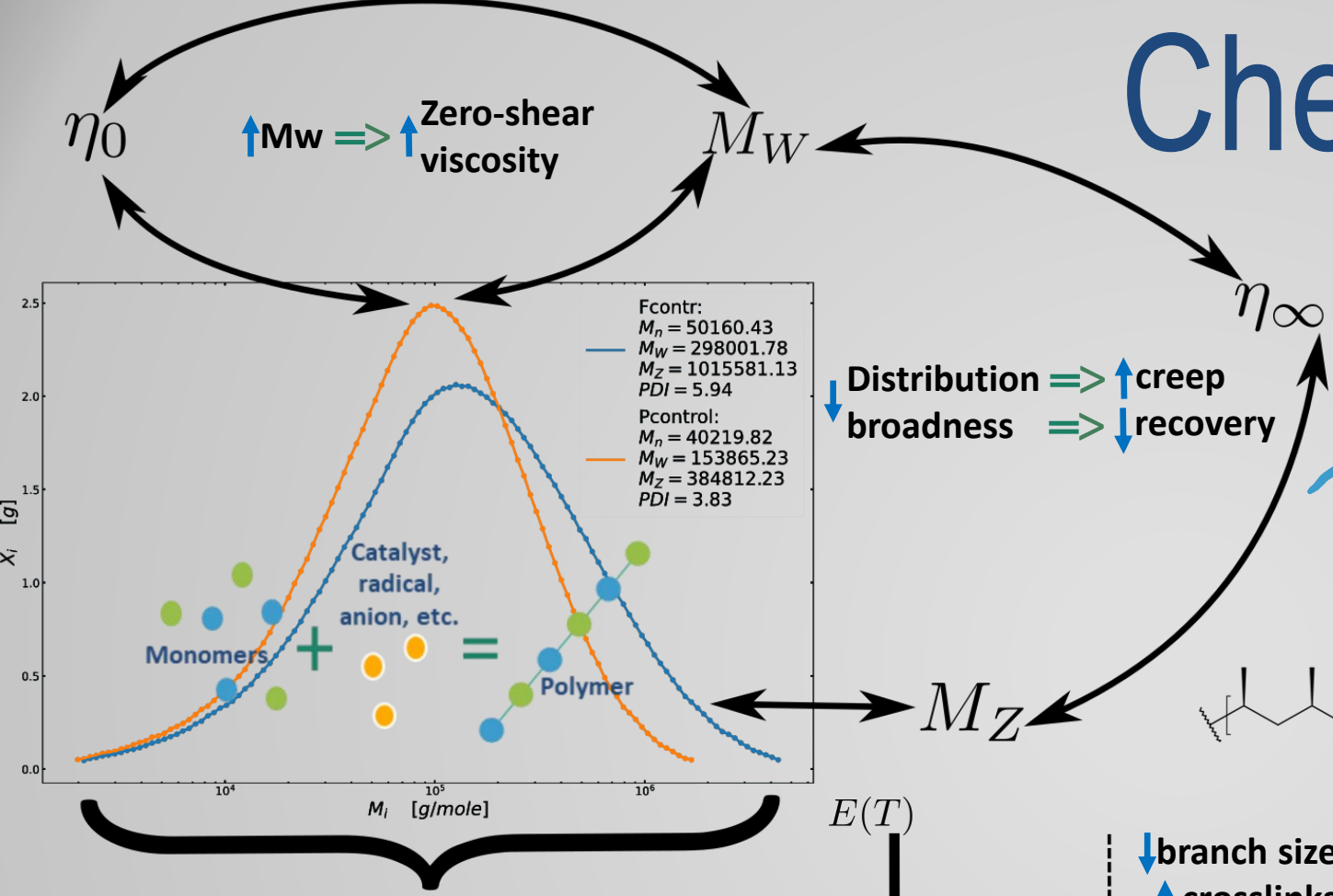
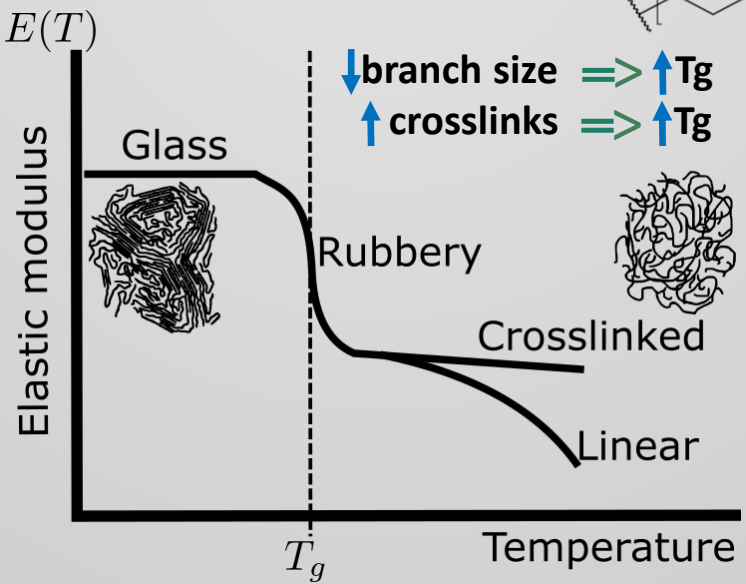
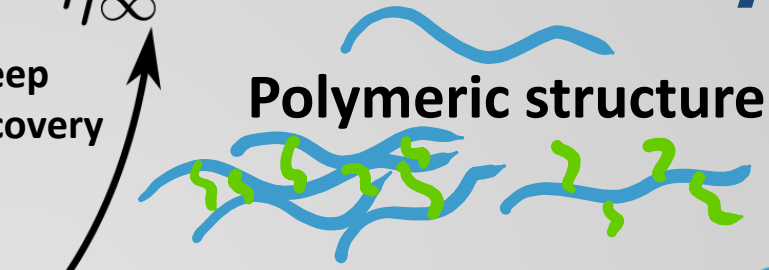
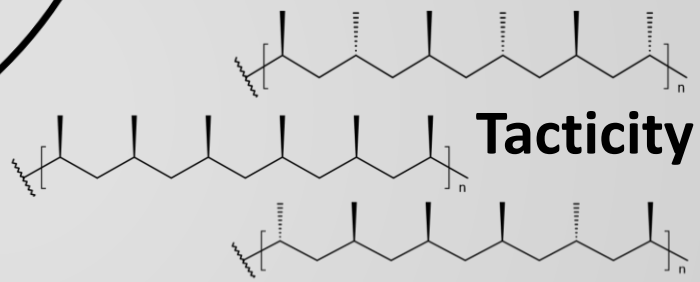
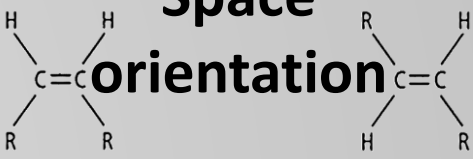
Chemical & Physical Aspects

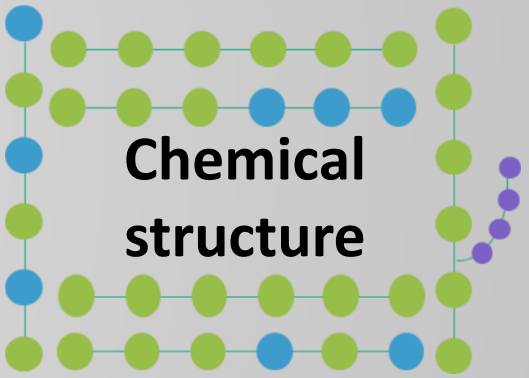


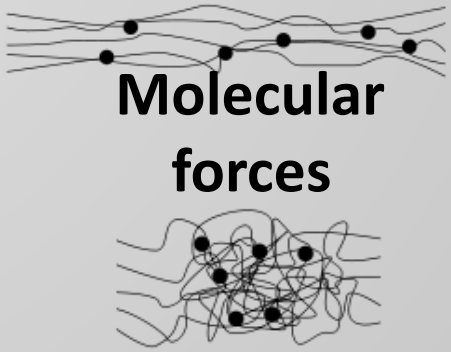






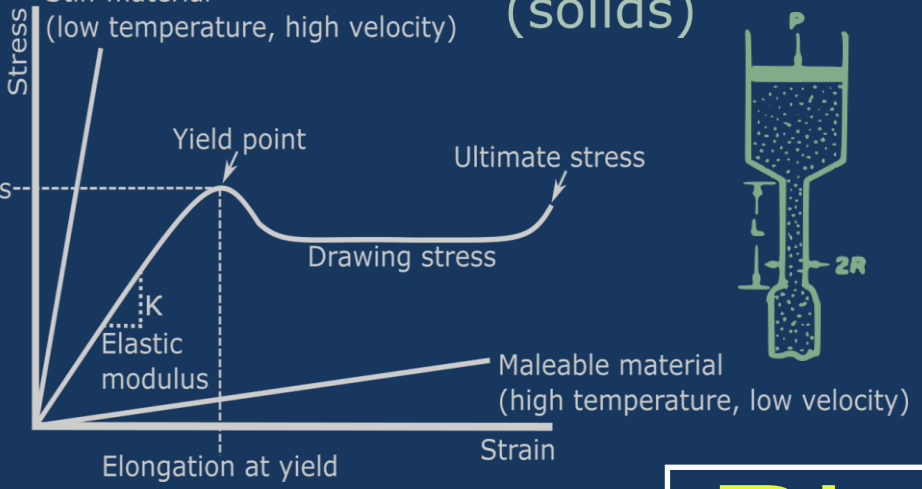






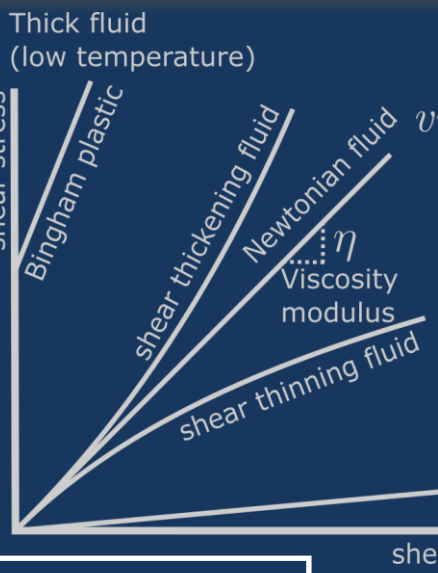
Rheology

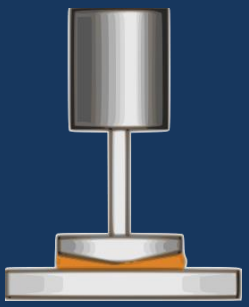
Tensile test (solids)



Constant shear rate test

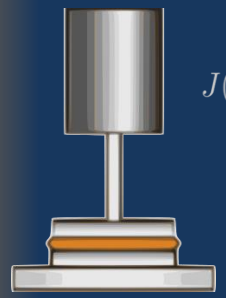
$$visosity\ modulus\ \eta\ [Pa \cdot s] = \frac{stress}{shear\ rate}$$





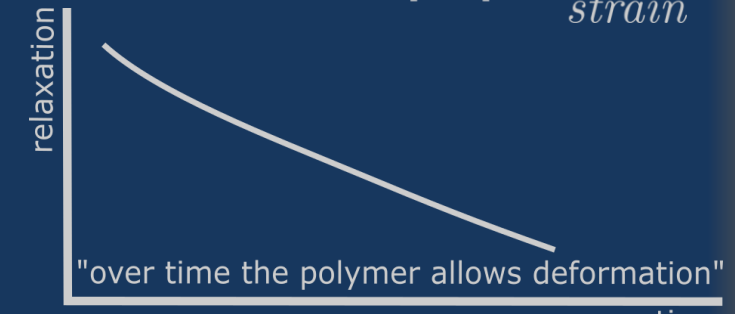
Constant stress test

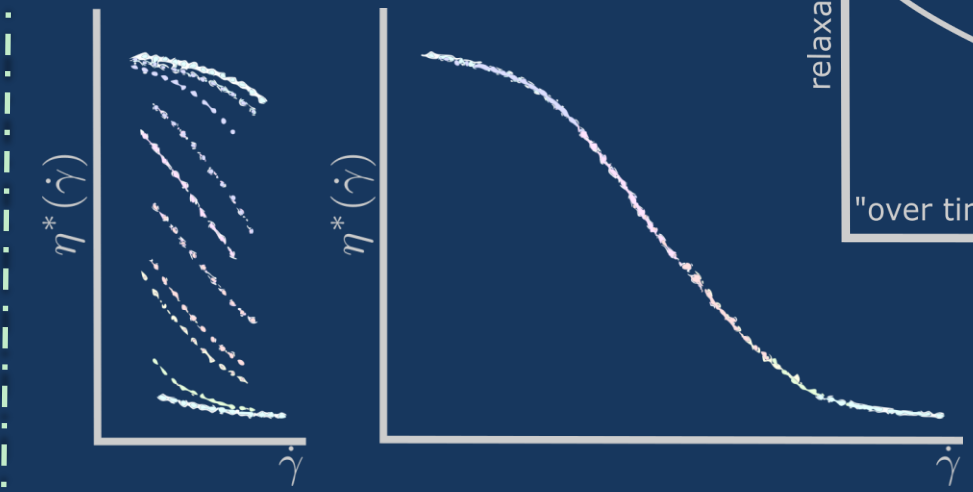
$$creep\ \&\ recovery\ compliance\ J(t)\ \left[\frac{1}{Pa}\right] = \frac{strain}{stress}$$



Constant strain test

$$relaxation\ modulus\ G\ [Pa] = \frac{stress}{strain}$$

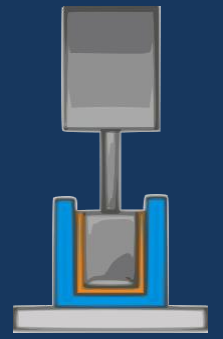




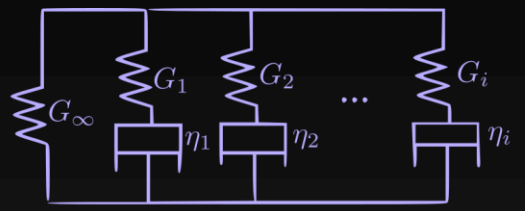
Oscillation test

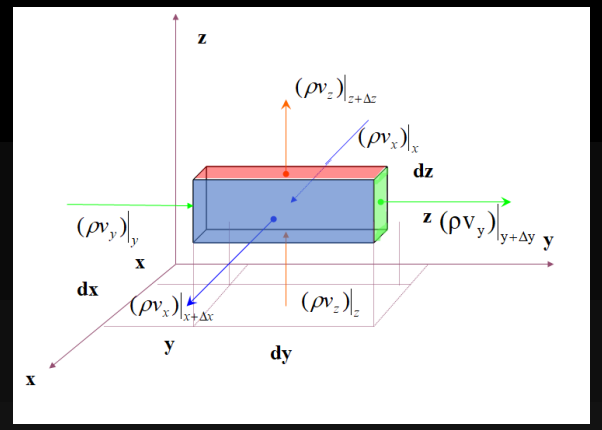
Complex modulus G* and viscosity η*

Time-Temperature Superposition



Viscoelastic models





Generalized Maxwell model

$$G(t) = G_\infty + \sum_{i=1}^{n} G_i e^{-\frac{G_i}{\eta_i} t}$$

G_∞ is the relaxation modulus at $t = \infty$
G_i is the relaxation modulus of the ith spring
η_i is the viscosity of the dashpot for the ith series
n is the number of spring–dashpot series
τ_i is the relaxation time for a single spring–dashpot series

Linear Infinitesimal Viscoelasticity (LIVE)
"non-zero normal stress with increasing shear rate"

Kinematic tensors

Cauchy & Finger Strain Tensors
Non-Linear behavior
(Stress is a function of shear rate)

Memory function

Damping function

Constitutive Models

PTT model
(PanThienTanner)

$H(\lambda)\ in\ Pa$
Discrete relaxation spectra
a distribution moduli for
the Generalized Maxwell model

$G_g = \int H(\lambda) dln\lambda$
instantaneous modulus

$\eta_0 = \int H(\lambda)\lambda \cdot dln\lambda$
zero shear viscosity

$J_e{}^0 = \frac{\int H(\lambda)\lambda^2 dln\lambda}{\left(\int H(\lambda)\lambda \cdot dln\lambda\right)^2}$
steady state recoverable compliance

Wagner model

$$\eta(t=\infty, \dot{\gamma}_o) = f_1 \sum_{1=1}^{n} \frac{a_i}{{\alpha_i}^2} + f_2 \sum_{1=1}^{n} \frac{a_i}{{\beta_i}^2}$$

$\alpha_i = \frac{1 + n_1 \lambda_i \dot{\gamma}_o}{\lambda_i}$

$\beta_i = \frac{1 + n_2 \lambda_i \dot{\gamma}_o}{\lambda_i}$

$f_2 = 1 - f_1$

with the fitted parameters, estimate:

Recovery compliance

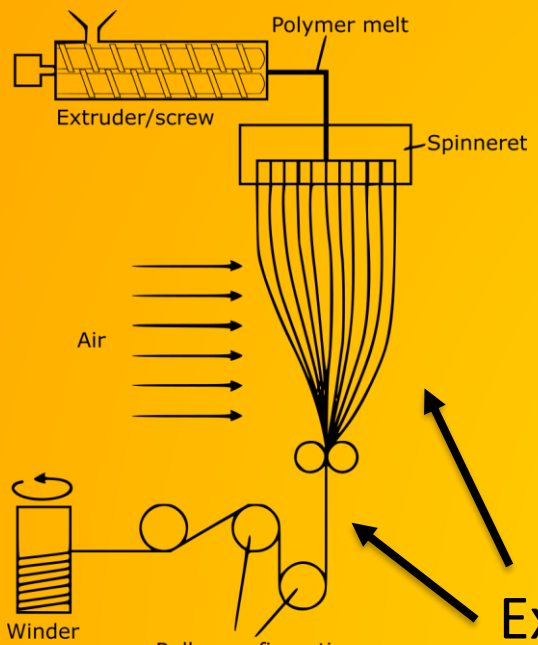
Stress growth

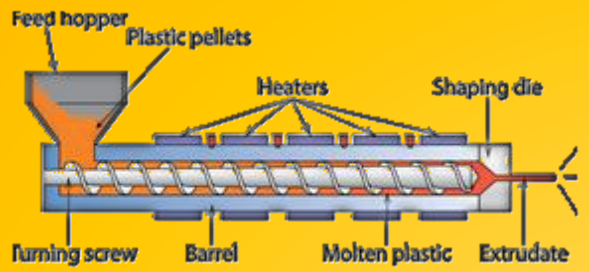
Creep compliance

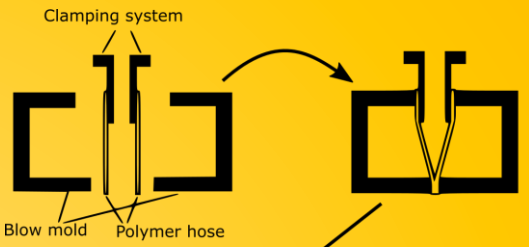
First normal stress difference

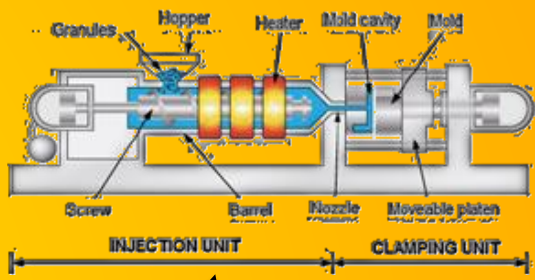
Elongational viscosity

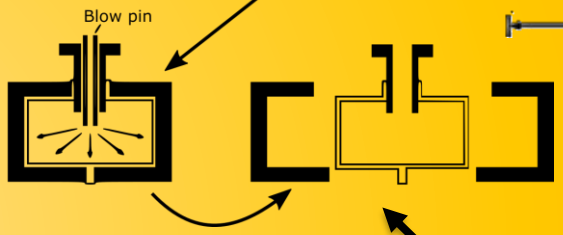
Polymer Processing

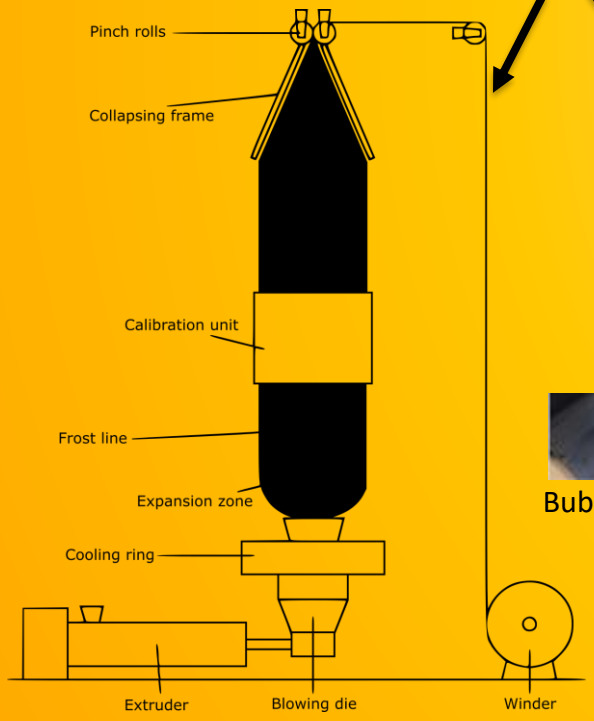












Extrusion

Important parameters

- die dimensions
- Polymer rheology
- Cooling conditions
- Screw design
- Barrel temperature
- Shot size

Defects

- Bubbles
- Shrinkage
- Pimples
- Surging
- Orange peel

Injection Molding

Important parameters

- Lumpy surface
- Mold design
- Clamping force
- Injection pressure

Defects

- Sink marks
- Flash
- Jetting
- Weld lines
- Burn marks
- Warpage

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