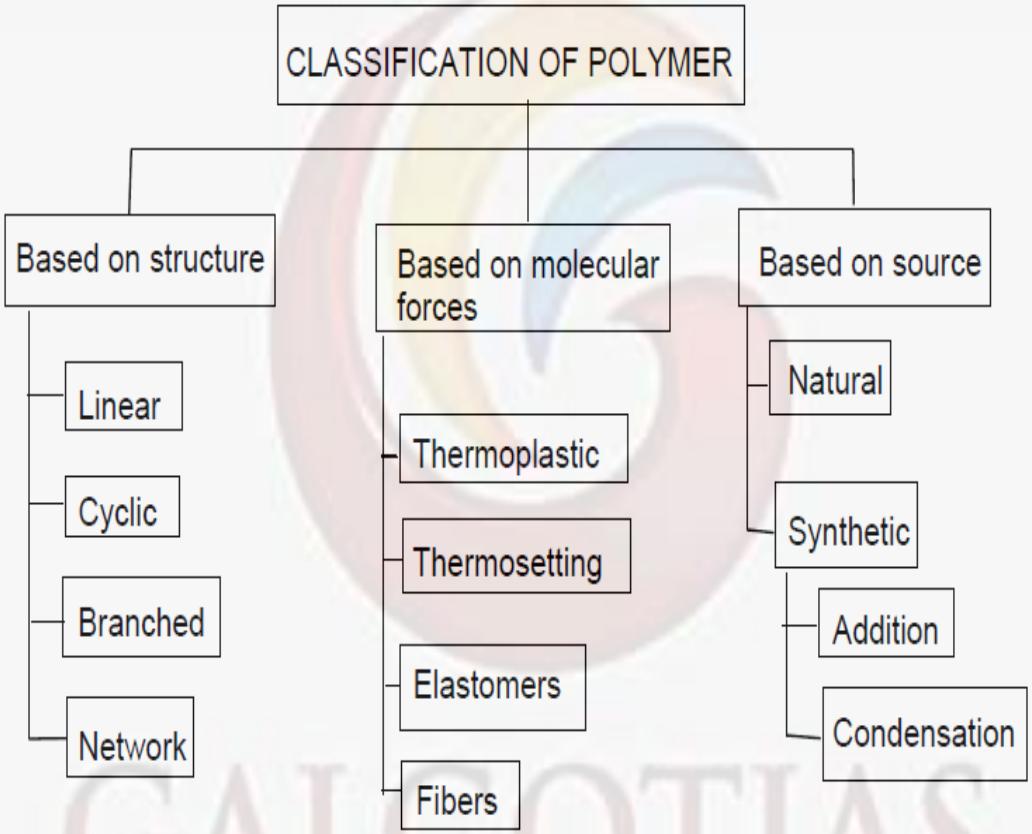
Polymers: Macromolecules formed by a set of small molecules termed as monomers.

Polymers can also be classified as:

(1) Man-made or synthetic polymers (synthesized in laboratory)
(2) Biological polymer (found in nature)

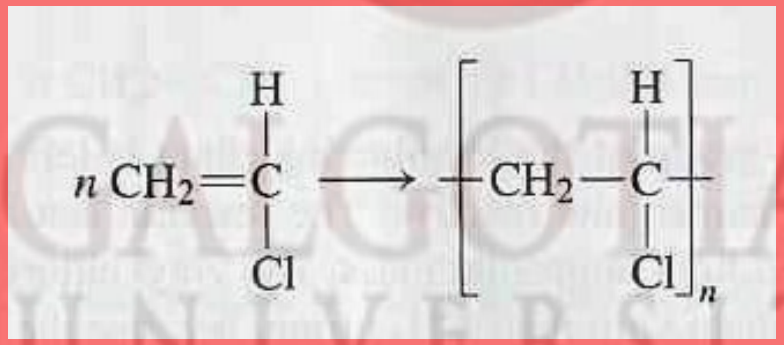
Examples of Synthetic polymers: nylon, poly-ethylene, poly-styrene

Examples of Biological polymers: DNA, proteins, carbohydrates



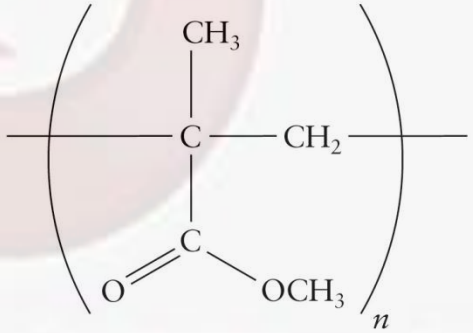
1.Addition polymerization
2. condensation polymerization

Addition polymerization: monomers react to form a polymer without net loss of atoms. It can be done by free radical, cationic & anionic polymerization mechanism chain reaction



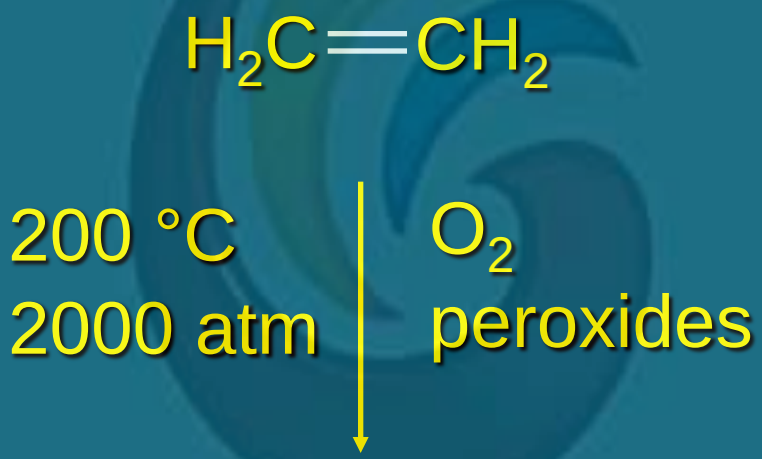

vinyl chloride PVC polymer

**TABLE 19.2** Common Addition Polymers

| Monomer name | Formula | Polymer formula | Common name |
|---|---|---|---|
| ethene* | $CH_2=CH_2$ | $-(CH_2-CH_2)_n-$ | polyethylene |
| vinyl chloride | $CHCl=CH_2$ | $-(CHCl-CH_2)_n-$ | polyvinyl chloride |
| styrene | $CH(C_6H_5)=CH_2$ | $-(CH(C_6H_5)-CH_2)_n-$ | polystyrene |
| acrylonitrile | $CH(CN)=CH_2$ | $-(CH(CN)-CH_2)_n-$ | Orlon, Acrilan |
| propene* | $CH(CH_3)=CH_2$ | $-(CH(CH_3)-CH_2)_n-$ | polypropylene |
| methyl methacrylate | $CH_3OOCC(CH_3)C=CH_2$ |  | Plexiglas, Lucite |
| tetrafluoroethene* | $CF_2=CF_2$ | $-(CF_2-CF_2)_n-$ | Teflon, PTFE† |

*The suffix *-ene* is replaced by *-ylene* in the common names of these compounds, hence the names of the corresponding polymers.
†PTFE, polytetrafluoroethylene.

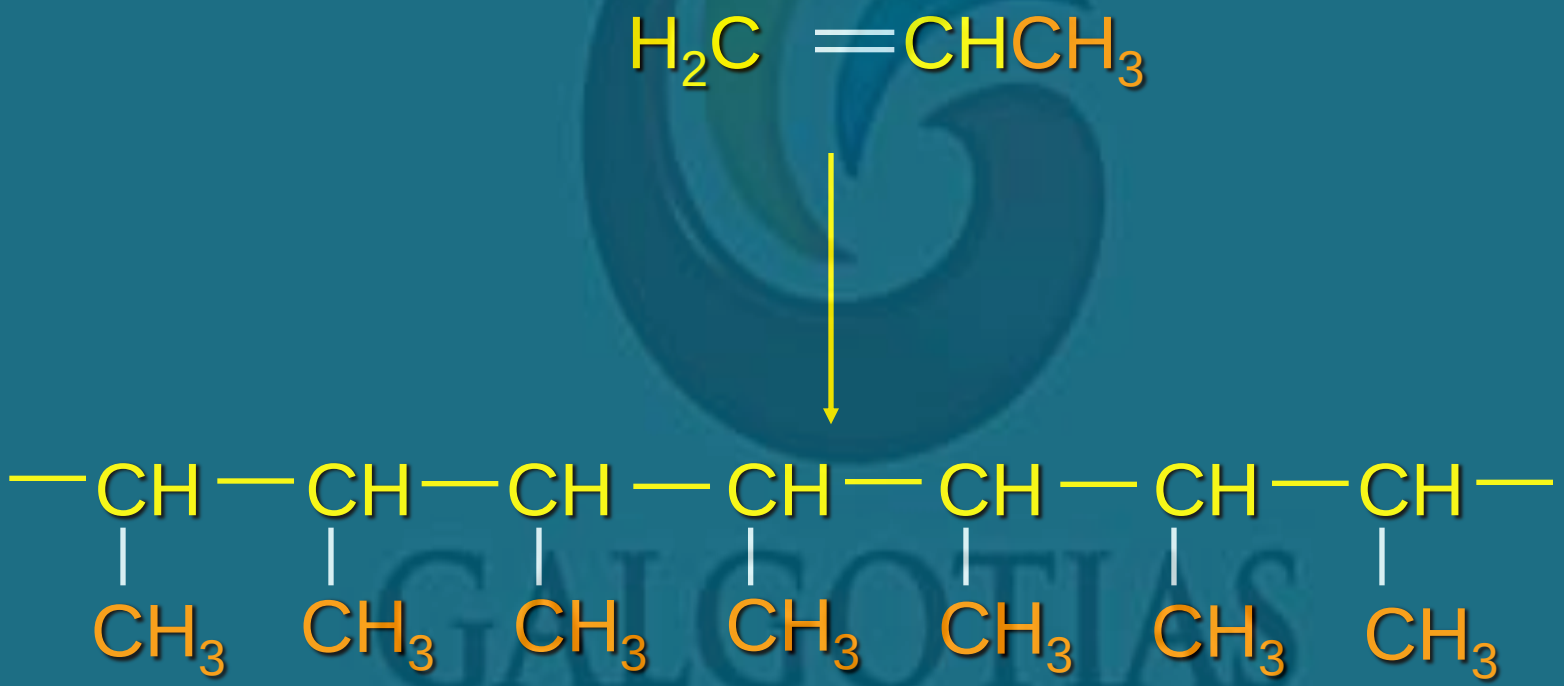
# Ethylene



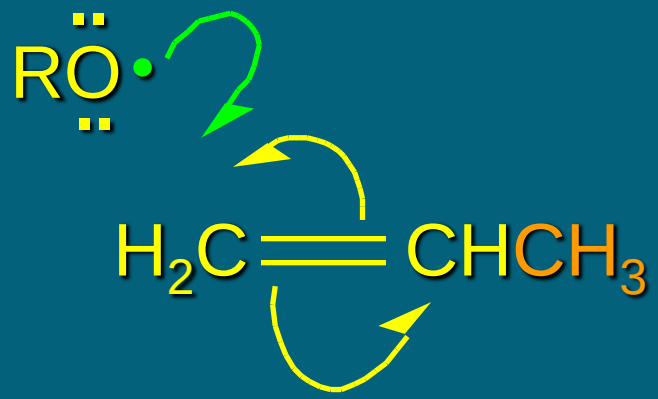


polyethylene

# Free-Radical Polymerization of Propene

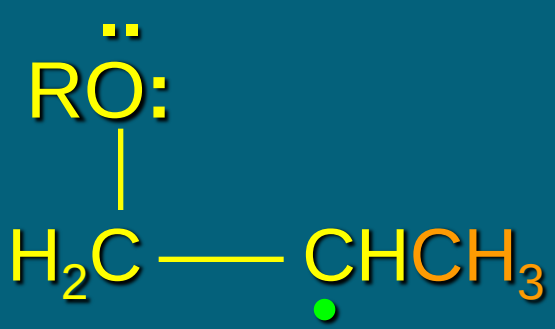



polypropylene

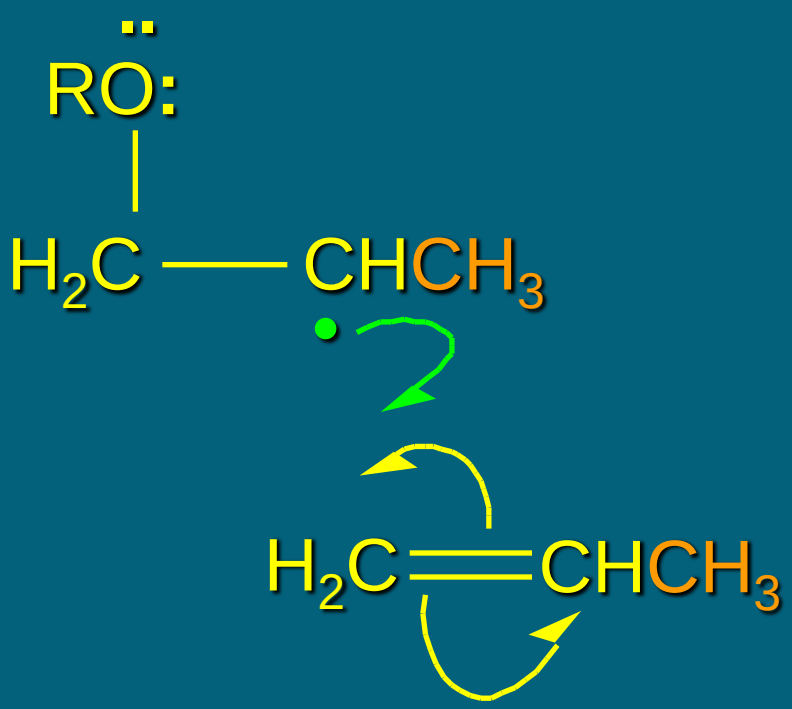



# Mechanism

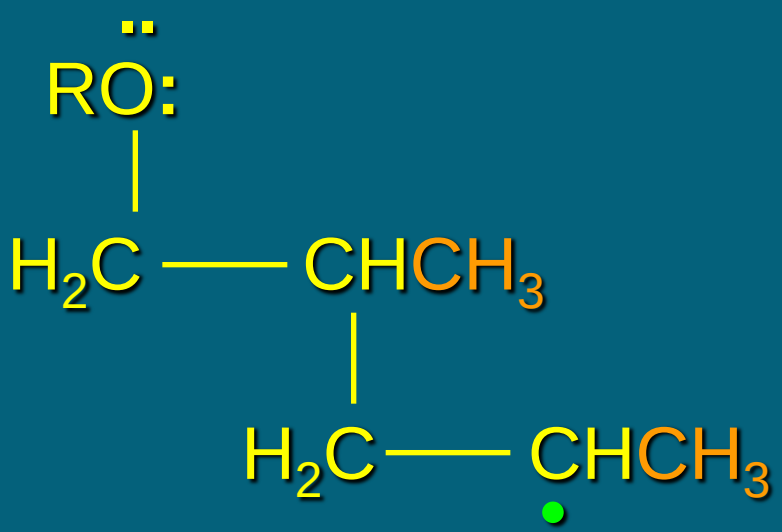
# Mechanism



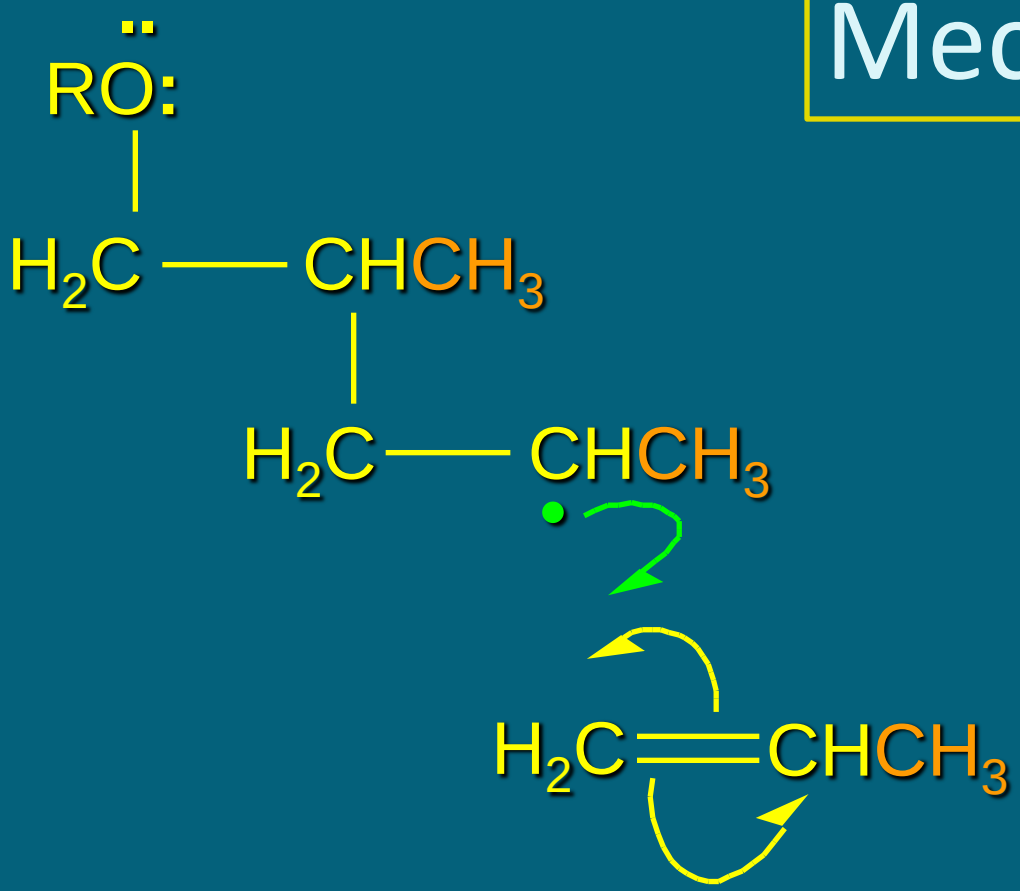
# Mechanism



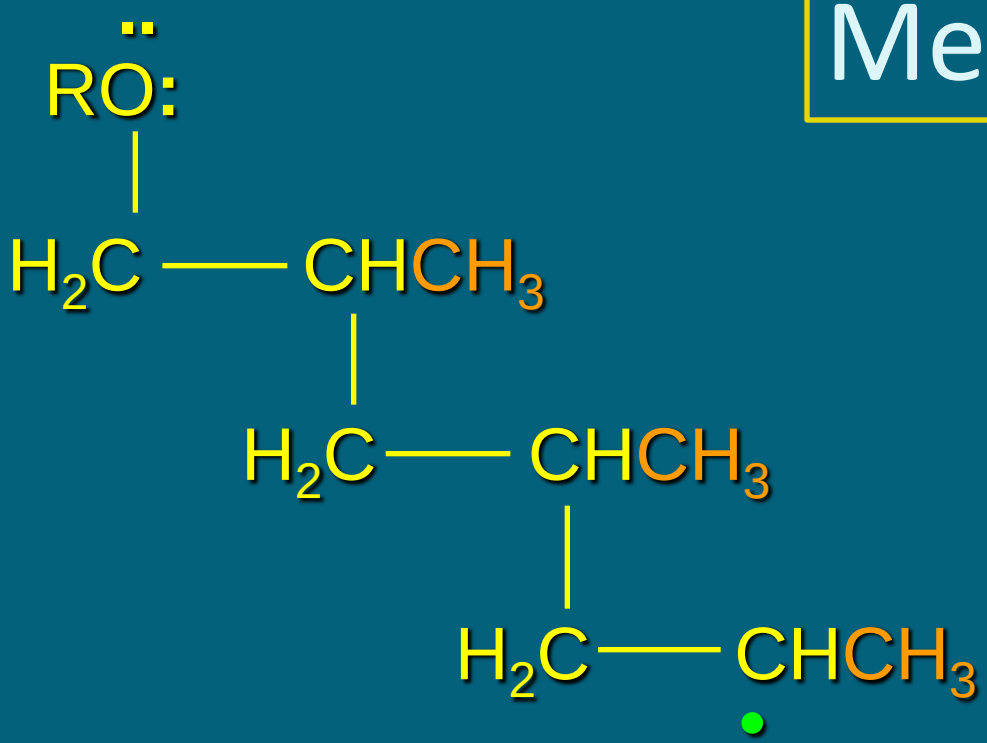
# Mechanism



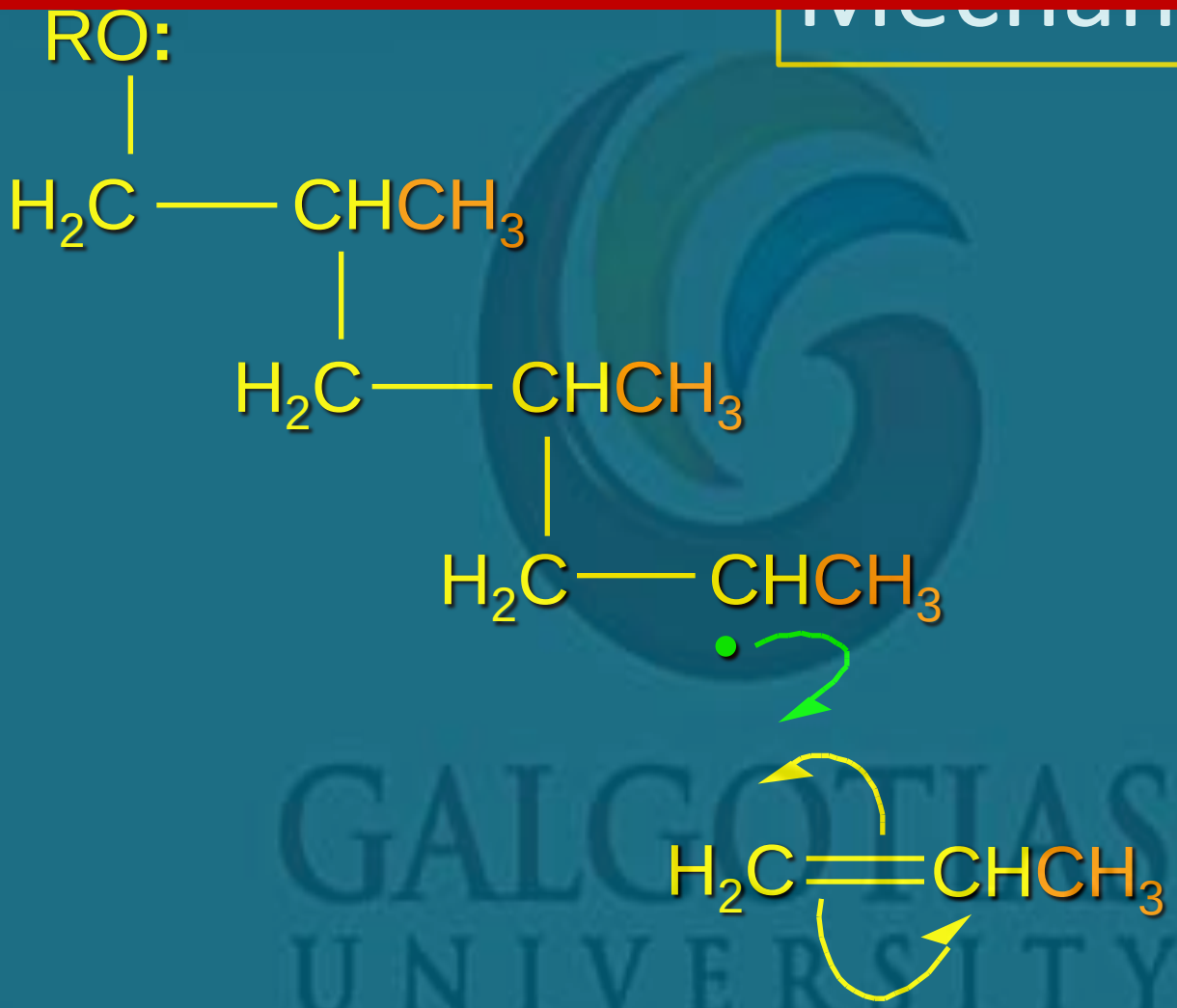
# Mechanism



# Mechanism

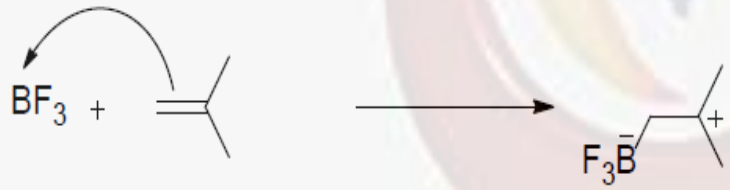


Mechanism

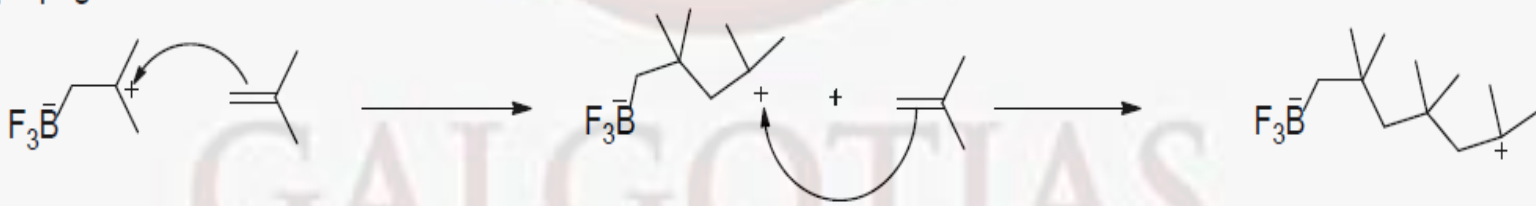


- In cationic polymerization, a cation intermediate is generated by the addition of a Lewis acid such as $BF_3$, $AlCl_3$, etc. with the monomer typically alkene. The cation formed in the initiation step reacts with another monomer and generate a new cation, this process is repeated until chain termination occurs.

initiation




propagation



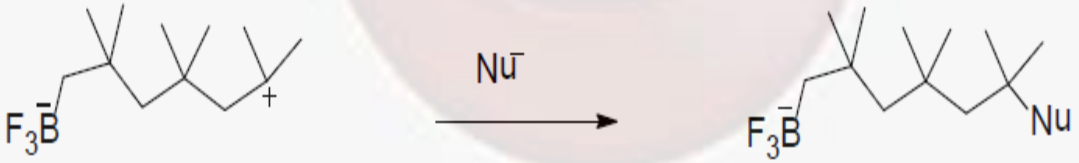

- Chain propagation can be affected by three ways either by loss of a proton or by addition of a nucleophile or by reacting with the solvent molecule

- Chain propagation can be affected by three ways either by loss of a proton or by addition of a nucleophile or by reacting with the solvent molecule.

termination

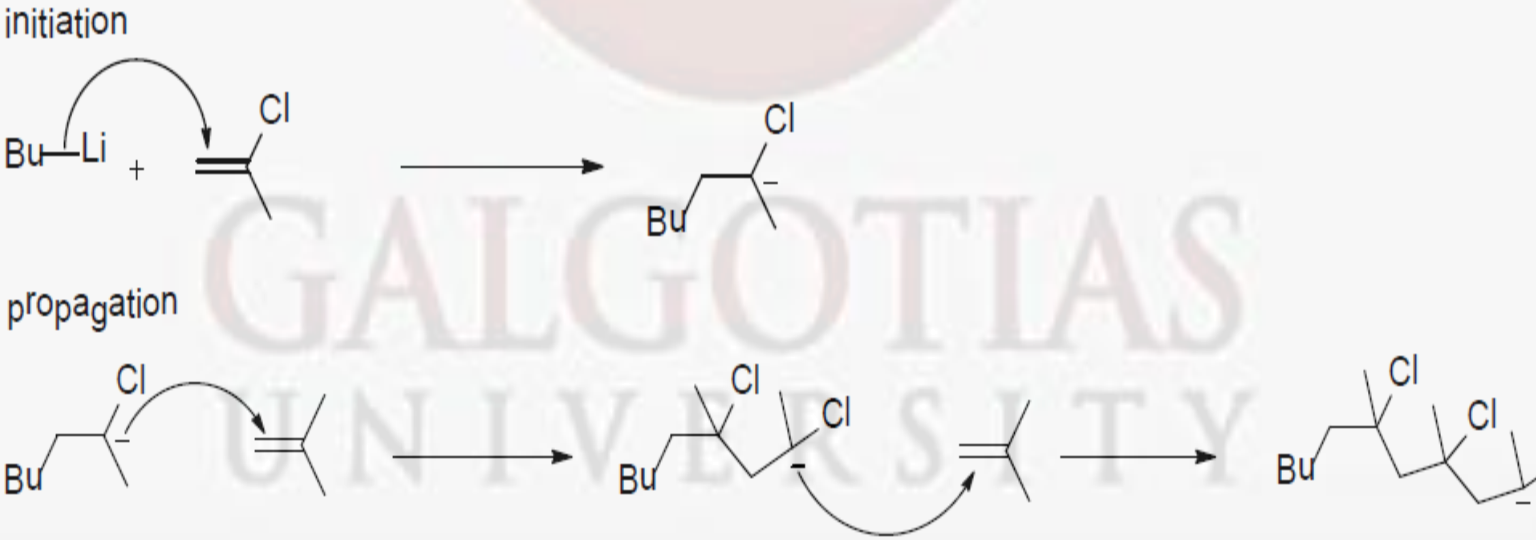
loss of a proton

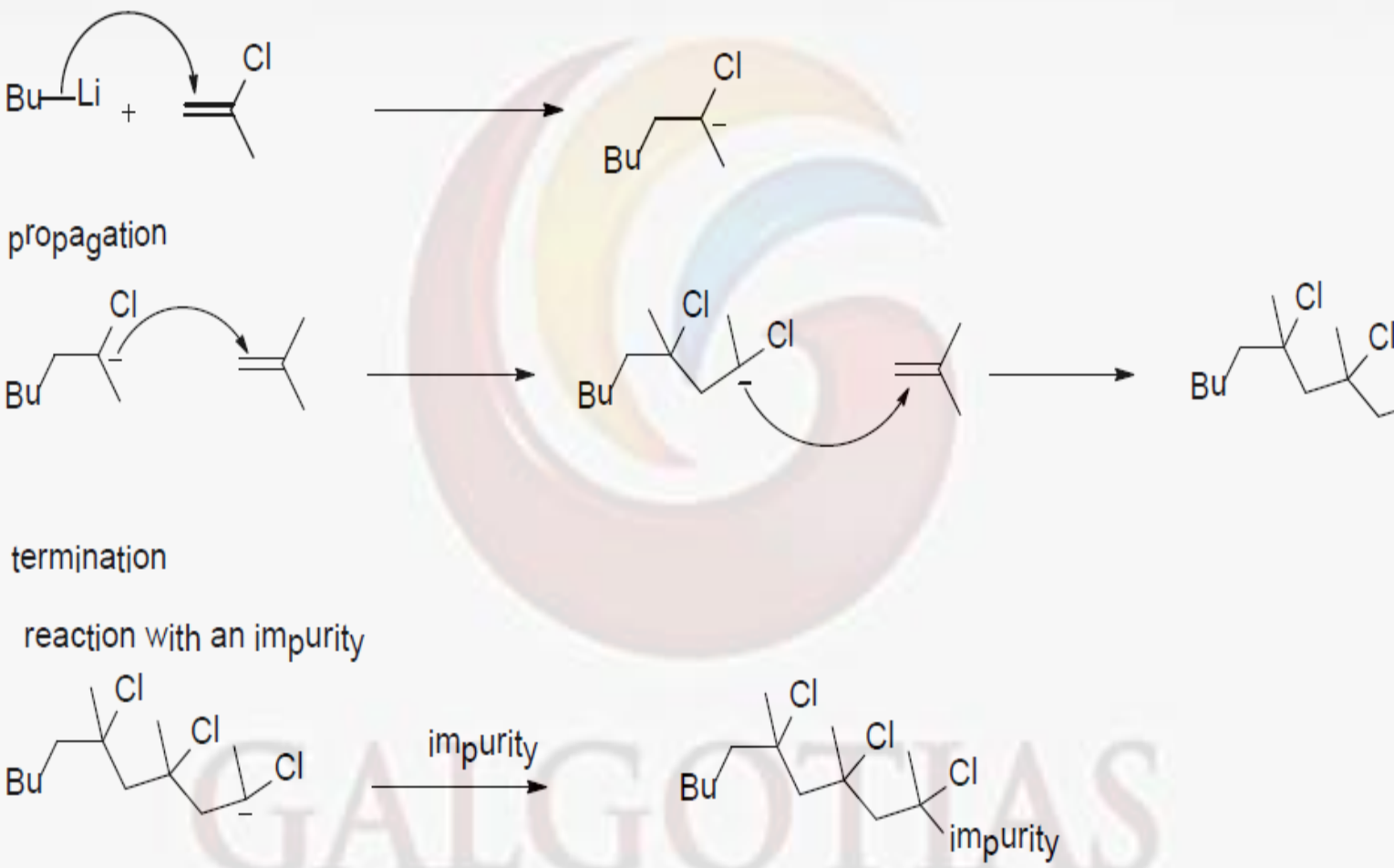

reaction with a nucleophile




chain transfer reaction with the solvent

monomer alkene and generates a new anions, this process occurs only when the nucleophilicity of the initiator nucleophiles are strong enough to attack the electron rich olefins. Similarly, if electron withdrawing substituents are attached to the olefin bond increases the rate of addition. Here the chain propagation step was terminated by reaction of generated nucleophiles with impurity or solvent molecules.




Bu
Li
+
Cl
Bu
Cl
propagation
Bu
Cl
Bu
Cl
Cl
Bu
Cl
termination
reaction with an impurity
Bu
Cl
Cl
Cl
impurity
Bu
Cl
Cl
Cl
impurity

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- **"Lord Todd: the state of chemistry". Chemical & Engineering News Archive. 58 (40): 28–33. 1980-10-06. doi:10.1021/cen-v058n040.p028. ISSN 0009-2347.**

# School of Basic & Applied Sciences

**Course Code : BSCC3004** **Course Name: Organic Chemistry V**

References and suggestions for further reading:

1. Textbook of Polymer Science by Fred W. Billmeyer, Wiley

2. Polymer Chemistry by Charles E Carraher, Jr., Marcel Dekker, Inc.

3. Principle of Polymerization by George Odian, Wiley