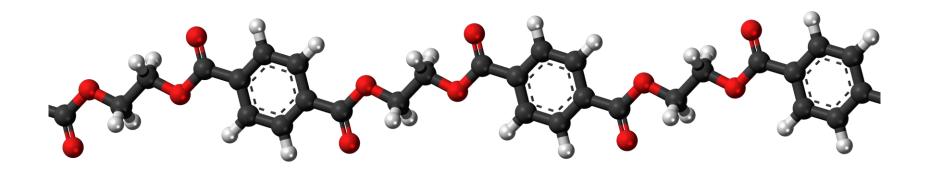
2302106 – Basic Organic Chemistry for ISE – Part II Lecture 6-3

Polymers – Condensation Polymers



Instructor: Asst. Prof. Dr. Tanatorn Khotavivattana E-mail: tanatorn.k@chula.ac.th

Recommended Textbook:

Chapter 26 in Organic Chemistry, 8th Edition, L. G. Wade, Jr., 2010, Prentice Hall (Pearson Education)

Condensation Polymers

• Condensation polymers result from formation of ester or amide linkages between difunctional molecules

Option 1

Option 2

1

- Usually proceeds by step-growth polymerization, in which any two monomer molecules may react to form a dimer, and dimers may condense to give tetramers, and so on
- Each condensation is an individual *step* in the growth of the polymer, and there is **no chain reaction**

Condensation Polymers

Four most common types :

1) Polyamides

2) Polyesters

3) Polycarbonates

4) Polyurethanes









1) Polyamides : Nylon is the common name for polyamides

- Generally made from reactions of **diacids** with **diamines**
- The most common polyamide is called **nylon 6,6** because it is made by reaction of a **six-carbon diacid** with a **six-carbon diamine**
- A proton-transfer reaction gives a white solid called **nylon salt**. When nylon salt is **heated** to 250 °C, water is driven off as a gas, and molten nylon results.

$$HO - C - (CH_2)_4 - C - OH + H_2N - (CH_2)_6 - NH_2 \longrightarrow$$

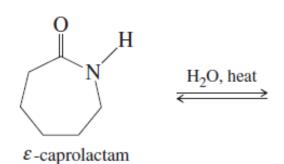
adipic acid

hexamethylene diamine



1) Polyamides : Nylon

• Nylon can also be made from a single monomer having an amino group at one end and an acid at the other (amino acids)



- When caprolactam is **heated with a trace of water**, some of it hydrolyses to the free amino acid. Continued heating gives condensation and polymerization to molten nylon 6
- Nylon 6 (also called *Perlon*®) is used for making **strong**, **flexible fibres** for ropes and tire cord

2) Polyesters

- The most common polyester is **Dacron**®, the polymer of **terephthalic acid** (paraphthalic acid or benzene-1,4-dicarboxylic acid) with **ethylene glycol**
- In principle, this polymer might be made by mixing the diacid with the glycol
- In practice, however, a better product is obtained using transesterification



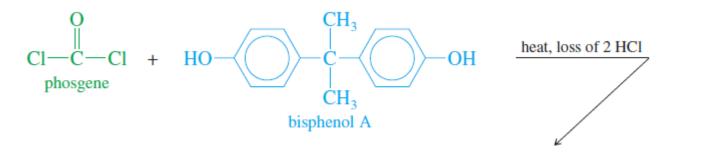
Wrinkle-free non-iron clothes

$$CH_{3}O - C - OCH_{3} + HO - CH_{2}CH_{2} - OH - OCH_{3} + OCH_{$$

Dacron® fiber is used to make fabric and tire cord



• Phosgene (the acid chloride of carbonic acid) reacts with a diol to give poly(carbonate ester) as a product





7

- **Lexan**®
- bulletproof windows
- crash helmets



0	
R - NH - C - O - R'	
a urethane or carbamate ester	

• urethanes are most commonly made by treating an isocyanate with an alcohol or a phenol

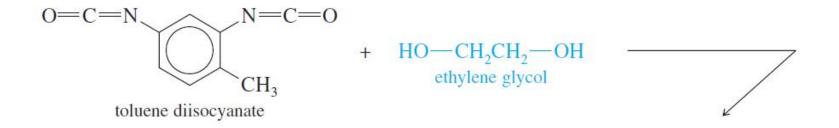
$$R \longrightarrow R \longrightarrow C \longrightarrow O + HO \longrightarrow R' \longrightarrow alcohol$$

$$\bigvee$$
 N=C=O + HO-CH₂CH₃ \rightarrow

phenyl isocyanate

4) Polyurethanes:

• Polyurethane results when a **diol** reacts with a **diisocyanate**





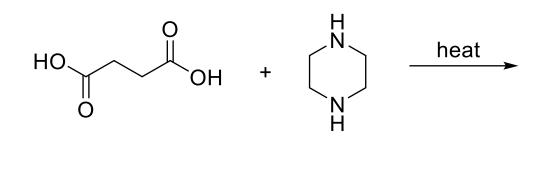
Polyurethane foams

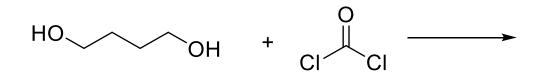
- Mattresses
- Car seats
- Pillows



Condensation Polymers – Examples

• Suggest the product of the following reactions





Condensation Polymers – Examples

• Suggest the product of the following reactions

