



Introduction

A polymer is a large molecule composed of many smaller repeating units.
First synthetic polymers:

Polyvinyl chloride (PVC) in 1838
Polystyrene in 1839

Now, >250 billion pounds produced annually, worldwide.









Addition Polymers

- · Three kinds of processes (intermediates):
 - ⇒ Free radicals

 - ⇒ Carbanions
- · Examples of addition polymers:
 - ⇒ polypropylene plastics
 - ⇒ polystyrene foam insulation
 - ⇒ poly(acrylonitrile) Orlon[®] fiber
 - ⇒ poly(methyl α-methacrylate) Plexiglas ®

Monomer	Repeating unit	Polymer name	Uses
CH2=CH2	$-CH_2-CH_2-$	polyethylene	film, toys, bottles, plastic bags
CH ₂ =CH	-CH ₂ -CH-	poly(vinyl chloride)	"squeeze" bottles, pipe, siding, flooring
СН2=СН-СН3	$\stackrel{-\mathrm{CH}_2-\mathrm{CH}}{\underset{\mathrm{CH}_3}{\vdash}}$	polypropylene	molded caps, margarine tubs, indoor/outdoor carpeting, upholstery
CH2=CH	-CH2-CH-	polystyrene	packaging, toys, clear cups, egg cartons, hot drink cups
CF ₂ =CF ₂	$-CF_2-CF_2-$	poly(tetrafluoroethylene) Teflon®	nonsticking surfaces, liners, cable insulation
CH ₂ =CH C=N	$-CH_2-CH-$	poly(acrylonitrile) Orlon [®] , Acrilan [®]	rugs, blankets, yarn, apparel, simulated fur
CH ₂ =C-CH ₃ COCH ₃	-CH ₂ -CH ₃ -CH ₂ -C- COCH ₃	poly(methyl methacrylate) Plexiglas [®] , Lucite [®]	lighting fixtures, signs, solar panels, skylights
CH ₂ =CH OCCH ₃	-CH2-CH- OCCH3	poly(vinyl acetate)	latex paints, adhesives



















- Isotactic and syndiotactic polymers are stronger and stiffer due to their regular packing arrangement.
- Anionic intermediate usually gives isotactic or syndiotactic polymers.
- Free radical polymerization is nearly random, giving branched atactic polymers.







Vulcanization

- Process was discovered accidentally by Goodyear when he dropped rubber and sulfur on a hot stove.
- Sulfur produces cross-linking that strengthens the rubber.
- Hardness can be controlled by varying the amount of sulfur.



Other Types of Copolymers



- Two or more different monomers.
- Saran[®]: alternating molecules of vinyl choride and 1,1-dichloroethylene.
- ABS plastic: acrylonitrile, butadiene, and styrene.





Copolymers are polymers made from more than one monomer.

The presence of more than one monomer allows for some control of properties.

Copolymers are classified according to the distribution of monomers in the polymer.

- Random
- Block
- Graft









- Classify the copolymer below.
 -A-A-B-A-B-B-A-A-B-B-A-B-A-
- A) random
- B) block
- C) graft
- D) branched





























Thermal Properties

- Glasses at low temperature, fracture on impact.
- At the glass transition temperature, *T*_g, crystalline polymers become flexible.
- At the crystalline melting temperature, $T_{\rm m}$, crystalline polymers become a viscous liquid, can be extruded to form fibers.







