Polymers Continued....

Plastic Man #17 (May 1949)
Cover art by Jack Cole.

Polymers Continued

From Monday:

- Polymer- Long chain molecule made from repeating units
- Monomer examples
- Boiling points of hydrocarbons
- M_n- Number average molecular weight
- Linear, branched, cross linked

Polymers

Today:

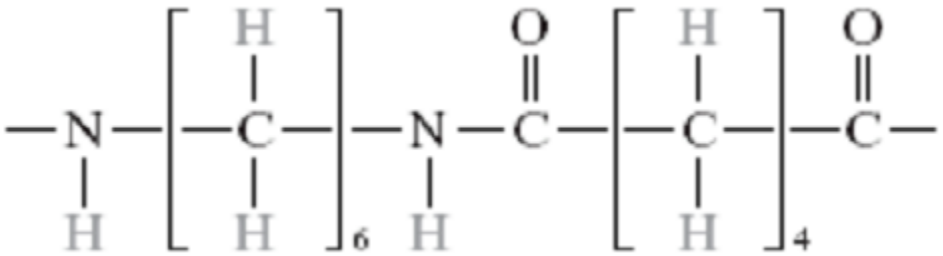
- Nylon Demonstration
- Resin Codes of Common Polymers
- Special conducting polymers
- Mechanical Behavior of Polymers
- Glass transition temperature (Tg)

Nylon 6,6 Demonstration

Two Solutions

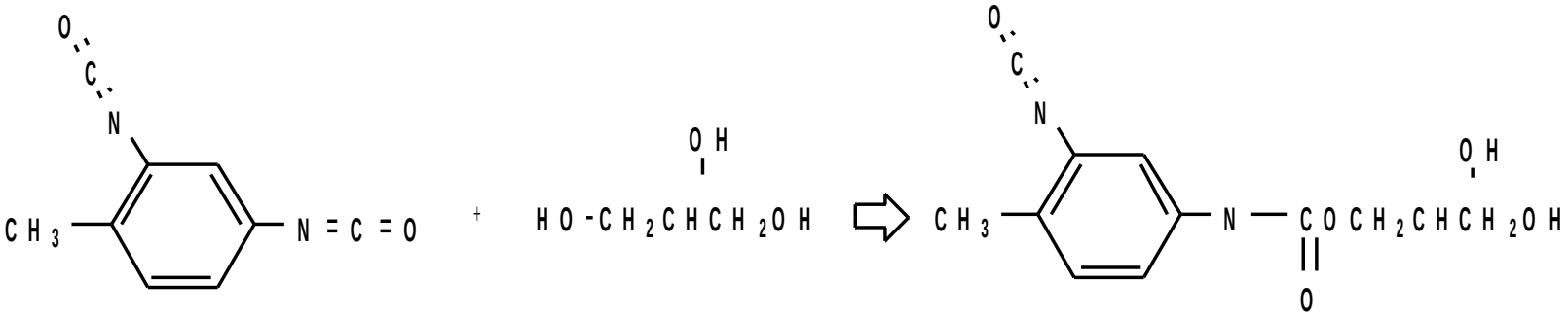
- $NH_2(CH_2)_6NH_2$
- $ClOC(CH_2)_4COCl$

Produces Nylon 6,6



Poly (urethane)

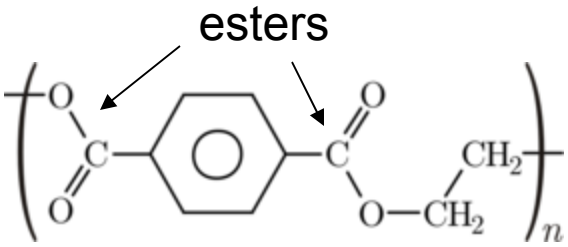
Poly (urethane) – A thermoset cross linked polymer



Note: Can be reused, but not recycled

Common Polymers- Resin Codes

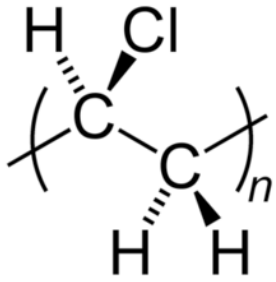
Poly (ethylene terephthalate)



Drink Bottles
Plastic Parts
Clothing Fibers

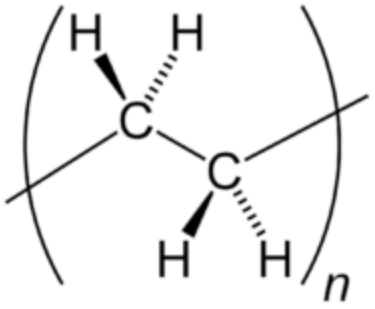
poly (ester)

Poly (vinyl chloride)



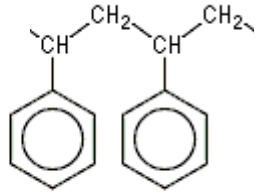
Pipe

High density poly (ethylene)



Food Containers
Grocery Bags
Injection Molded Parts

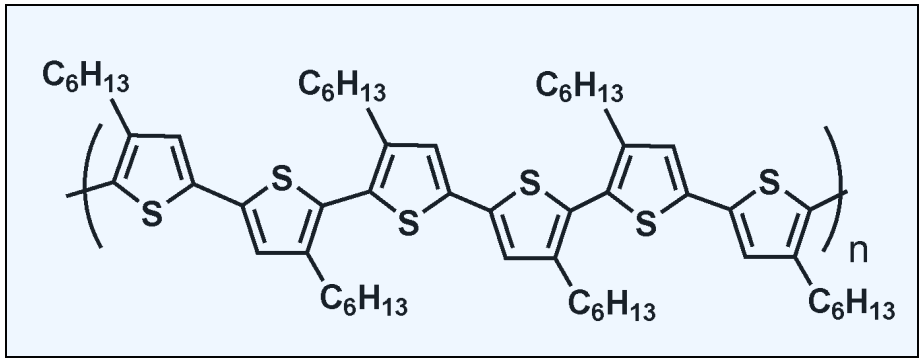
Poly (styrene)



Styrofoam
CD cases

Uncommon Polymers- Conducting Polymers

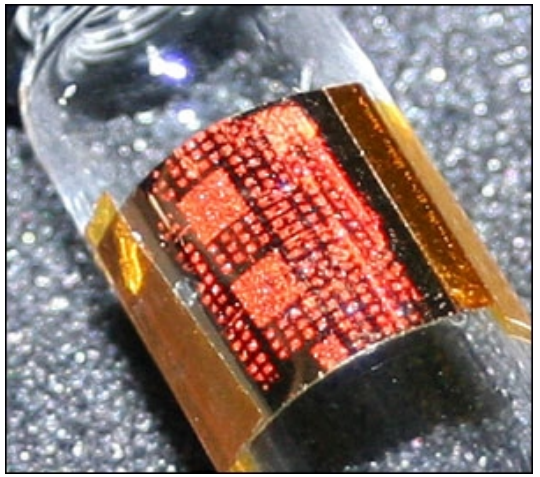
poly (3-hexyl thiophene)



Polymer Solar Cell

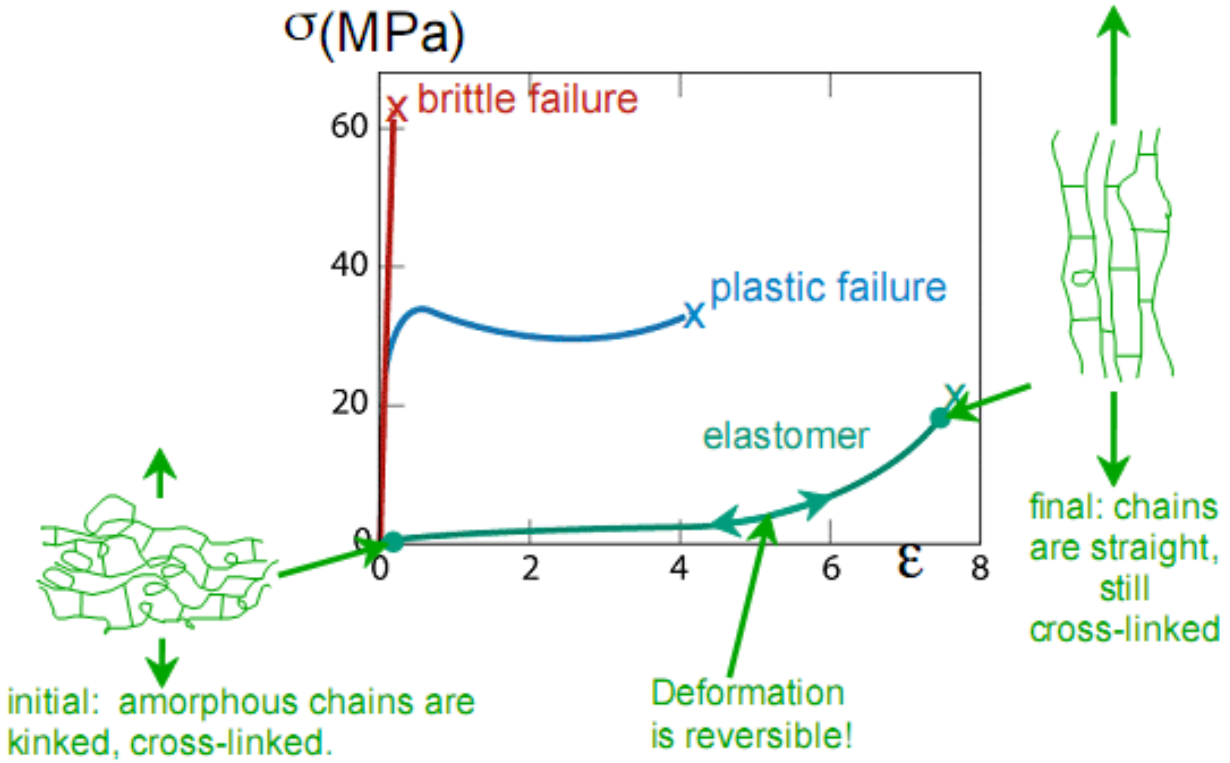
(Photo: UCSB)

Polymer Transistor



(Photo: Alejandro Briseno)

Tensile response: elastomers



Stress-strain curves adapted from Fig. 15.1, *Callister 7e.* Inset figures along elastomer curve (green) adapted from Fig. 15.15, *Callister 7e.* (Fig. 15.15 is from Z.D. Jastrzebski, *The Nature and Properties of Engineering Materials*, 3rd ed., John Wiley and Sons, 1987.)

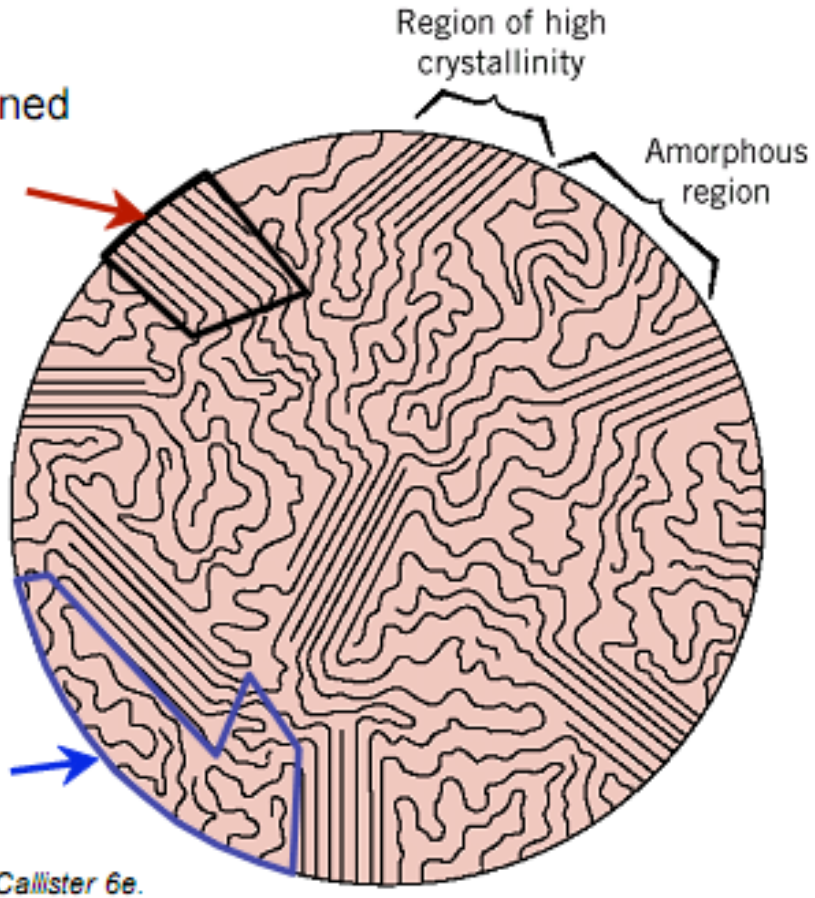
- Compare to responses of other polymers:
  - -- brittle response (aligned, crosslinked & networked polymer)
  - -- plastic response (semi-crystalline polymers)

Polymer crystalline structure

Polymers rarely 100% crystalline

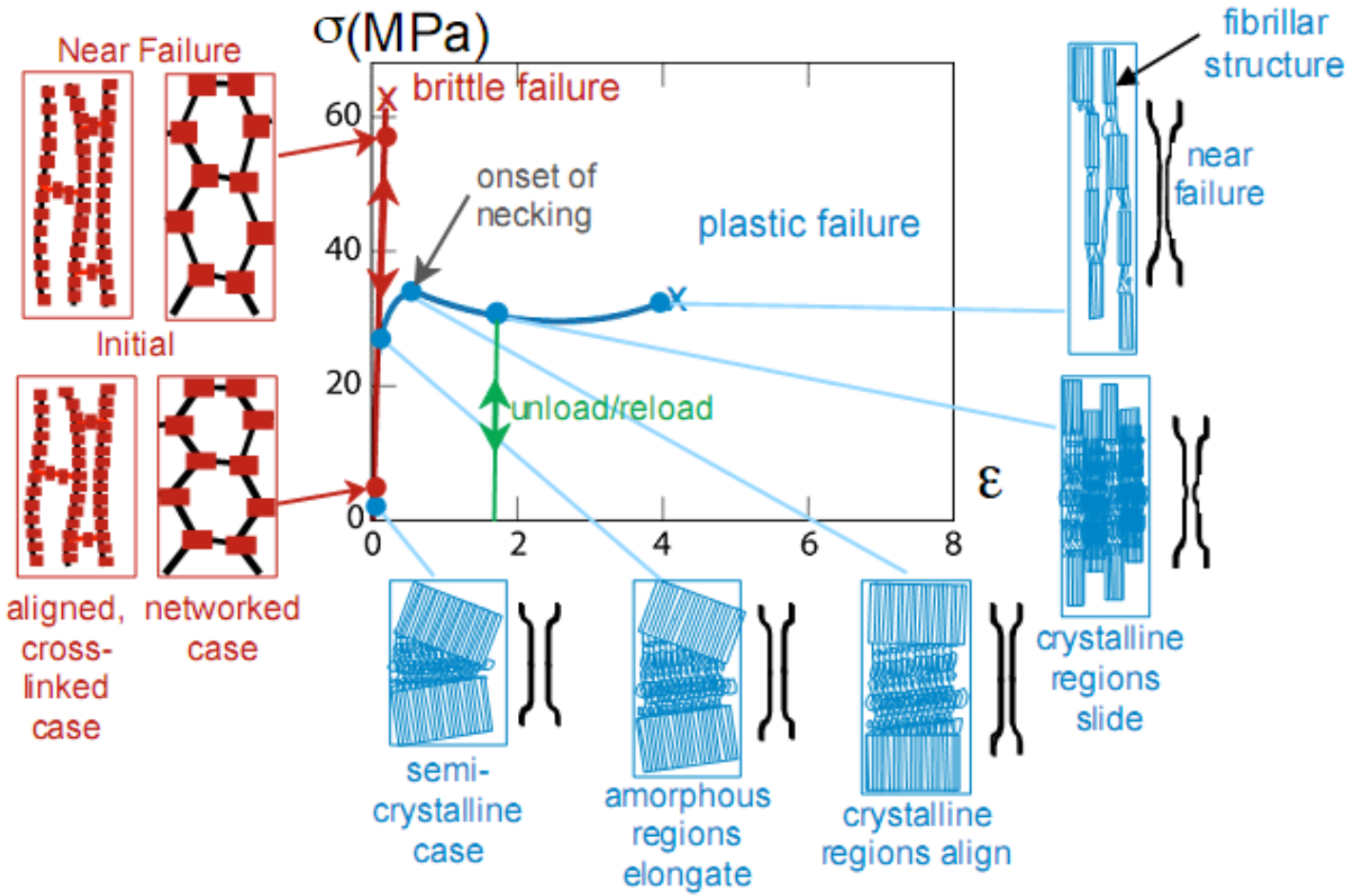
Too difficult to get all those chains aligned

- % Crystallinity: % of material that is crystalline.
  - -- *TS* and *E* often increase with % crystallinity.
  - -- Annealing causes crystalline regions to grow. % crystallinity increases.



Adapted from Fig. 14.11, *Callister 6e.* (Fig. 14.11 is from H.W. Hayden, W.G. Moffatt, and J. Wulff, *The Structure and Properties of Materials*, Vol. III, *Mechanical Behavior*, John Wiley and Sons, Inc., 1965.)

Brittle and plastic behavior



Stress-strain curves adapted from Fig. 15.1, *Callister 7e.* Inset figures along plastic response curve adapted from Figs. 15.12 & 15.13, *Callister 7e.* (Figs. 15.12 & 15.13 are from J.M. Schultz, *Polymer Materials Science*, Prenti-- Hall, Inc., 1974, pp. 500-501.)

T_g Glass Transiton Temperature

Tg – temperature at which a material transitions from a glassy, crystalline state to an amorphous state

HDPE Tg ~ -100°C

Will HDPE be mostly amorphous or crystalline at room temperature?

PS Tg ~ 95°C

Will PS be mostly amorphous or crystalline at room temperature?

Can use density (ρ) to calculate % crystallinity