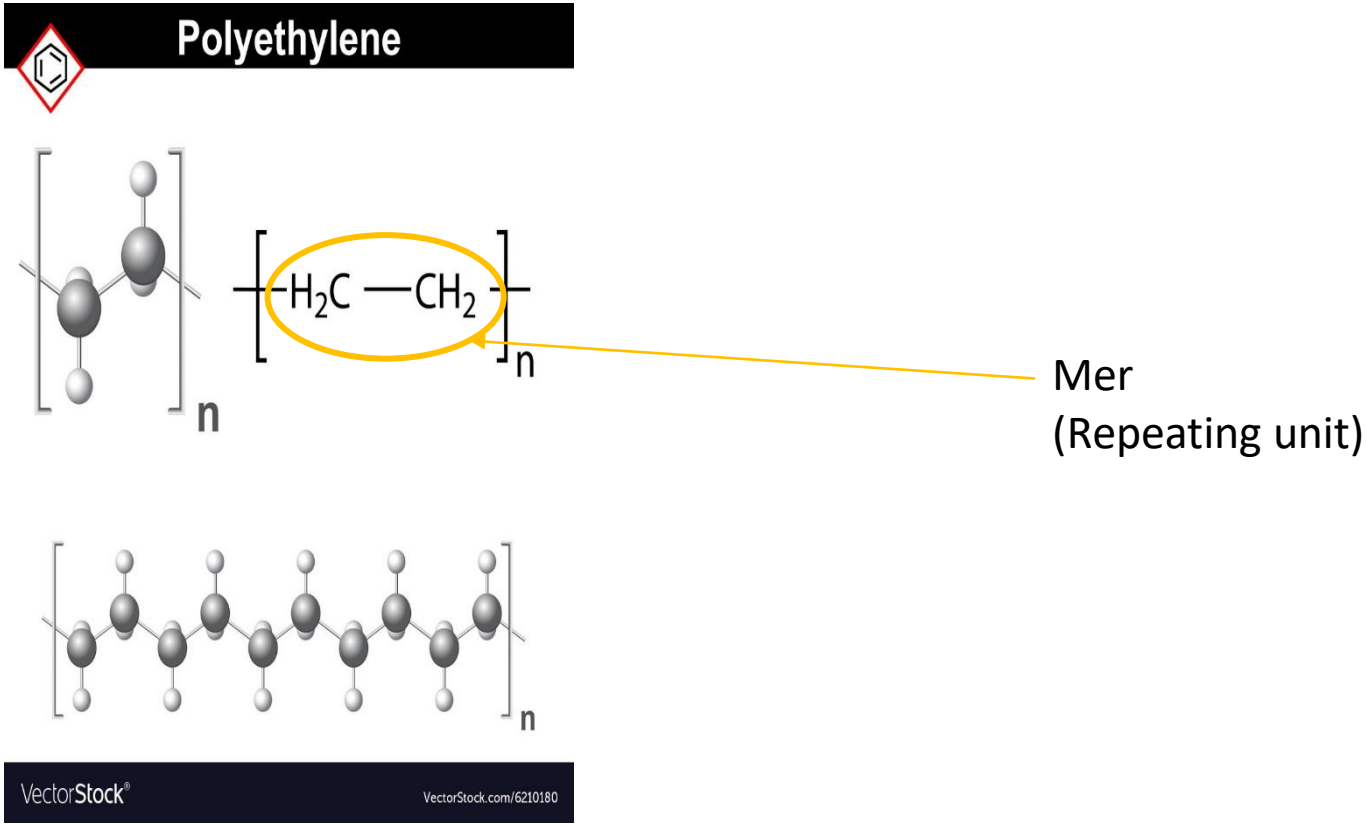
I. Introduction

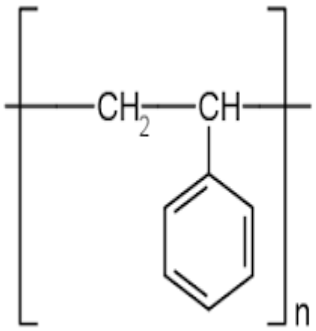
Sources:

1. Polimer kimyası, Prof. Dr. Mehmet Saçak, Gazi Kitabevi, Ankara, 2002.
2. Lif ve Elyaf Kimyası, Prof. Dr. Mehmet Saçak, Gazi Kitabevi, Ankara, 2002.
3. Lecture notes: http://web.mit.edu/5.33/www/lec/poly.pdf
4. Book chapter: https://www.sciencedirect.com/topics/engineering/linear-polymer
5. https://pslc.ws/macrog/radical.htm

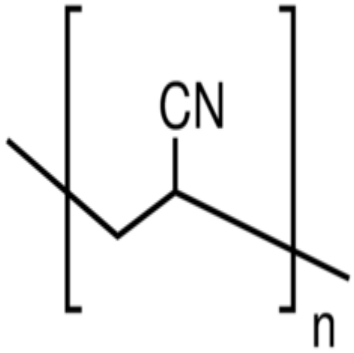
- Polymers are large molecules that are built up by the covalent bonding of small molecules (monomers). A polymer may consist of ten to thousands of monomer molecules. The monomer molecules are covalently bound to each other with polymerization reactions to give yield a polymer. For the definition of a polymer molecule, a polymer chain term is frequently used.



- Homopolymer if a polymer consists of one type of monomer, then its called homopolymer, but if it contains more than two different monomers with chemical structures, we call it as copolymer.

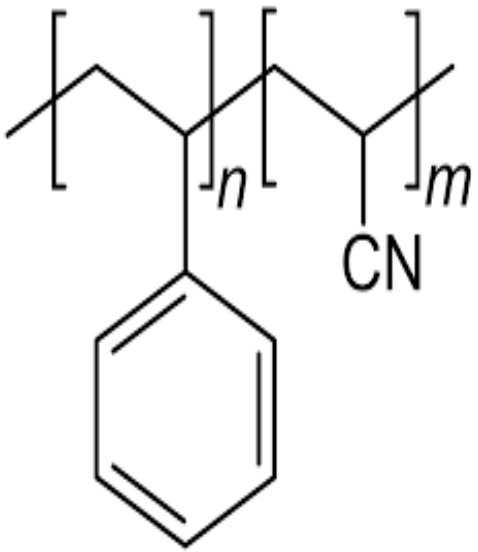


polystyrene



polyacrylonitrile

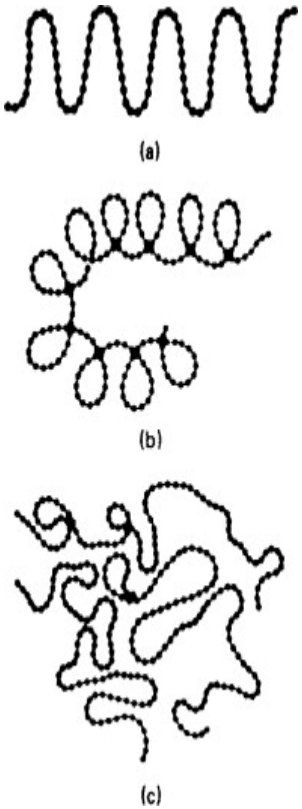
Homopolymer



copolymer

- Lineer polymers: A linear polymer is a long continuous chain of carbon–carbon bonds with the remaining two valence bonds attached primarily to hydrogen or another relatively small hydrocarbon moiety.*

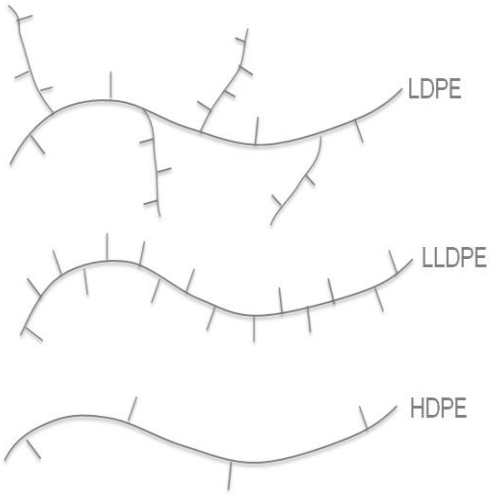
Lineer polymers can be easily dissolved in an apropriate solvent , and many times shaped after melting.



Simplified representation of various linear polymer configurations

*Hanna Dodiuk, Sidney H. Goodman, in Handbook of Thermoset Plastics (Third Edition), 2014

Branched polymers: Resemble linear polymers with the addition of shorter chains hanging from the polymer main chain. Since these shorter chains can interfere with efficient packing of the polymers, branched polymers tend to be less dense than similar linear polymers. Since the short chains do not bridge from one longer backbone to another, heat will typically break the bonds between the branched polymer chains and allow the polymer to be a thermoplastic, although there are some very complex branched polymers that resist this 'melting' and thus break up before softening, i.e., they are thermosetting.*



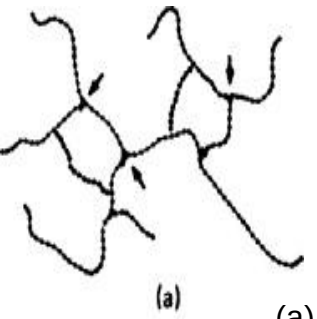
https://polymerdatabase.com/polymer%20physics/Branched%20Polymers.html

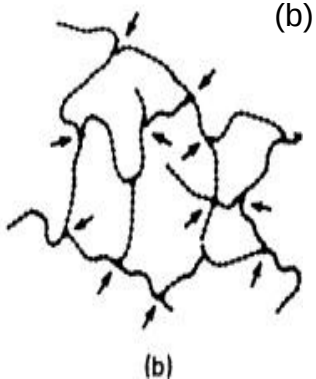
*https://www.e-education.psu.edu/matse81/node/2210

Cross-linked polymers

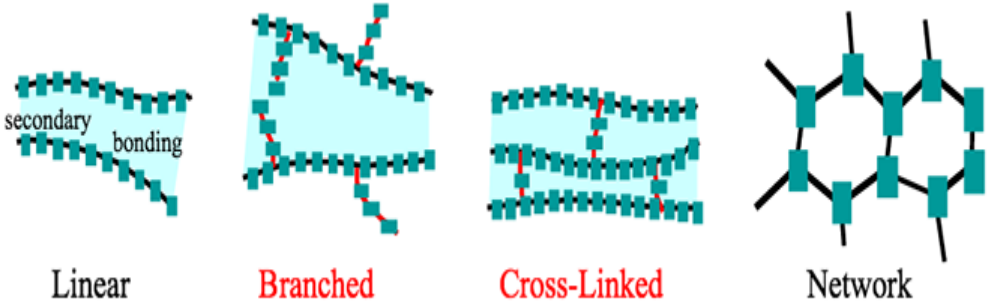
A **cross-linked polymer** is formed as a result of the chemical interaction between linear polymer chains or the build-up from monomeric resinous reactants of a 3-D fish-net configuration. The process of interaction is called ***crosslinking*** and is the main distinguishing element of a ***thermosetting polymer*.**

The "thermo" implies that the crosslinking proceeds through the influence of heat energy input, much crosslinking occurs at room temperature (25°C, 77°F) and below. The "setting" term references the fact that an irreversible reaction has occurred on a macro-scale. The network polymer formed has an "infinite" molecular weight with chemical interconnects restricting long chain macromovement.*





(a) Lightly crosslinked network polymer.
(b) Highly crosslinked network polymer.



*Hanna Dodiuk, Sidney H. Goodman, in Handbook of Thermoset Plastics (Third Edition), 2014

- *Thermoplastics* are the lineer or branched polymers that do not contain crosslinks between their chains.

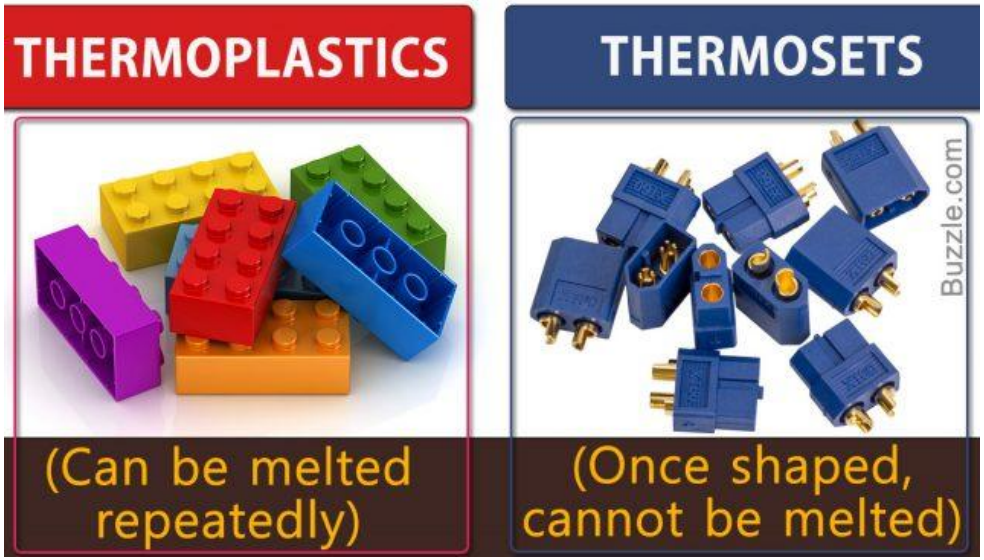
- These polymers can be dissolved in the appropriate solvents, melted when they are heated and reusable after many times processing (recylcling).

- Polyethylene (PE), polypropylene (PP), poly(vinyl chloride) (PVC), and poly(styrene) (PS) are the main thermoplastic polymers used in the industry.

? Homework: Write some usage fields of thermoplastic polymers

Trick (look at to the kitchen)

Thermosetting is a concept used for the polymers that contain dense cross links between their chains (network struture). These polymers cannot be melted, reshaped, and dissolved. They decompose with heat effects. Phenol formaldehyde, urea-formaldehyde, melamine-formaldehyde can be given as examples for thermosettings.



Elastomer is a general name for the materials that can display rubber property. The elastomer materials can be elongate at a high degree when a stress is applied, and when the stress is removed, they turn to their original length (elasticity).

https://learnmechanical.com/difference-between-thermoplastics-and-thermosetting-plastics/

The polymeric products

product	Polymeric source
socks	Cotton, polyester, polyamide, acrylic
Tooth brushes	Polyamide, polyethylene
Contact lenses	Poly(methyl methacrylate), polyacrylamides
Houseware goods	polyethylene
Hose pipe	Polybutadiene
CD-DVD	Polycarbonate
Eye-glass/sunglasses	polycarbonate
?	*Fill the blank*
?	*Fill the blank*
?	*Fill the blank*
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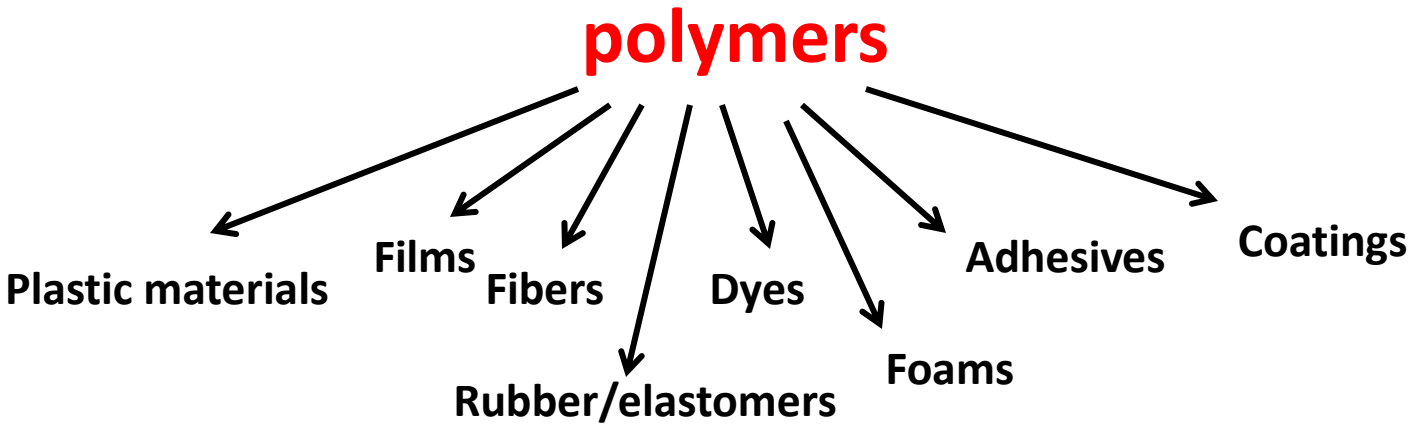
← **Homework**

-During the preparation of these products, plastisizers, dyes, filling materials, antioxidants, stabilizers, and etc. are added to the mixture.

Important usage fields of polymers



monomer

↓ polymerization

polymer

↓ additives

processing

↓ finishing

product

Thermoplastic entry before processing

Only physical processing

Such as extrusion, injection

The product

Elastomer (natural rubber) sheets before processing

<u>Chemical processing of natural rubber</u>
Such as compression molding

Natural rubber products

Basic approaches used for the processing of the polymers (whatever the source of the polymer, method):

- *Continous processing of polymers on a certain diameter geometry* (extrusion, film blowing,…)
- *Processing of polymers on a mold surface* (vacuum moulding, blowing,…)
- *gradual coating of the polymer on the surface of a mold or a material* (spraying, rotatory moulding,…)
- *Filling of a polymer on a mold space* (pouring, compression molding, injection,…)