

ORTHOPAEDIC CENTER



THE UNIVERSITY OF
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1872

Biomechanics Review

Part 2

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Viscosity

- Viscosity is a property of gases and liquids. Specifically, it is a measure of a material's resistance to gradual deformations by shear or tensile stress.
 - Simply: “How slow does a fluid flow?”
 - Example: Honey vs. Water
- Viscosity is measured where the larger the viscosity the “thicker” fluid

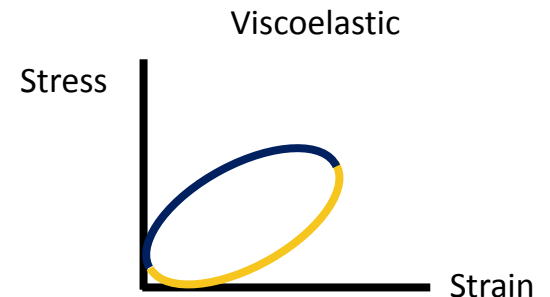
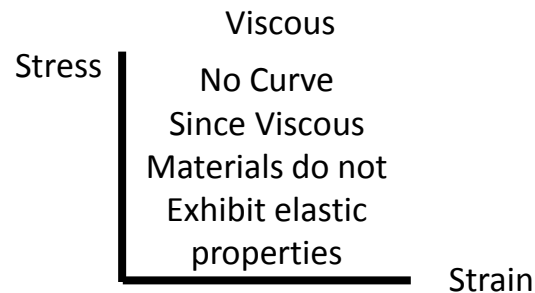
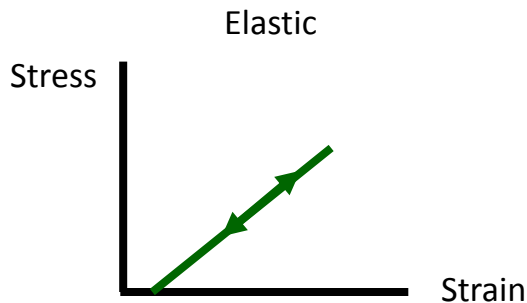
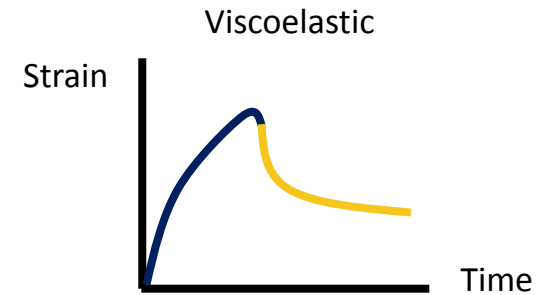
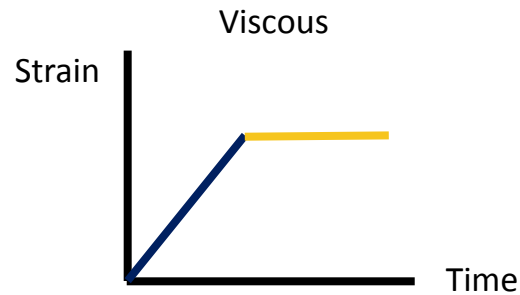
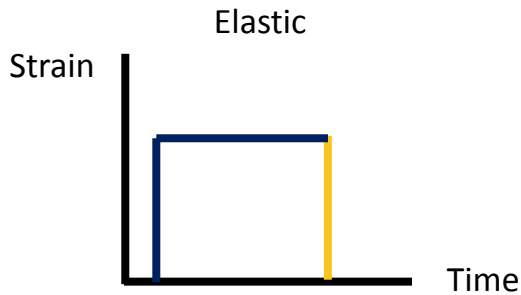


Viscoelasticity

- Viscoelastic materials are materials that have both viscous and elastic qualities to them.
- Ultimately, viscoelastic materials show gradual deformation as stress is applied to the object. Therefore, viscoelastic materials are time dependent
- Properties: Hysteresis, Creep, Relaxation
- **Geometry: unlike purely elastic materials, viscoelastic materials will have differing properties depending on its shape**
- Video: https://www.youtube.com/watch?v=u_jFzoYadJ8



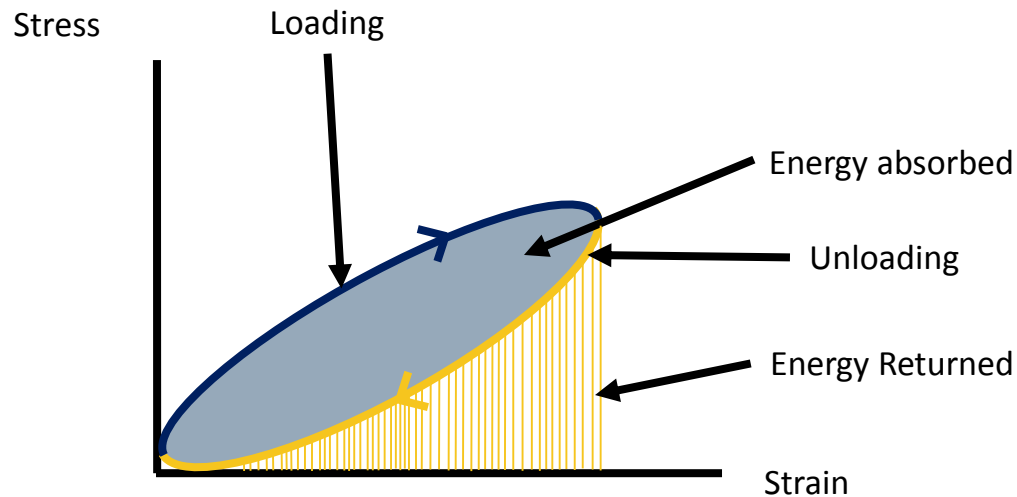
Elasticity vs. Viscosity vs. Viscoelasticity



Blue lines are under loading
Yellow lines are free from loading
Green line is unloading or loading

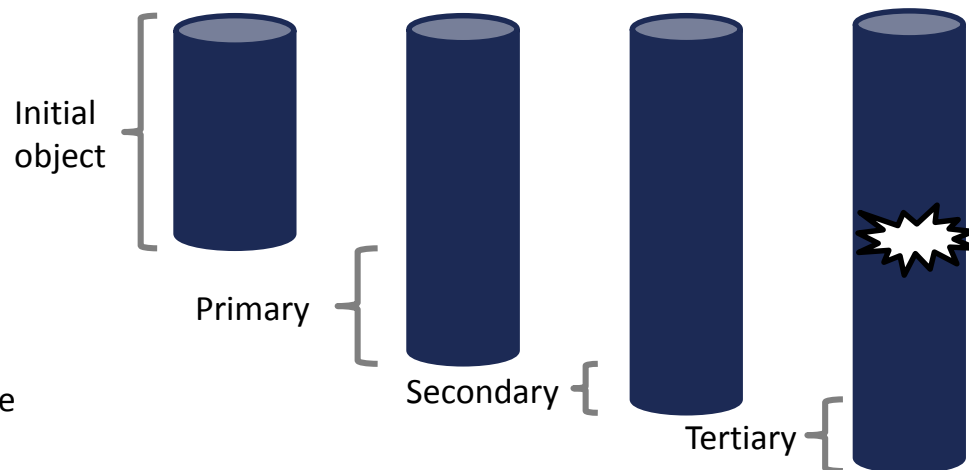
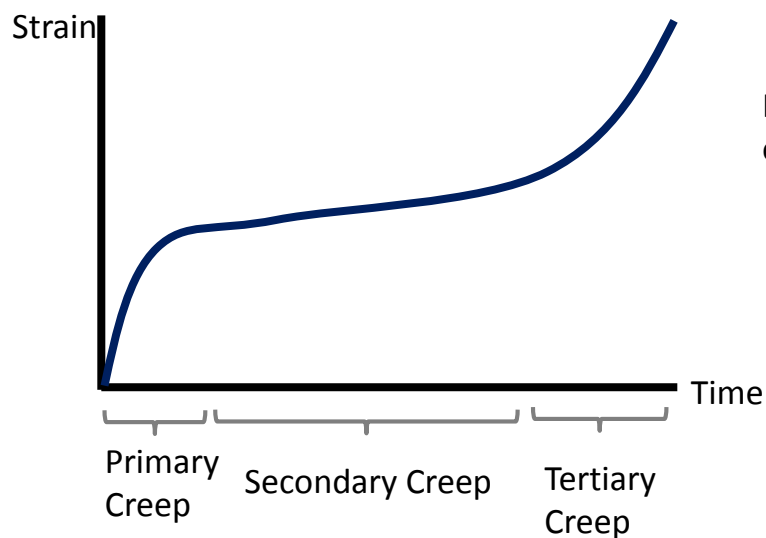
Hysteresis

- The energy lost from the deformation since viscoelastic materials are not perfect elastic materials.



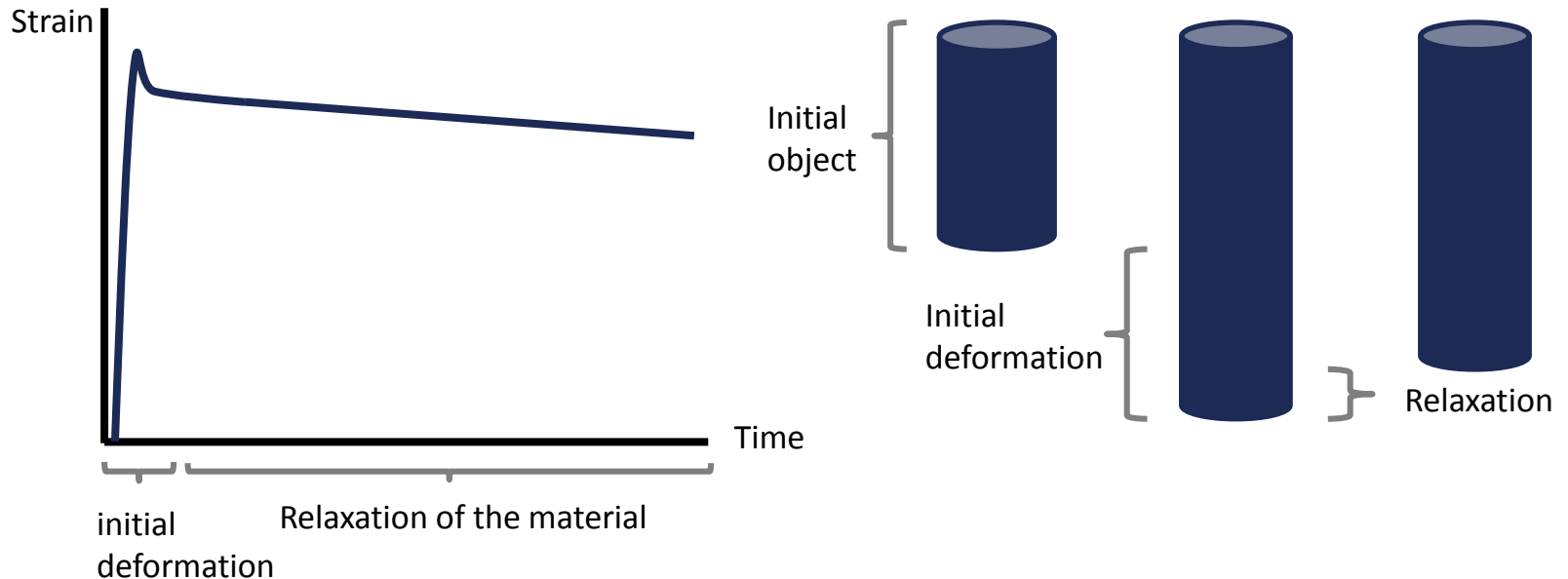
Creep

- The later deformation that occurs after the initial deformation that continues to deform the object but at a much slower rate



Stress Relaxation (Force Relaxation)

- When the material is stretched rapidly then the material slowly reforms to its initial shape



Significance?

- Since all biologic tissues are composites of many materials many tissues express viscoelastic properties.
 - All soft tissues observe viscoelastic properties of stress relaxation, creep, and hysteresis
- Collagen, Elastin, and other matrix polymers exhibit viscoelastic properties so any tissue containing them will exhibit some level of viscoelastic properties.



Source

- Özkaya, Nihat, et al. *Fundamentals of biomechanics: equilibrium, motion, and deformation*. Springer, 2016.

