

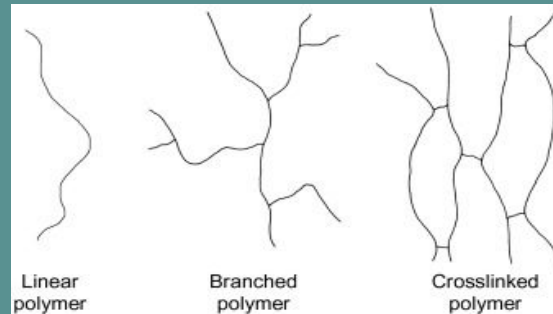
# Unit 3- Lesson 11

Chemistry 0

May 2022, L. Tracey Gao

# Polymer Properties

- The **physical properties** of a polymer (its hardness, stretchiness, melting temperature, etc.) are largely determined by the **structure** of the polymer and the way in which the polymer chains pack with each other in a solid.





# Polymer Properties

- **Thermoplastics** soften when heated, they can be easily molded into a variety of shapes and structures.  
*Examples:* polyethylene and polystyrene
- **Synthetic fibers** can be drawn out into long, thin fibers that can be used to make thread which can then be woven into cloth.  
*Examples:* nylon
- **Elastomers** are polymers that have the ability stretch and spring back to their original shape.  
*Examples:* natural rubber

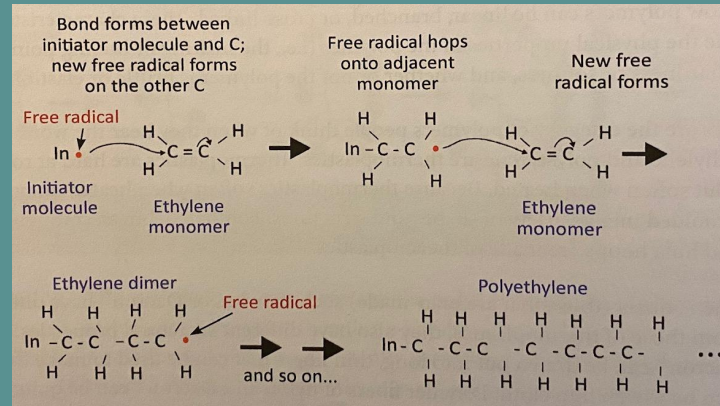


## How do you make synthetic polymers?

- Polymers are built by hooking monomers together in chemical reaction.
- This can be done using many different reactions, we will focus on two:
  - Addition Reactions
  - Condensation Reactions

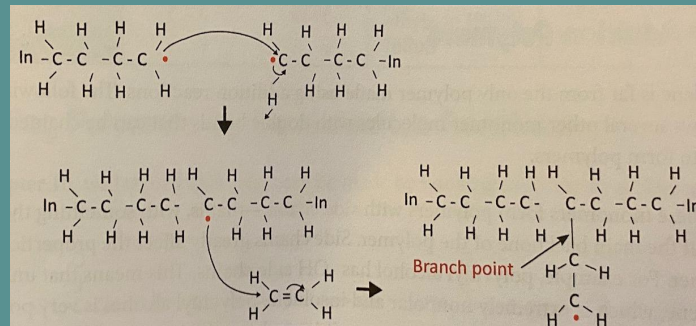
# Polymer Addition Reactions

- Addition reactions link together molecules using double bonds as the functional group.
- It starts with the formation of a free radical. A free radical is just a “dangling bond”- an unbonded electron that is very reactive.



# Polymer Addition Reactions

- In real life, no chemical reaction happens perfectly. Side reactions may destroy the active free radical and thus stop the polymer chain from growing. This is called **chain termination**.
- Also, in the reaction vessel, many polymer chains can get started and grow at the same time. If the free radical on one growing chain hits the middle of a second chain, the polymers can become **branched** or **cross-linked**.

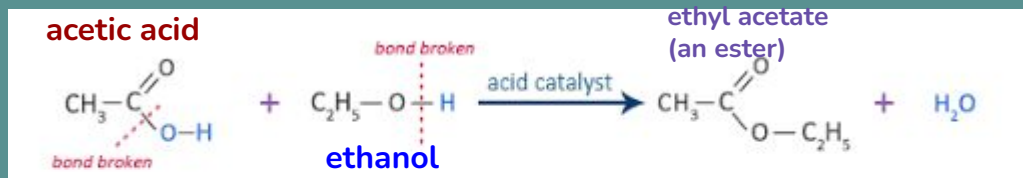


# Addition Polymers

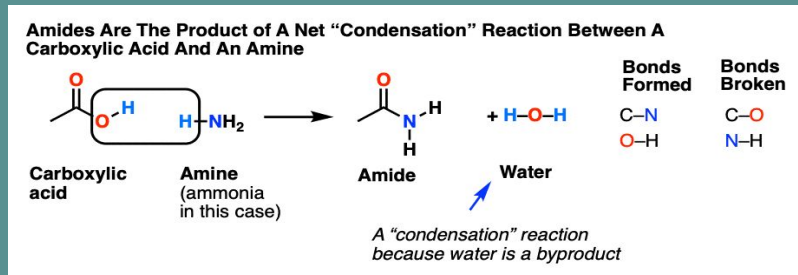
Monomer Name	Structure	Polymer Name	Uses
ethylene	$\begin{array}{ccccccc} & \text{H} & \text{H} & \text{H} & \text{H} & & \\ &   &   &   &   & & \\ - & \text{C} & - & \text{C} & - & \text{C} & - & \text{C} & - \\ &   &   &   &   & & \\ & \text{H} & \text{H} & \text{H} & \text{H} & & \end{array}$	polyethylene	Bags, films, toys, computer keyboards
vinyl chloride	$\begin{array}{ccccccc} & \text{H} & \text{H} & \text{H} & \text{H} & & \\ &   &   &   &   & & \\ - & \text{C} & - & \text{C} & - & \text{C} & - & \text{C} & - \\ &   &   &   &   & & \\ & \text{H} & \text{Cl} & \text{H} & \text{Cl} & & \end{array}$	polyvinyl chloride	PVC pipes, raincoats
vinyl alcohol	$\begin{array}{ccccccc} & \text{H} & \text{H} & \text{H} & \text{H} & & \\ &   &   &   &   & & \\ - & \text{C} & - & \text{C} & - & \text{C} & - & \text{C} & - \\ &   &   &   &   & & \\ & \text{OH} & \text{H} & \text{OH} & \text{H} & & \end{array}$	polyvinyl alcohol	Coatings, thickener in glues, "slime"
styrene	$\begin{array}{ccccccc} & \text{H} & \text{H} & \text{H} & \text{H} & & \\ &   &   &   &   & & \\ - & \text{C} & - & \text{C} & - & \text{C} & - & \text{C} & - \\ &   &   &   &   & & \\ & \text{C}_6\text{H}_5 & \text{C}_6\text{H}_5 & \text{C}_6\text{H}_5 & \text{C}_6\text{H}_5 & & \end{array}$	polystyrene	Foam insulation, drinking cups
tetrafluoroethylene	$\begin{array}{ccccccc} & \text{F} & \text{F} & \text{F} & \text{F} & & \\ &   &   &   &   & & \\ - & \text{C} & - & \text{C} & - & \text{C} & - & \text{C} & - \\ &   &   &   &   & & \\ & \text{F} & \text{F} & \text{F} & \text{F} & & \end{array}$	Polytetrafluoroethylene (PTFE)	Nonstick coatings, watertight seals

# Polymer Condensation Reactions

- Condensation reactions:
  - Esters can be made by hooking together an acid and an alcohol.



- Amides can be formed by linking an acid and an amine.





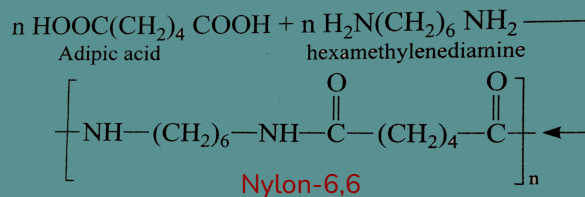


# Polymer Condensation Reactions

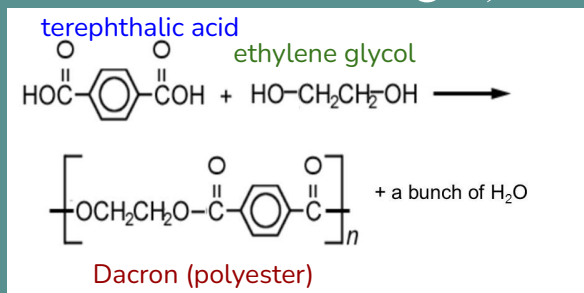
- A condensation reaction is a chemical reaction in which two monomers combine to form a new molecule, giving off a by-product water.
- This type of reaction is very useful for chaining monomer units together into long-chain polymers called condensation polymers.

# Condensation Polymers

- The formation of Nylon-6,6 (a polyamide polymer, a polymer with repeating units linked by amide bonds):



- The formation of Dacron (a polyester polymer, formed by hooking monomers together with ester linkages):



# Summary

<https://www.youtube.com/watch?v=9GMbRG9CZJw>

