B.Sc. Semester-VI
Organic Chemistry
Paper-XIV

2. Synthetic Polymers

Coverage:

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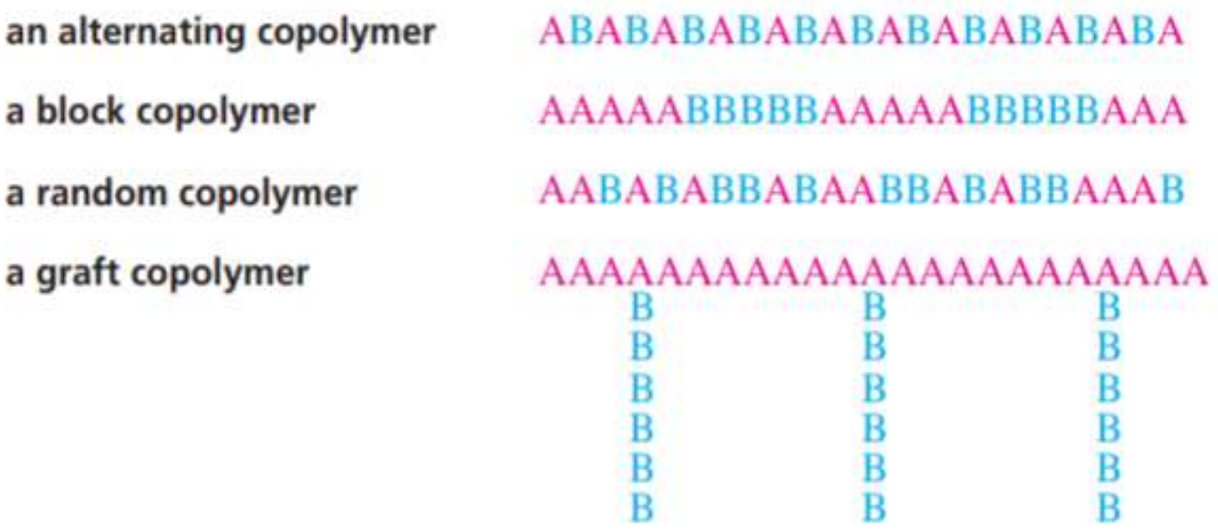
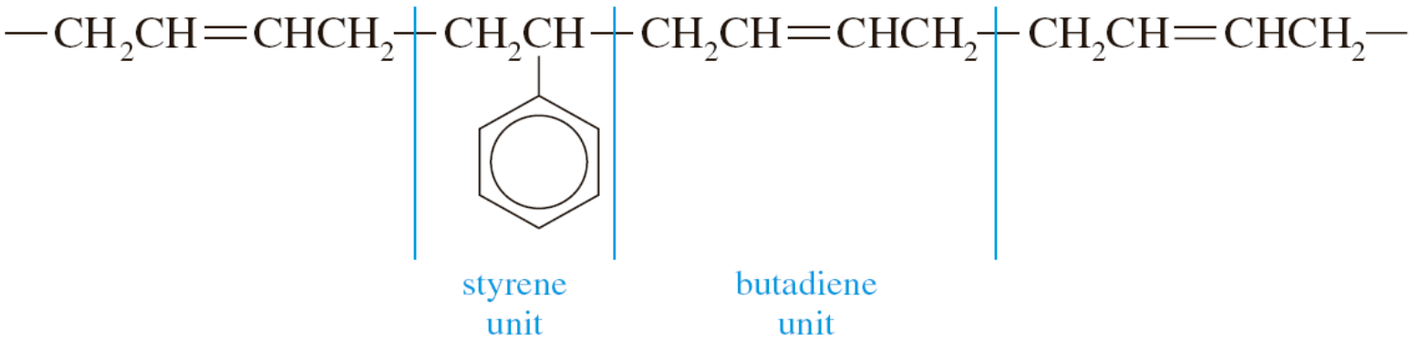
7. (i) Copolymers

The polymers we have discussed so far are formed from only one type of monomer and are called **homopolymers**. Often, two or more different monomers are used to form a polymer. The resulting product is called a **copolymer**. Increasing the number of different monomers used to form the copolymer dramatically increases the number of different copolymers that can be formed. Even if only two kinds of monomers are used, copolymers with very different properties can be prepared by varying the amounts of each monomer. Both chain-growth polymers and step-growth polymers can be copolymers. Many of the synthetic polymers used today are copolymers. Table 28.6 shows some common copolymers and the monomers from which they are synthesized.

There are four types of copolymers. In an **alternating copolymer**, the two monomers alternate. In a **block copolymer**, there are blocks of each kind of monomer. In a **random copolymer**, the distribution of monomers is random. A **graft copolymer** contains branches derived from one monomer grafted onto a backbone derived from another monomer. These structural differences extend the range of physical properties available to the scientist designing the copolymer.



One synthetic rubber (styrene–butadiene rubber, SBR) is made from the two monomers styrene and 1,3-butadiene. This polymer is a copolymer. A copolymer is made from two different monomers.



segment of styrene–butadiene rubber (SBR)

7. (ii) Some Examples of Copolymers and Their Uses

Monomer	Copolymer name	Uses
$CH_2{=}CH(Cl)$ (vinyl chloride) + $CH_2{=}CCl_2$ (vinylidene chloride)	Saran	film for wrapping food
styrene + $CH_2{=}CH{-}C{\equiv}N$ (acrylonitrile)	SAN	dishwasher-safe objects, vaccum cleaner parts
$CH_2{=}CH{-}C{\equiv}N$ (acrylonitrile) + $CH_2{=}CH{-}CH{=}CH_2$ (1,3-butadiene) + styrene	ABS	bumpers crash helmets, telephones, luggage
$CH_2{=}C(CH_3)_2$ (isobutylene) + $CH_2{=}C(CH_3){-}CH{=}CH_2$ (isoprene)	butyl rubber	inner tubes, balls, inflatable sporting goods

8. Step-Growth Polymerization

Step-growth polymers are formed by the intermolecular reaction of bifunctional molecules (molecules with two functional groups). When the functional groups react, in most cases a small molecule such as H_2O, alcohol, or HCl is lost. This is why these polymers are also called *condensation polymers*.

There are two types of step-growth polymers. One type is formed by the reaction of a single monomer that possesses two different functional groups A and B. Functional group A of one monomer reacts with functional group B of another monomer.

The other type of step-growth polymer is formed by the reaction of two different bifunctional monomers. One monomer contains two A functional groups and the other monomer contains two B functional groups.

The formation of step-growth polymers, unlike the formation of chain-growth polymers, does not involve chain reactions. Any two monomers (or short chains) can react. The progress of a typical step-growth polymerization is shown schematically in Figure 28.3. When the reaction is 50% complete (12 bonds have formed between 25 monomers), the reaction products are primarily dimers and trimers. Even at 75% completion, no long chains have been formed. This means that if step-growth polymerization is to lead to long-chain polymers, very high yields must be achieved.