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

Pair correlation function: water

Courtesy of Dr. J. Kolafa. Used with Permission.
3.012 Fundamentals of Materials Science: Bonding - Nicola Marzari (MIT, Fall 2005)
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)
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
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

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.

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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.
Step growth

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

Terephthoyl chloride

$$\text{Cl} - \text{C} - \text{O} - \text{C} - \text{Cl}$$

Ethylene glycol

$$\text{HO} - \text{CH}_2 - \text{CH}_2 - \text{OH}$$

Dimer

$$\text{Cl} - \text{C} - \text{O} - \text{C} - \text{O} - \text{CH}_2 - \text{CH}_2 - \text{OH} + \text{HCL}$$

Figure by MIT OCW.