Lecture 28, Apr 4, 2022

Optical Properties of Polymers

- Crystalline and amorphous regions in polymers have different optical properties
- In a crystalline polymer the mix of amorphous and crystalline regions scatter light, making the polymer translucent or opaque
- Polymers that don't crystallize (e.g. PMMA) are 100% amorphous, no light scattering results in transparency

Optical Properties

- The visible light range is approximately $\lambda = 400\text{nm}$ to $\lambda = 700\text{nm}$
- The photon energy is $E = \dfrac{hc}{\lambda} = 1.77\text{eV}$ for 700nm, and 3.1eV for 400nm

Bonding

- Ionic bonding (ionic solids): exchange of electrons
  - Example: NaCl with the rock salt structure
    * Using $E = \dfrac{q_1 q_2}{4\pi\varepsilon_0 r}$ we can calculate the energy by calculating the sum of an infinite series
    * 6 attractive neighbours at a distance of a away; 12 repulsive neighbours at a distance of $\sqrt{2}a$ away, etc
    * This series converges to $M\dfrac{e^2}{4\pi\varepsilon_0}\dfrac{1}{a}$ where M is the Madeluing constant
- Covalent bonding: sharing of electrons
  - When two atoms are brought together for covalent bonding, their electron wavefunctions overlap
  - In the anti symmetric combination, this is the *anti-bonding state*
    * There's a node exactly in the middle of the two wavefunctions
    * The node results in the two electron clouds being separated
  - In the symmetric configuration, it is called the *bonding state*
    * There is now a nonzero probability for electrons to be between the two atoms to facilitate bonding
  - The bonding state is at a lower energy than the two individual atoms, and the antibonding state is higher
  - Electrons go into this bonding state since it has lower energy, and this makes a bond
- Metallic bonding: cloud of free electrons holding together nuclei