IME 601 - FUNDAMENTALS OF MFG. ENG.

POLYMER PROCESSES — BASIC CLASS NOTES

Reading Review and Class Preparation
This should be filled out prior to class.

Key Concepts to Be Discussed in Class:

Questions About Subject Matter for Class Session:

So What? Why? Who Cares?

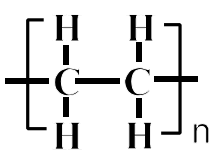
- Polymers are Being Considered as Alternatives to Metals
- More Polymers than Metals
  - Wider Variety of Properties
- Have Enabled
  - Medical Advances
  - Economic and Environmental Advances
  - Clothing and Apparel
- Most Composites are Based on Polymers
  - Fiber Glass Reinforced Plastic

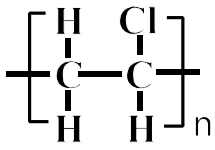
Outline

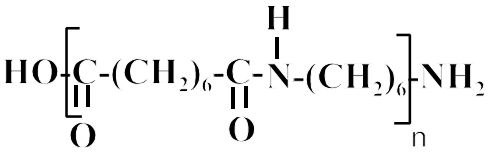
- Polymers
  - As a Material
  - Properties (Mechanical, Physical)
  - Types of Polymers
- Processing Polymers
  - Casting
  - Extrusion
  - Injection Molding
  - Blow Molding
  - Thermoforming
  - Joining

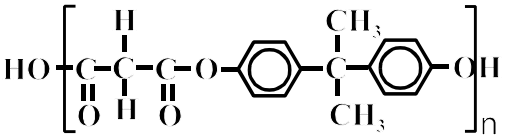
Polymers

- Long-Chain Molecules Based on Carbon
  - Molecular Weight ≥ 10^4 or 10^5 g/mol
  - Formed by Perpetuating Reaction



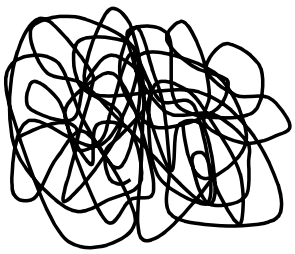


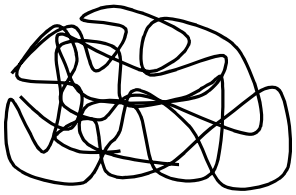


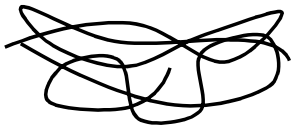


Strength of Polymers

- Behavior Under Applied Load
- Chains Disentangle







Types of Polymers

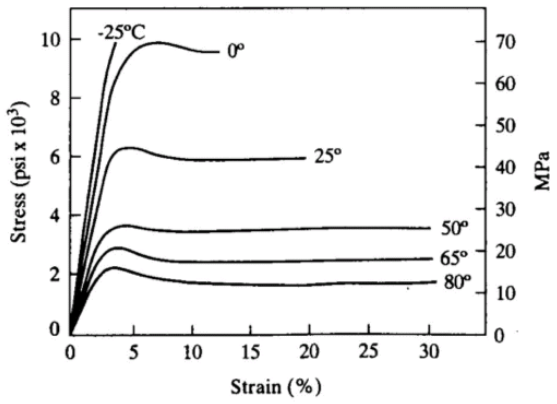
- Thermoplastic – polymers that will melt and flow (can be re-shaped)
  - Low Density Polyethylene (LDPE)
  - High Density Polyethylene (HDPE)
  - Polystyrene (glassy at room temperature)
  - Poly(vinyl chloride)
  - Acrylonitrile-Butadiene-Styrene (ABS)
- Thermoset – polymers that cannot melt or flow due to crosslinking.
  - Epoxies
  - Polyesters
  - Vulcanized Rubber

Materials Facts

- Two Types of Solids Exist
  - Crystalline
  - Amorphous or Glasses
- Amorphous Materials
  - Are Not Supercooled Liquids
  - Solidify at Glass Transition Temperature Not Melting Temperature
- Polymers Are Either
  - Completely Amorphous
  - Partially Amorphous

Stress - Strain of Thermoplastic

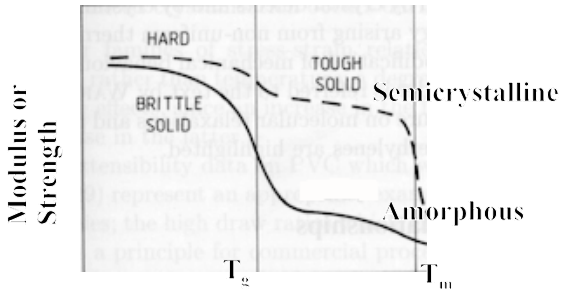
- Major Temperature Dependence
- Glass Transition Temperature
  - Ductile / Brittle Transition



Ref. W. Riffe - Class Notes

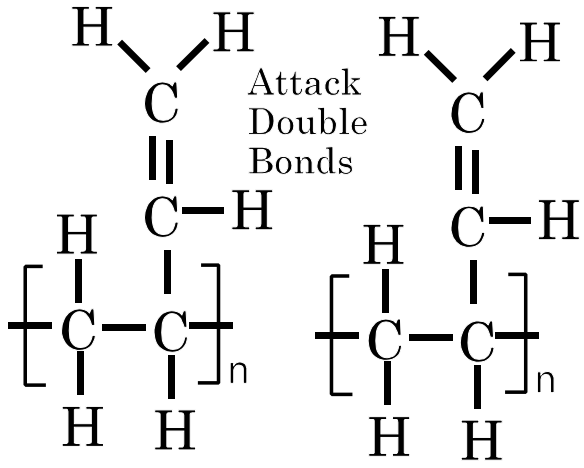
Temperature Dependent Mec. Prop

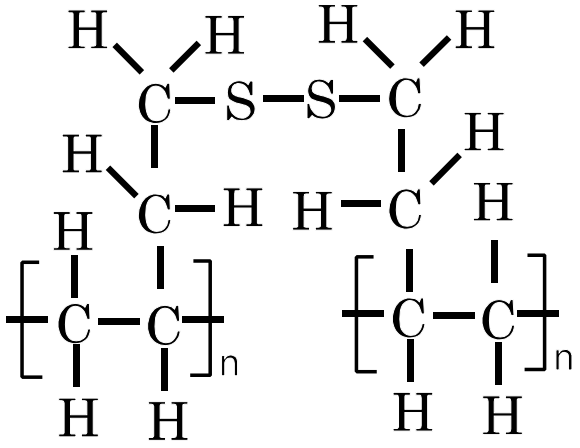
- SC and Amorphous Strong and Brittle Below T_g
- Big Difference Above T_g



Thermosets

- Crosslinking of Polybutadiene Polymer





Team Problem

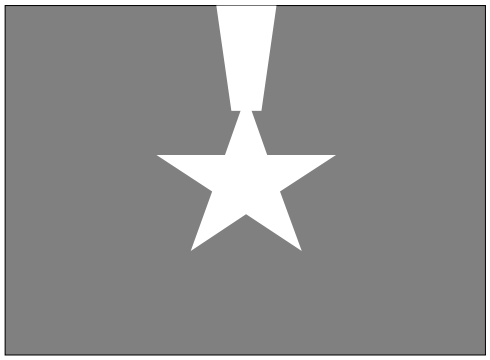
- How do the Properties of Polymers effect Manufacturing?
  - Consider Manufacturing Processes and Polymers

- How Could One Cast a Polymer?

- What About the Mechanical Forming Processes?
  - Extrusion
  - "Forging"
  - Rolling
  - Injection Molding

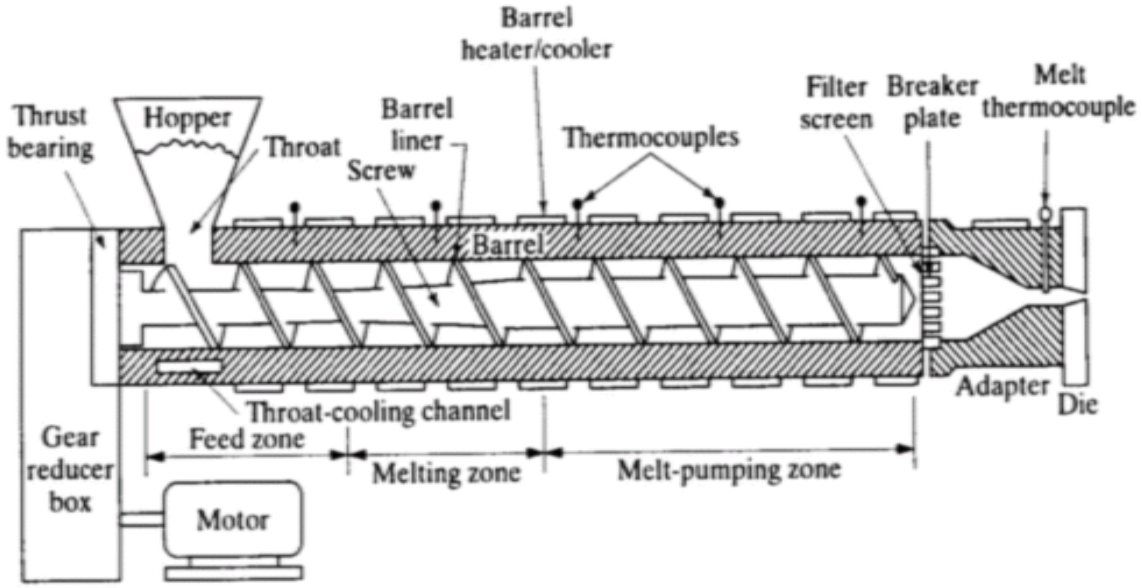
Casting

- Definition
  - Pour Liquid Material (Metal) Into a Cavity of Prescribed Geometry and Let it Solidify
- Thermoplastic
  - PrePolymer
  - Reactant
- Thermoset
  - 2 Part Epoxy



Extrusion

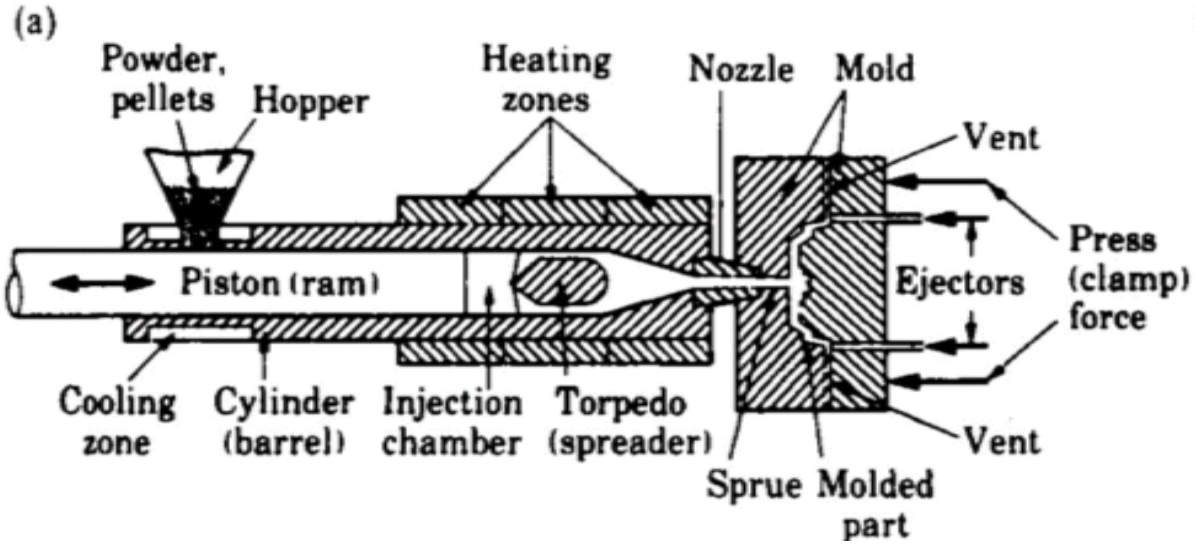
- Definition
  - Push a Material Through a Die
  - Polymers -Usually Liquid
- Can Make
  - Simple Shapes
  - Polymer Blends



Ref. W. Riffe - Class Notes

Injection Molding

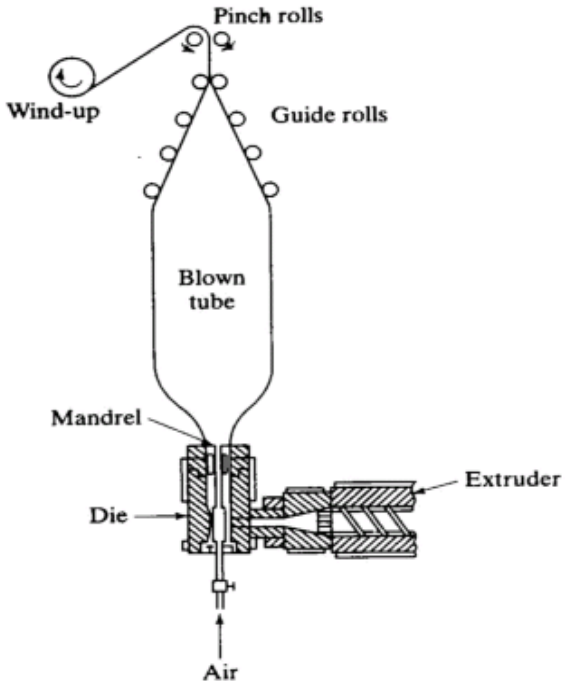
- Week 10 Practica
- Similar to Die Casting
  - Molten Material Pushed Into Die
- Can Be Combined With Extrusion



Ref. W. Riffe - Class Notes

Blow Molding

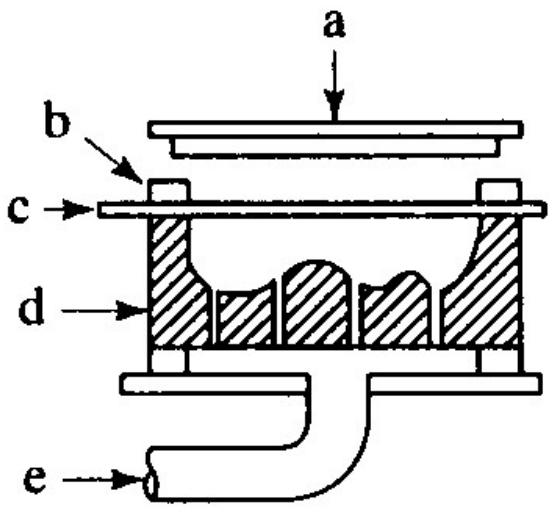
- Based on Glass Blowing
  - Liquid Material
  - Expand With Air
  - Cool to Shape
- Can Make
  - Bottles
  - Jars



Ref. W. Riffe - Class Notes

Thermoforming

- Similar to "Forging"
  - Apply a Compressive Force
  - Shape Material
- Use Vacuum
  - Apply Large Force over Area



Ref. W. Riffe - Class Notes

Summary

- Polymer Processing
  - Polymers as Materials
  - Take Advantage of Temperature Dependent Mechanical Properties
  - Processes Analagous to Metals
  - Specific Processes Discussed

After Class Review
Summarize Key Concepts and List Further Questions
Review Notes and Make Links to HW Problems

Key Concepts	Questions