

Polymer Notes

- ❖ Why are they useful/ when are they used?
 - Important Properties
 - chemically resistant
 - lightweight
 - tailorable: can easily alter optical & electrical properties, flexibility, strength, weight...
 - Sample Uses (see Table 15.3)
 - building materials, piping
 - manufacturing equipment, chemical delivery systems
 - lightweight aerospace uses
 - sporting goods
- ❖ Review what we already know
 - Hydrocarbon molecules, C-C bonding
 - Monomers that contain double or triple C bonds
 - an initiator species comes along (has an unsatisfied bond)
 - it breaks the double bond in the monomer, joining the two together
 - the unsatisfied bond is passed on to the outside of the monomer
 - it attaches to another monomer and so on
 - Chains can also interact with one another- crosslinking
- ❖ Polymer chains
 - As the monomers link up, they form polymer chains
 - Monomer species type in the chain
 - the properties of the polymers obviously depend on the properties of the monomer it is made out of
 - see Table 14.3 for a table of common monomers & their properties & uses
 - Monomers in a polymer may vary- copolymer is made up of 2 or more monomer types
 - random
 - alternating-monomer types alternate
 - block-identical monomer types come in clumps

- example: styrene-butadiene-styrene: SBS rubber (used in sneakers)
 - styrene strong: butadiene rubbery
 - graft- different monomer types are branches off chain
 - example: HIPS: high impact polystyrene- chain of polystyrene with butadiene grafted on it
- ❖ Sidegroup configurations within the chains
- Sidegroups, usually denoted R, are added to monomers to tailor the desired property of the polymer
 - How the polymer behaves depends not only on the type but the placement of these sidegroups
 - Stereoisomerism: monomers are linked together in same order: head to tail (where head is defined by placement of R in a certain location)
 - isotactic: R all on the same side of the chain
 - syndiotactic: R alternates sides of the chain
 - atactic: side that R is on is random
 - Importance
 - isotactic & syndiotactic can be packed into crystals & fibers easier
 - Geometrical isomers: placement of sidegroups around a double C bond
 - cis: on same side
 - trans: on opposite side
 - configuration affects density, interactions between chains, and crystallinity
- ❖ Molecular weight
- What's a "molecule"?, What they are trying to weigh is actually the chain
 - this varies because chains vary in size in a polymer (made up of differing number of monomers depending on when they started growing, how many free monomers they encountered)
 - Several different ways to define molecular weight: example is number average molecular weight: $M_n = \sum x_i M_i$
 - molecular weight has a big influence on properties

- greater intermolecular forces (which give polymers strength)- polyethylene has only secondary (Van der Waals) bonding between chains) but is used to make bullet proof vests!
- increase viscosity- bulky groups move past each other slower
- ❖ Chain interactions, shape
 - linear: "straight" chains- this just means it has no branches, forks- it can bend, twist, or kink...
 - twisted chains increase interaction with neighboring chains: tangled in a network that is harder to pull apart
 - branched- forks- monomers bonded on three rather than two sides
 - lowers interactions between chains by secondary forces (chains are further apart)
 - can therefore lower tensile strength of bulk polymer
 - lower density
 - difference between HDPE (high density polyethylene) and LDPE (low density) is that the HDPE is straight and LDPE is branched
 - LDPE has lower tensile strength but greater ductility
 - crosslinked, networked- links to other chains
 - chains are "locked" into position by interactions with other chains
 - increases strength of polymer, lowers ductility
 - crystallinity- the chains can begin to order in a fashion similar to metals- though they typically never obtain 100% crystal order
- ❖ Polymer Types
 - Thermoplastics
 - require heat to make them & form them into shape
 - can be reheated & reformed a number of times without altering their properties significantly
 - Thermosets
 - are set by chemical reaction into a permanent shape
 - can not be reset- heating causes chemical degradation of the material