3.012 Fund of Mat Sci: Structure – Lecture 22

POLYMERS

Photos removed for copyright reasons.

From day-to-day plastics to light-emitters to artificial muscles

Homework for Fri Dec 2

- Study: Chapter 2 of Allen-Thomas until 2.4.3

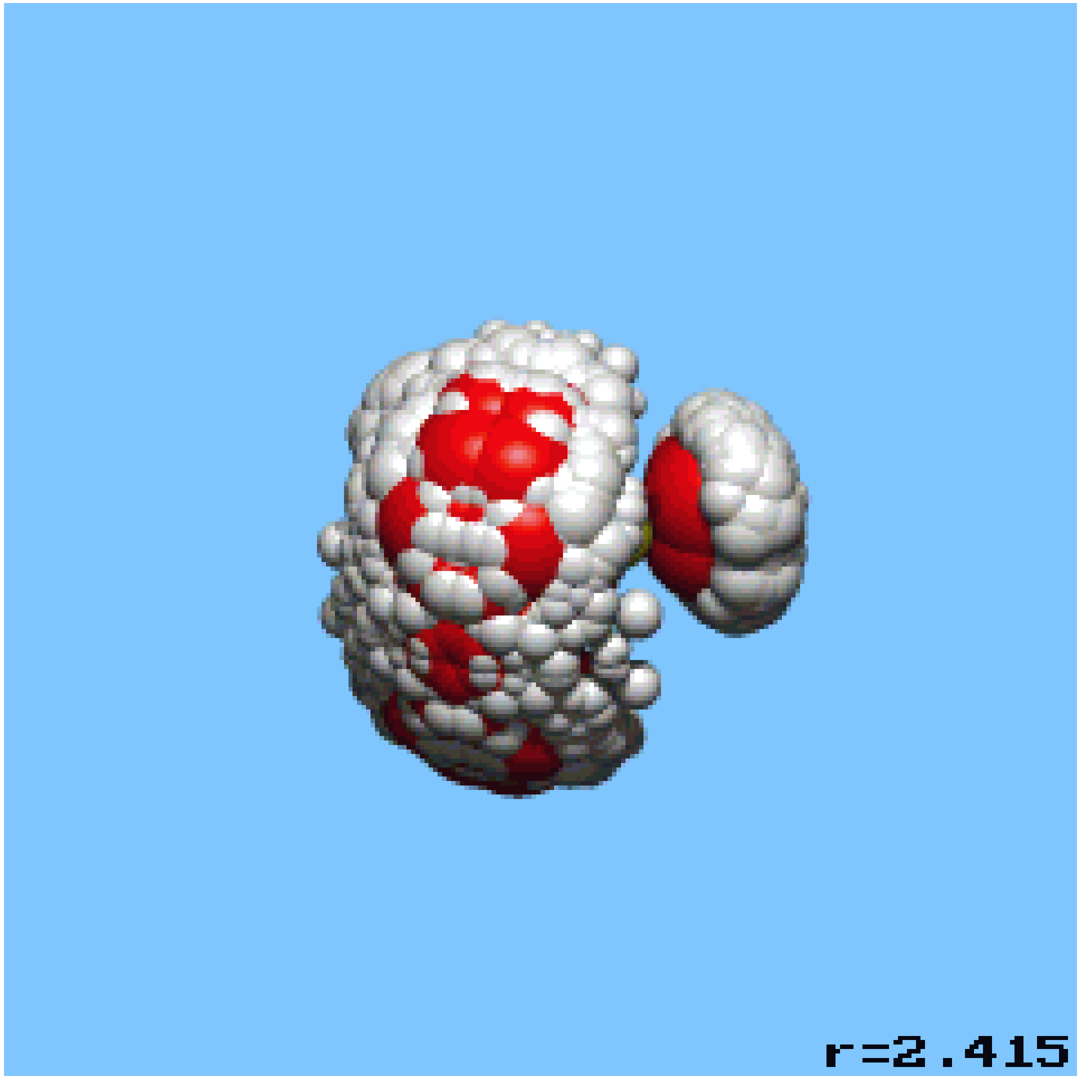
Last time:

1. Curie's principle
2. Amorphous systems: Te-Sb-Ge alloys in readable/writeable CD or DVD, silicon, ice
3. Order parameters

Pair correlation functions

Graphs of the pair-distribution functions for gas, liquid/gas, and monatomic crystal removed for copyright reasons.
See page 41, Figure 2.5 in in Allen, S. M., and E. L. Thomas. *The Structure of Materials*. New York, NY: J. Wiley & Sons, 1999.

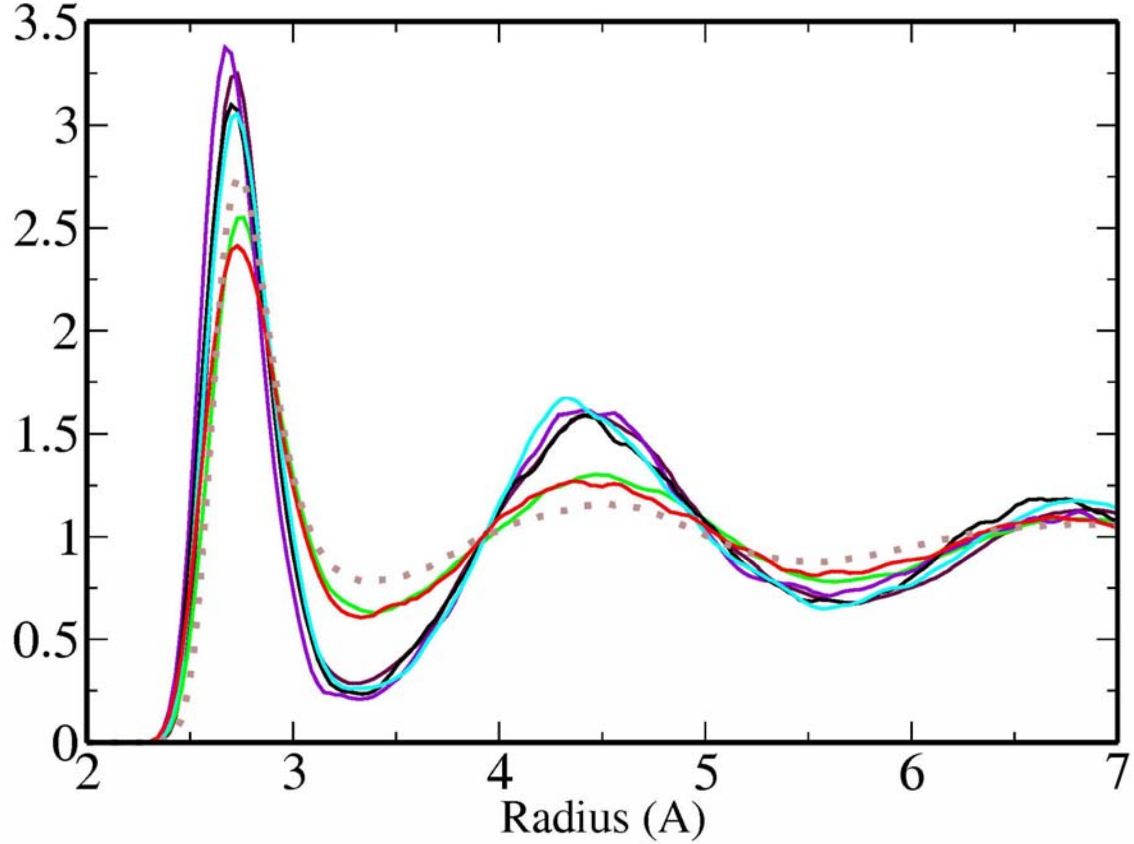
Pair correlation function: water



Courtesy of Dr. J. Kolafa. Used with Permission.

See animation at http://www.icpf.cas.cz/jiri/movies/water.htm.

Pair correlation function: water



Count thy neighbours

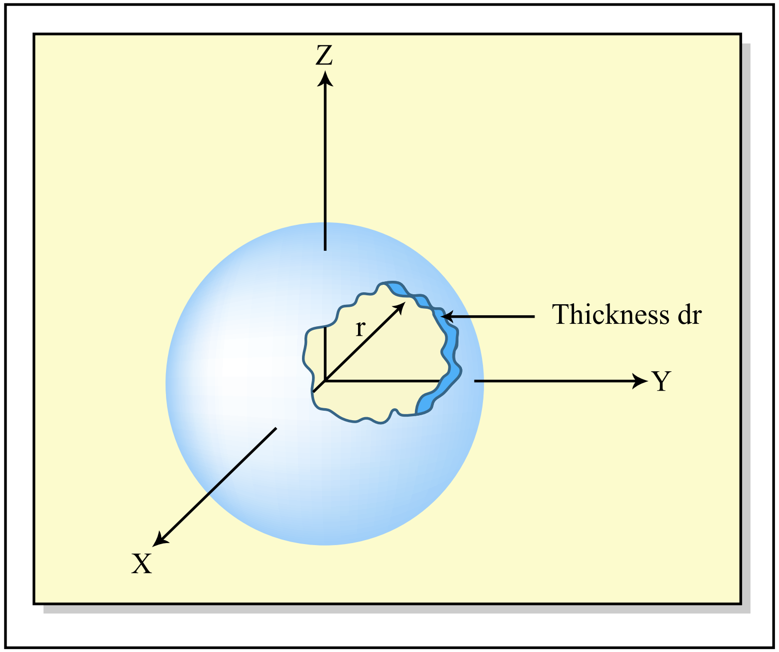
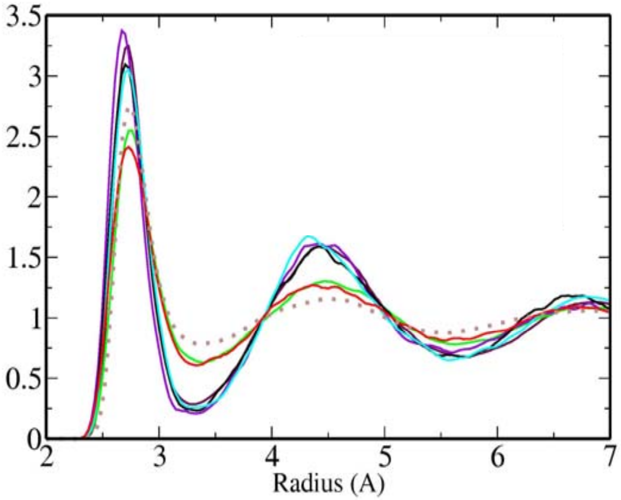


Figure by MIT OCW.



Models of disorder: hard spheres

- Bernal random close packed sphere model

Photos of the Bernal random close-packing model removed for copyright reasons.
See them at the Science & Society Picture Library: Image 1, Image 2.

Models of disorder: hard spheres

- Voronoi polyhedra (in a crystal: Wigner-Seitz cell)

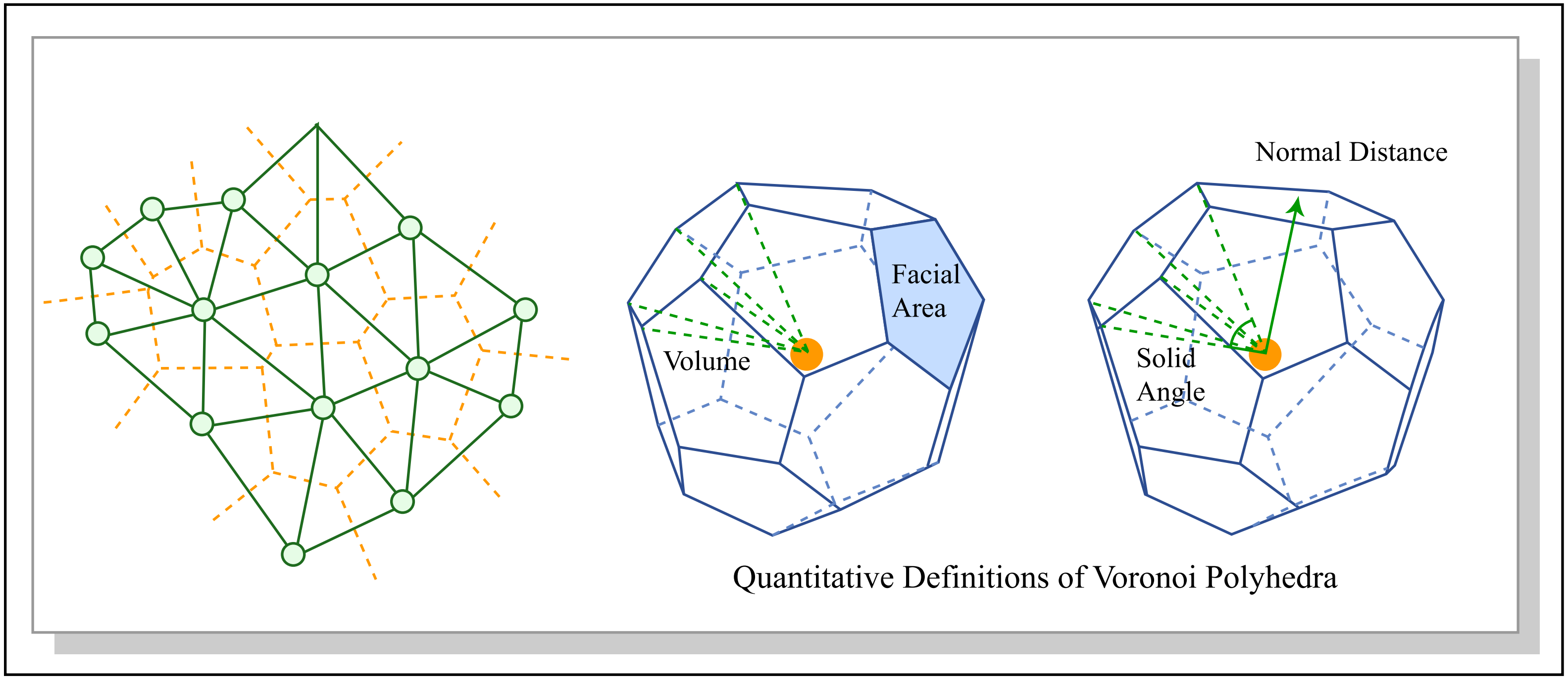
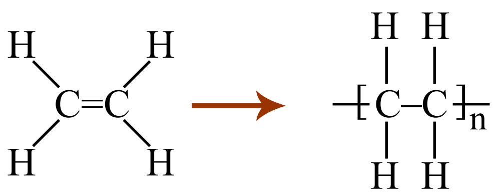


Figure by MIT OCW.

Polymers



Ethylene has two carbon atoms and four hydrogen atoms, and the polyethylene repeat structure has two carbon atoms and four hydrogen atoms. None gained, none lost.

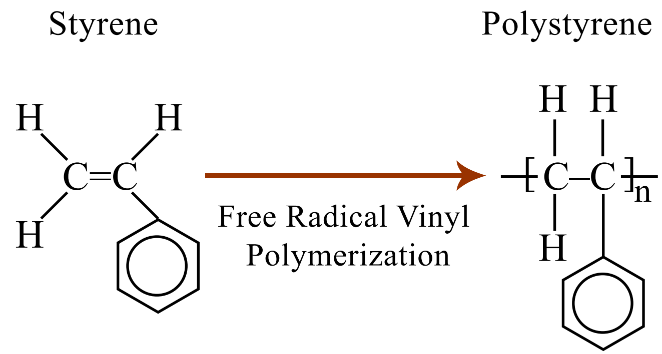


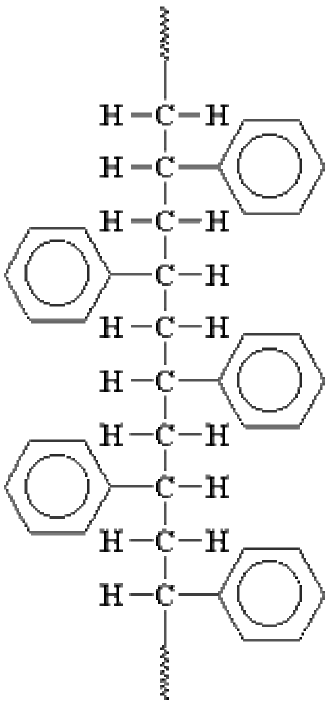
Figure by MIT OCW.

Polymers

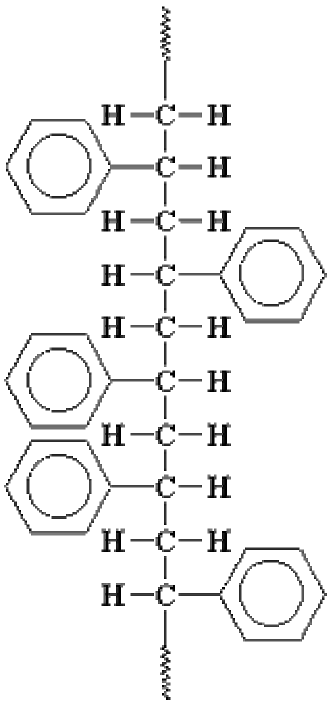
- Homopolymers
- Copolymers
  - Random
  - Block
- Graft, branched

Classification: Tacticity

- Isotactic
- Syndiotactic
- Atactic



syndiotactic polystyrene



atactic polystyrene

Glass Transition

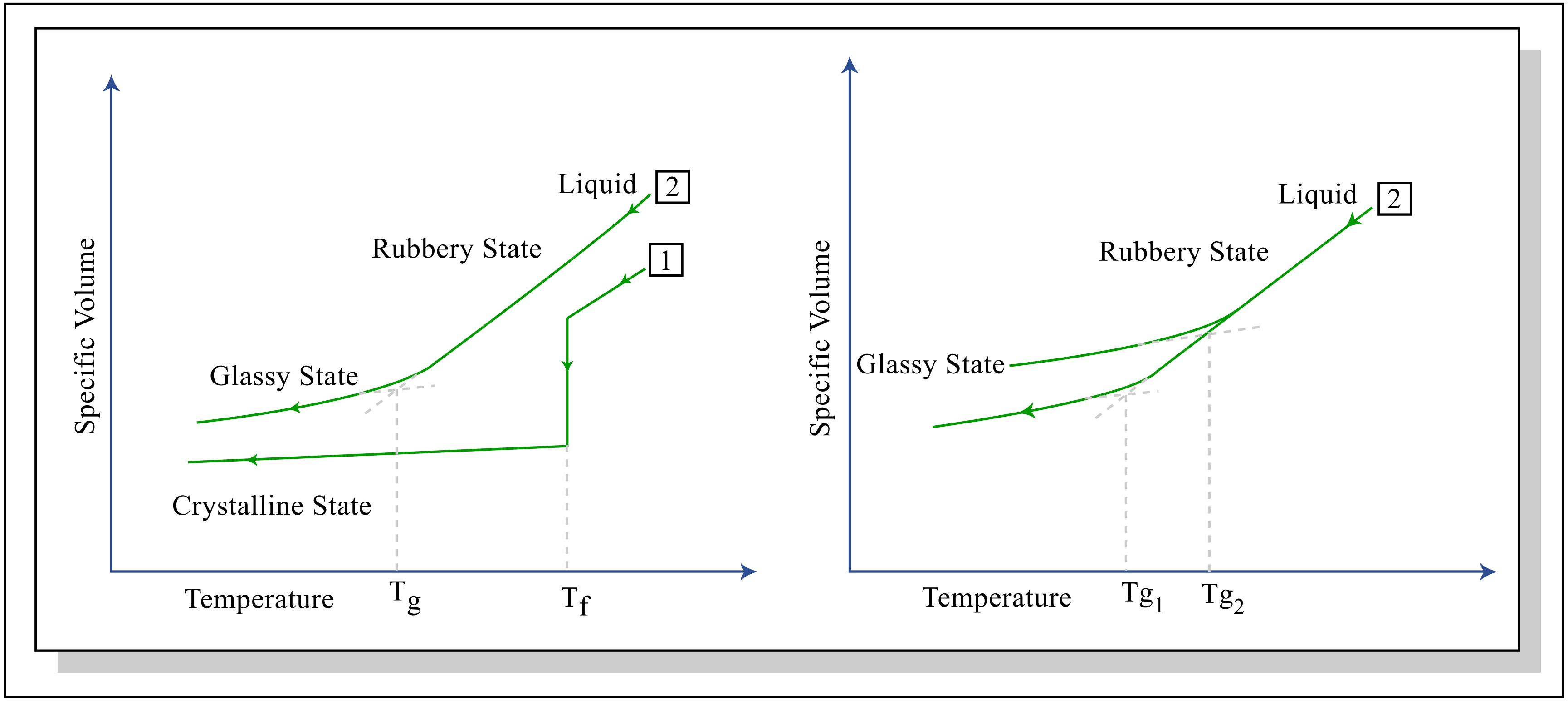
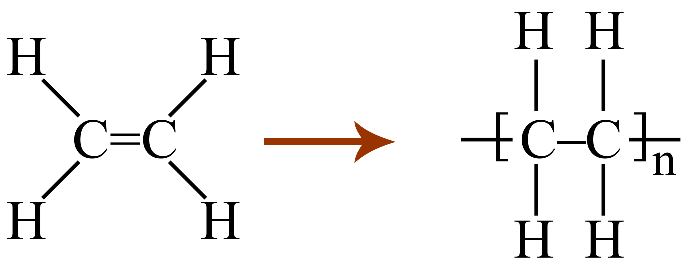


Figure by MIT OCW.

Classification: mechanical

- Thermoplastics: (linear, or at most contain branches). Melting temperature, and a glass temperature.
- Elastomers: low degree of cross-linking (rubbers)
- Thermosets: high-degree of cross-linking, structural rigidity

Addition vs. Condensation polymerization



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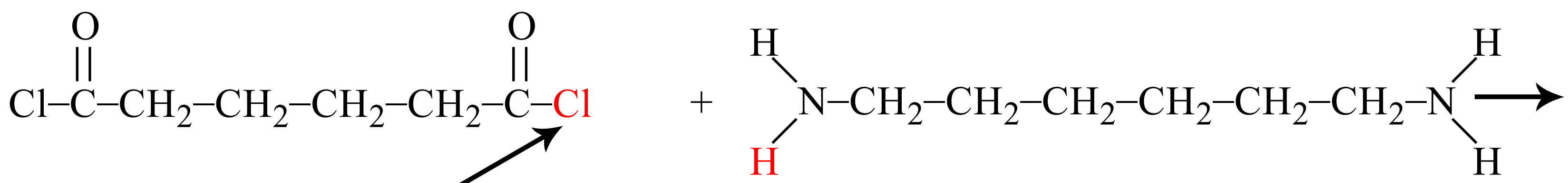


This Chlorine atom and this hydrogen atom don't end up in the polymer.
They split off to form HCl gas.

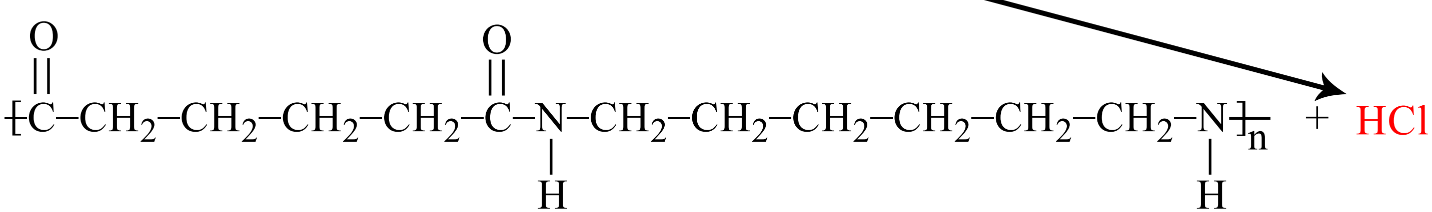
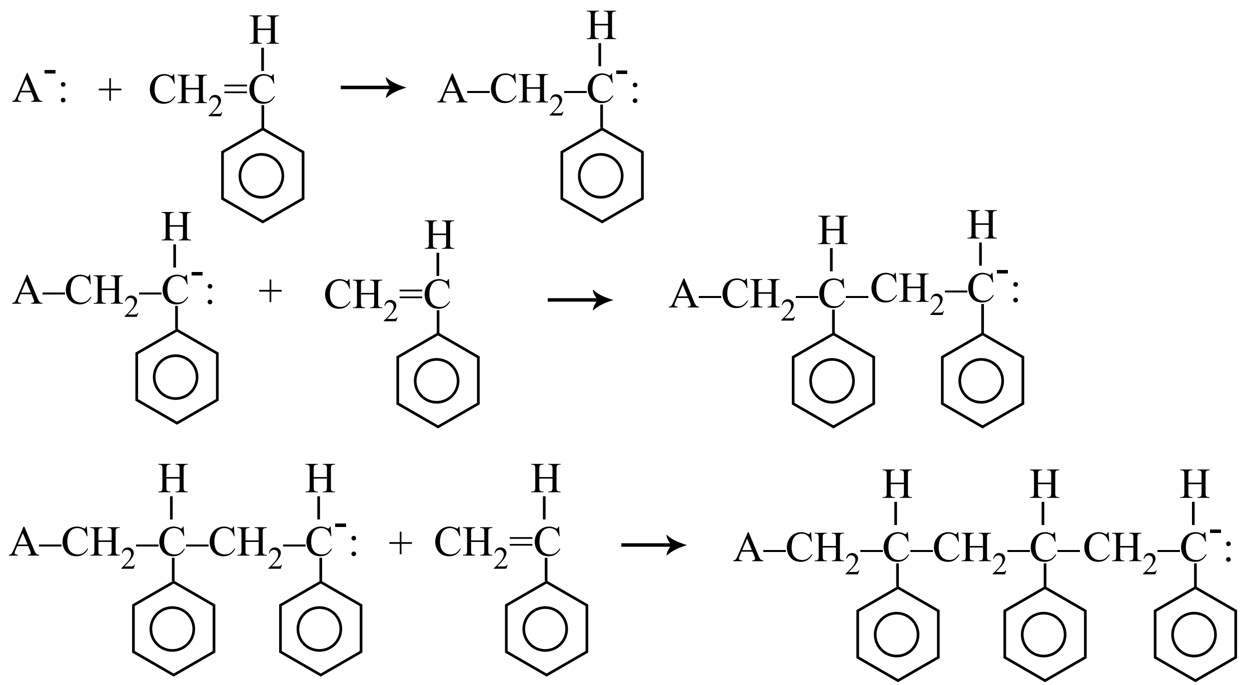


Figure by MIT OCW.

Chain growth



A Chain Growth Polymerization:
In the anionic polymerization of styrene, only styrene monomer can react with the growing polystyrene chain. Two growing chains won't react with each other.

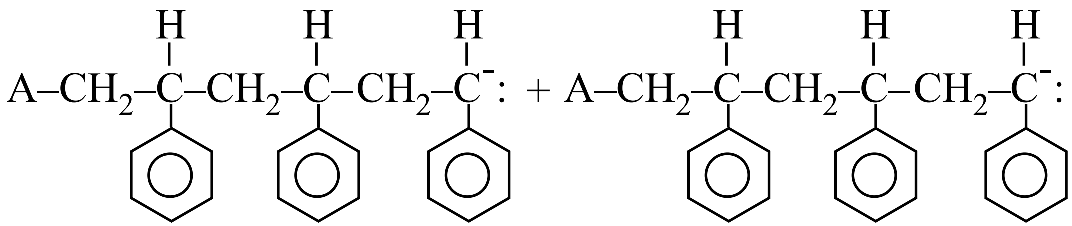
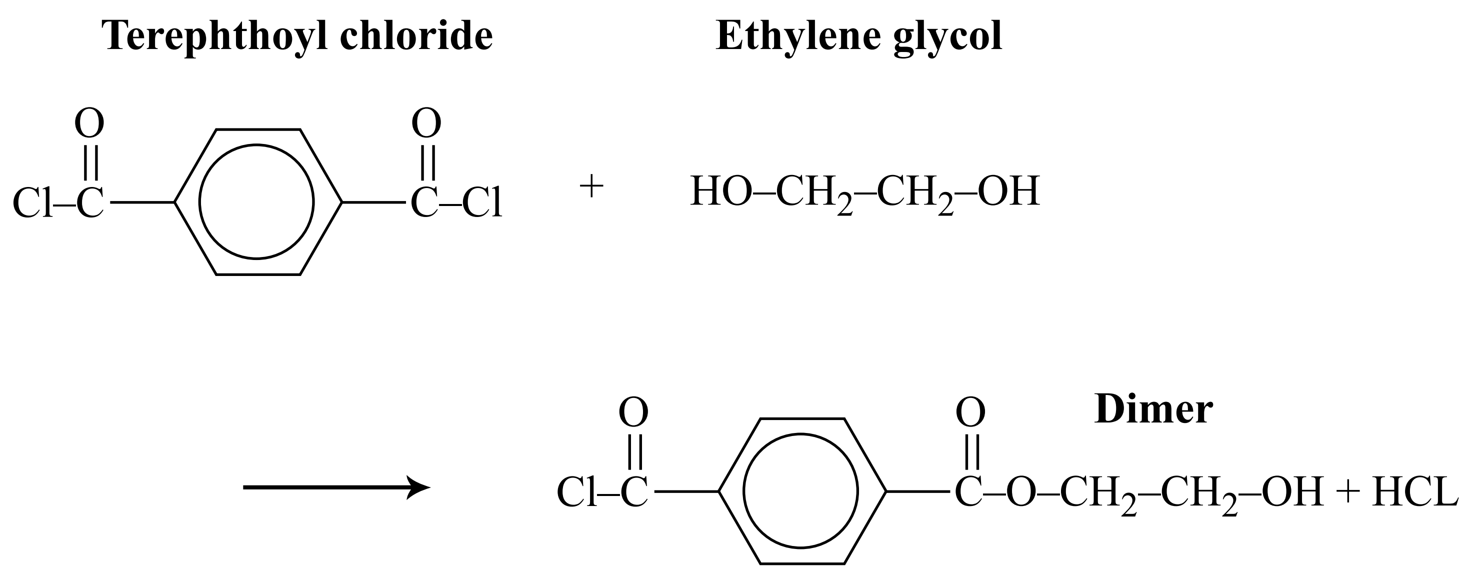


Figure by MIT OCW.

Step growth



Terephthoyl chloride and ethylene glycol react to form an ester dimer.

Figure by MIT OCW.