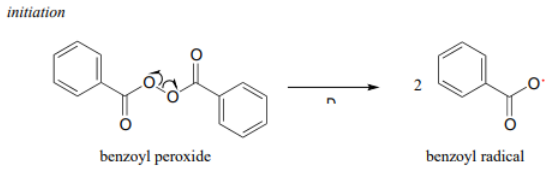
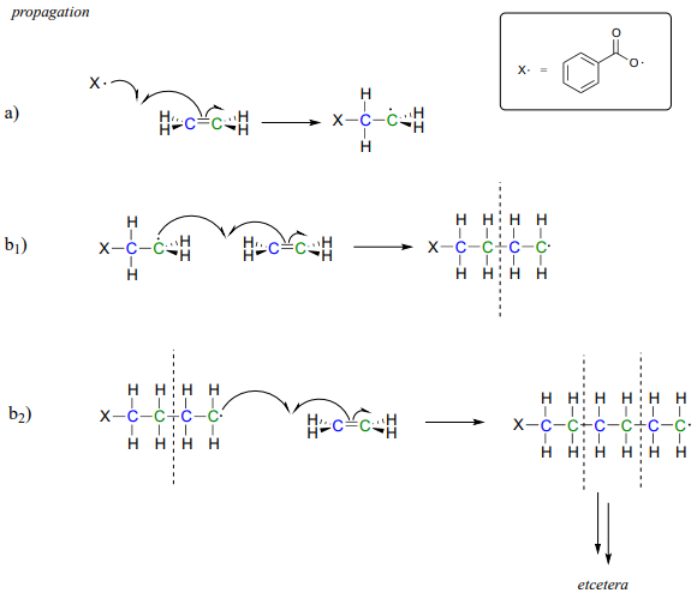
16.4: Useful Polymers formed by Radical Chain Reactions

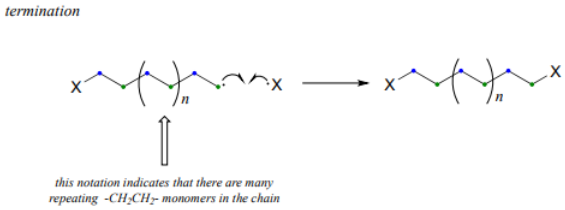
Many familiar household materials polymers made from radical chain reaction processes. Polyethylene (PET), the plastic material used to make soft drink bottles and many other kinds of packaging, is produced by the radical polymerization of ethylene (ethylene is a common name for what we call 'ethene' in IUPAC nomenclature). The process begins when a radical initiator such as benzoyl peroxide undergoes homolytic cleavage at high temperature:



In the propagation phase, the benzoyl radical ($X\cdot$ in the figure below) adds to the double bond of ethylene, generating a new organic radical.

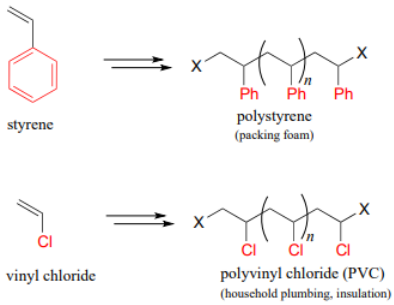


Successive ethylene molecules add to the growing polymer, until termination occurs when two radicals happen to collide.



The length of the polymer is governed by how long the propagation phase continues before termination, and can usually be controlled by adjusting reaction conditions.

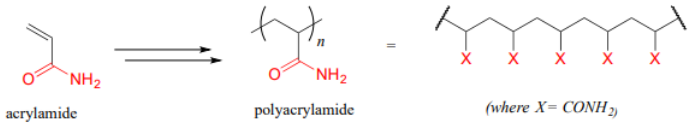
Other small substituted alkene monomers polymerize in a similar fashion to form familiar polymer materials. Two examples are given below.

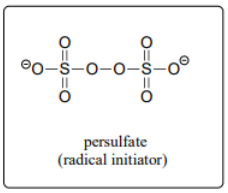


? Exercise 16.4.1

Show a mechanism for the formation of a 2-unit long section of polystyrene, starting with the monomer and benzoyl peroxide initiator. Keep in mind the relative stability of different radical intermediates.

A common way to separate proteins in the biochemistry lab is through a technique called polyacrylamide gel electrophoresis (**PAGE**). The polyacrylamide gel is formed through radical polymerization of acrylamide monomer, with the ammonium salt of persulfate used as the radical initiator.





In the end of chapter problems, you will be invited to propose a mechanism showing how a molecule called 'bis-acrylamide' serves as a 'crosslinker' between linear polyacrylamide chains to allow for formation of a net-like structure for the PAGE gel.
