Polymers II

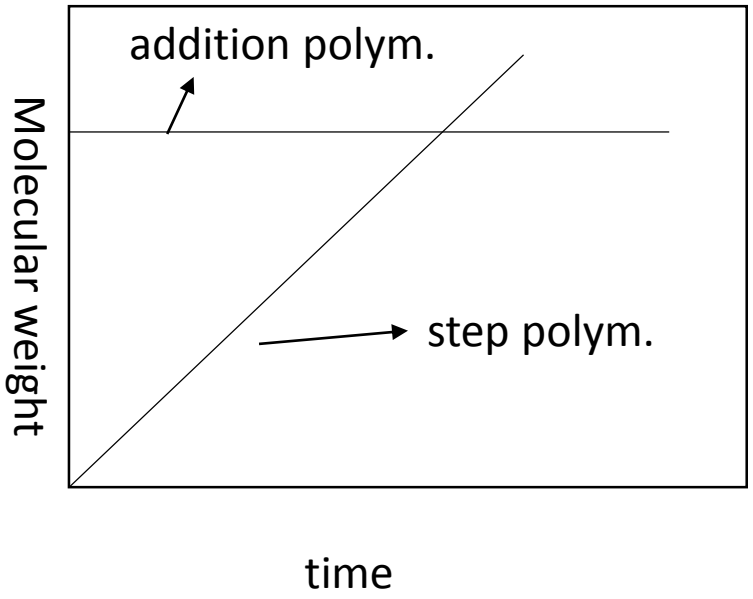
Synthesis of polymers.

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

Addition polymerization

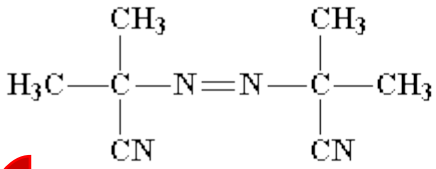
In this polymerization, the monomer molecules are added to the polymer chain rapidly and one-by-one. Due to the rapid chain growth, in the every stage of the polymerization, a polymer with high molecular weight is present.



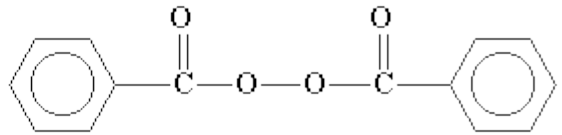
-Radical (free radicals)
-Ions (anionic/cationic)

Lif ve Elyaf Kimyası, Prof. Dr. Mehmet Saçak, Gazi Kitabevi, Ankara, 2002.

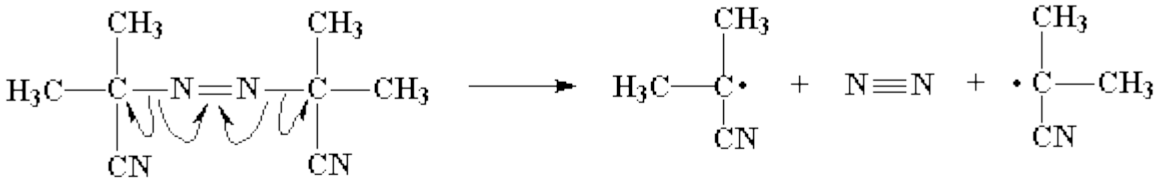
Radicalic Initiators

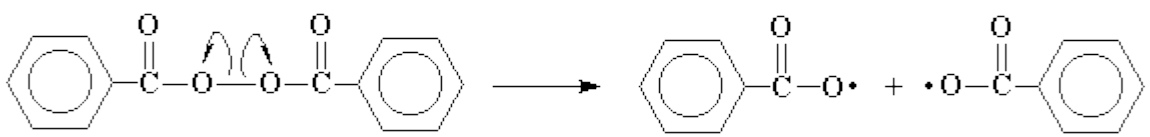


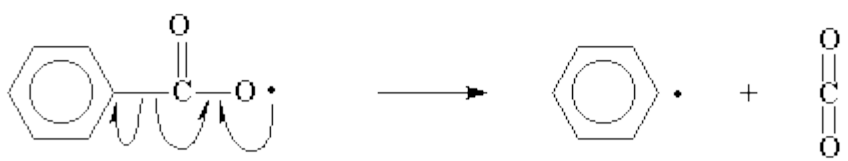
2-2'-azo-*bis*-isobutyrylnitrile
(AIBN)



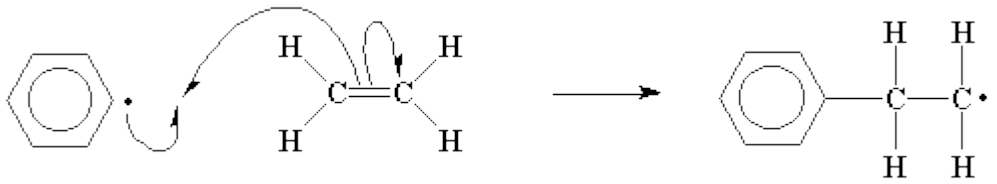
benzoyl peroxide



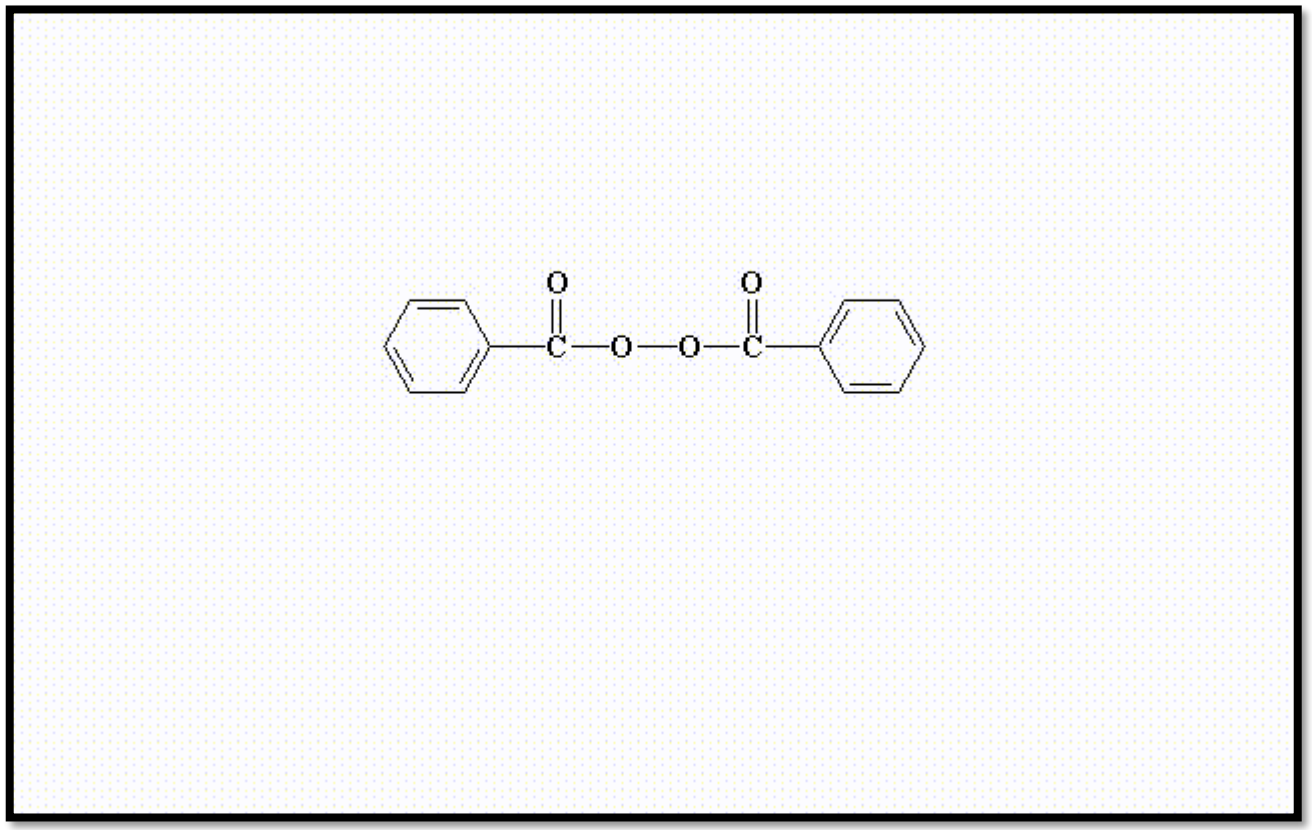




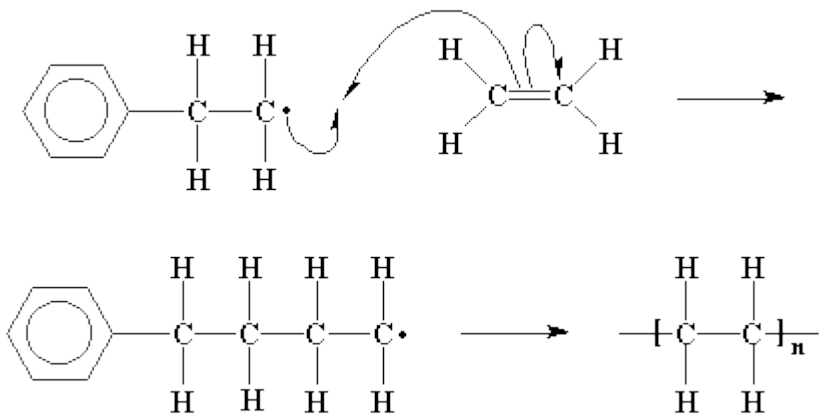
https://pslc.ws/macrog/radical.htm



Initiation with Benzoyl peroxide

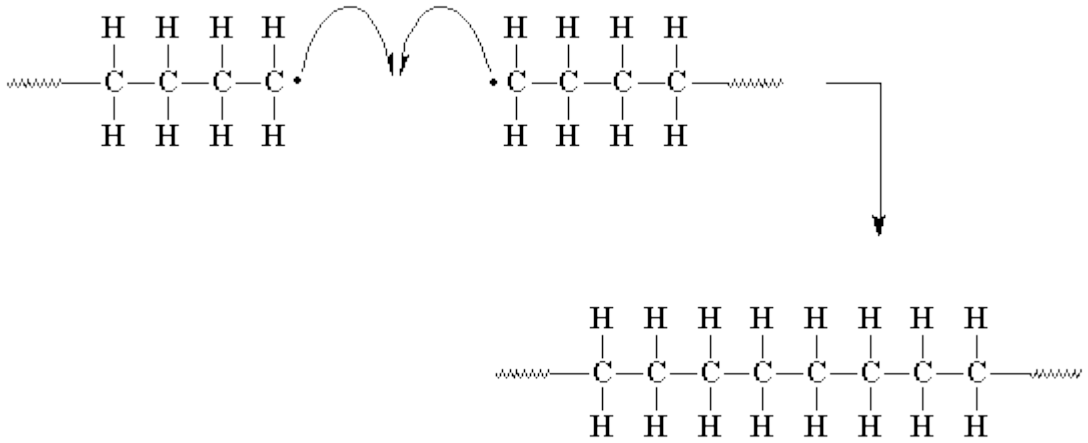


https://pslc.ws/macrog/radical.htm

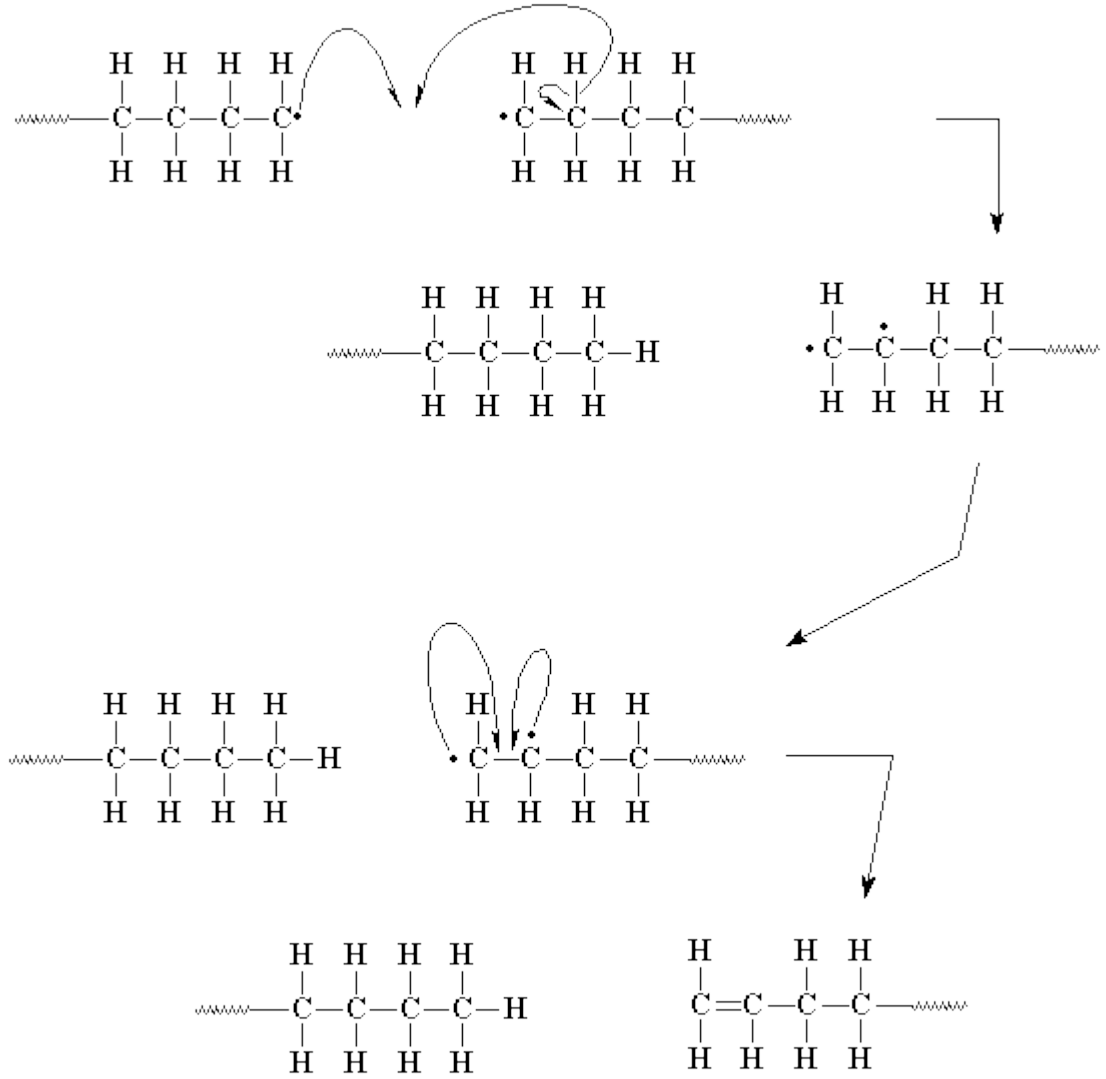


propagation

https://pslc.ws/macrog/radical.htm



Termination-combination



Termination-disproportion

https://pslc.ws/macrog/radical.htm

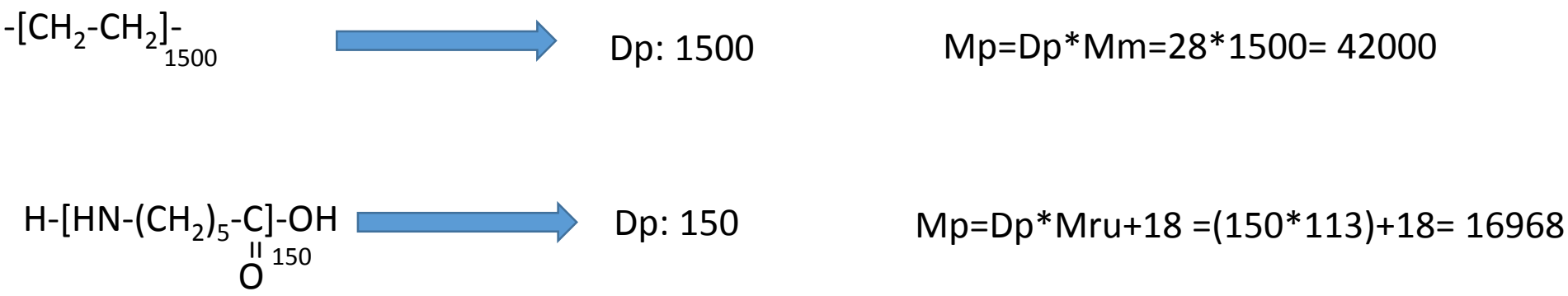
? Homework: Write an example for an other addition polymer

? Homework: compare the properties of addition and step polymerizations.

Dp concept for step and addition polymers

The definition for Dp concept differs for addition and step polymers.

* Dp can be defined as average number of monomer molecules per chain (repetitive unit)



* Dp is defined as number of average structural unit per chain

? Homework: Calculate the molecular weight of polyethylene adypat whose Dp value is 100.

Trick: $H\text{-}[O\text{-}CH_2\text{-}CH_2\text{-}O\text{-}(C{=}O)\text{-}(CH_2)_4\text{-}(C{=}O)]_{100}\text{-}OH$

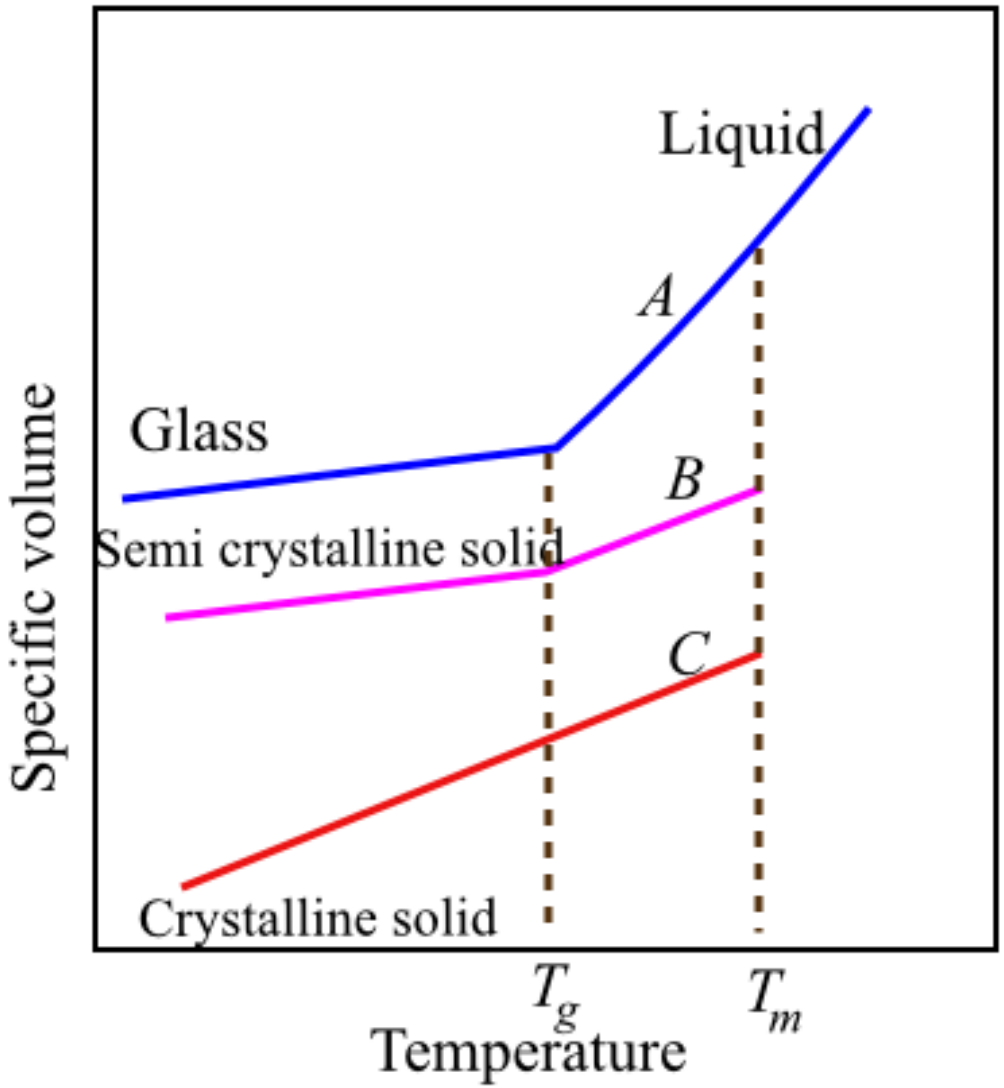
Thermoplastic, thermosetting , and elastomer polymers

- Thermoplastic is a concept used for the polymers that can be melted and reshaped by heat effect. PE, PS, PVC, PET, PP, Nylon 6,6 can be given as the commercial polymer that we use in the daily life.
- These polymers can be dissolved in many solvents and melted at adequate temperatures.
- 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).

Glass transition temperature (Tg)

- The glass transition temperature, often called T_g, is an important property when considering polymers for a particular end-use. Glass transition temperature is the temperature, below which the physical properties of plastics change to those of a glassy or crystalline state. Above T_g they behave like rubbery materials. Below the T_g a plastic's molecules have relatively little mobility. T_g is usually applicable to wholly or partially amorphous plastics. A plastic's properties can be dramatically different above and below its T_g. The value of the glass transition temperature depends on the strain rate and cooling or heating rate, so there cannot be an exact value for T_g.
- The glass transition temperature is the temperature range where the polymer substrate changes from a rigid glassy material to a soft (not melted) material, and is usually measured in terms of the stiffness, or modulus.*

Introduction to Plastics, Sina Ebnesajjad, in Chemical Resistance of Engineering Thermoplastics, 2016



Tg and Tm temperatures of some polymers

Polymer	Tg(°C)	Te(°C)
polyethylene	-115	95-140
Polypropylene Atactic isotactic	 -20 -10	 75 160
Polystyrene	100	240
Polyacrylonitrile	85	317
Polyvinyl chloride	81	285
PET	69-80	270
Nylon 6,6	57	267