Properties of Materials

CHAPTER 6:

Polymers: Introduction

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Introduction

- Aims
  - To make aware about polymers, their types and characteristics….
- Expected Outcomes
  - Identify the polymer families
  - Distinguish different engineering thermoplastics…..
- Other related Information
- References

- Kenneth G Budinsky & Michael G Biddinsky, Engineering Materials: Properties and Selection, Ed 9, Prentice Hall

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Polymers

- Polymers are long chain of repeating molecules based on element carbon
- Polymers have their origin in nature. Natural polymers have been around since beginning of life.
- Applications: Machines, packaging, appliances, automobiles

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Polymers

- Polymers are high molecular weight molecule which are made up of a small repeat unit (monomer).
- Monomers can be defined as compounds with low molecular weight that after connecting together form polymers
- Oligomers are nothing but the short polymer chain
- Copolymer are made up of two or more monomers
  - Random copolymer: X-Y-X-X-Y-Y-Y-Y-Y-X-X-X
  - Alternating copolymer: X-Y-X-Y-X-Y-X-Y-X-Y
  - Block copolymer: X-X-X-X-X-X-Y-Y-Y-Y-Y-Y

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Types of Polymers

- Polymers are classified as Thermosets and Thermoplastics
  - Thermoset are cross-linked polymer which cannot be melted (e.g. rubber bands, tyres)
  - Thermoplastic are plastics which can be melted
  - Elastomers are Polymers that when stretched, the original form is obtained after release. They are mostly thermoset polymers
  - Thermoplastic elastomers: Are elastic polymers that can be melted (e.g soles of tennis shoes)

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Polymer Synthesis

- Polymer synthesis is the polymer formation mechanism. The two major types of this are
  - Addition polymerization: The polymer grows by sequential addition of monomers to a reactive site
    - In this there is a linear chain growth.
    - Maximum molecular weight is obtained early in the reaction
  - Step-Growth polymerization: In this the monomers react with each other to make small oligomers. Small oligomers form bigger ones, and big oligomers react to make polymers.
    - Exponential Chain growth is observed
    - Later in the reaction Maximum molecular weight is obtained .

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Amorphous Polymers

- Polymers in the solid state may have either predominantly amorphous structure or a semi-crystalline structure
- Thermoplastics with extensive chain branching' large pendant groups tend to favor an amorphous structure
- Thermosetting polymers are amorphous because the cross linking inhibits crystallization
- Thermoplastic and thermosetting amorphous polymers exhibit glass transition temperature
- The glass transition temperature is defined as the temperature, upon heating or cooling, at which the molecules of an amorphous polymers reversibly change their mobility such that above this temperature it behaves like a rubbery substance and below Tg it behaves glassy substance more rigidity is observed.
- Mechanical properties of amorphous polymers degrade significantly near Tg
- Amorphous thermoplastics melt or liquefy over an extended temperature range whereas thermosetting polymers do not melt but will degrade above Tg

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Semi Crystalline Polymers

- Polymers with long slender aliphatic chains tend to crystallize
- Semi-crystalline polymers show a defined melting temperature ™
- Most crystalline polymers have some percentage of amorphous polymers
- A Tg may be detected for the amorphous phase present in crystalline polymer
- The amorphous phase present in crystalline polymer can have profound effects on the polymer's mechanical properties

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Additives

- Additives improve mechanical properties, thermal processing, surface characteristics, chemical properties as well as appearance.

Additive types

- Modify Mechanical property
- Modify Surface property
- Modify Chemical property
- Modify Processing modifier
- Modify Aesthetic property

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