ENGG2120 Fall 2011
Chapter 15 Assignment with Answers

1. What are the factors that increase chain stiffness of thermoplastic polymer?

Answer:

The factors that increase chain stiffness of thermoplastic polymer are
1. Bulky side groups
2. Polar groups or side groups
3. Double bonds or aromatic chain groups

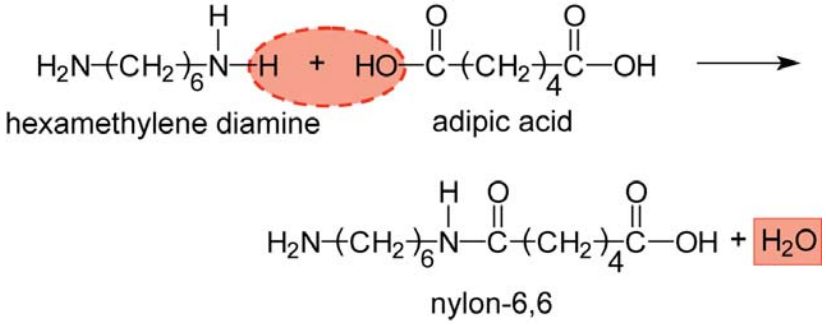
2. What is condensation polymerization and give an example?

Answer:

Condensation (or step reaction) polymerization

Condensation (or *step reaction*) **polymerization** is the formation of polymers by stepwise intermolecular chemical reactions that may involve some time more than one monomer species with release of a small molecule such as water, ethanol etc.

Example:



3. Write down **major** differences between thermoplastic and thermoset polymers

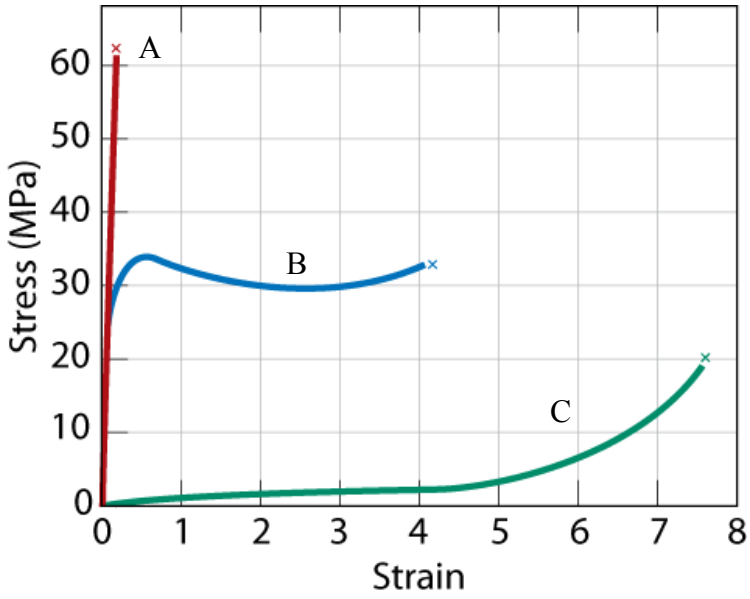
Answer:

Differences between thermoplastic and thermoset polymers

S. No	Thermoplastic	Thermoset
1	Little or no crosslinking	Large crosslinking
2	Ductile	Hard and brittle
3	Soften while heating	Do not soften while heating

4. Explain the stress–strain behaviour of brittle, plastic, and highly elastic (elastomeric) polymers.

Answer:



Three typically different types of stress–strain behaviour are found for polymeric materials, as represented in above figure

Curve *A* illustrates the stress–strain character for a brittle polymer, inasmuch as it fractures while deforming elastically. The behavior for a plastic material, curve *B*, is similar to that for many metallic materials; the initial deformation is elastic, which is followed by yielding and a region of plastic deformation. Finally, the deformation displayed by curve *C* is totally elastic; this rubber-like elasticity (large recoverable strains produced at low stress levels) is displayed by a class of polymers termed the elastomers.

5. Define T_m and T_g of a thermoplastic polymer.

Answer:

Melting temperature (T_m): The melting of a polymer crystal corresponds to the transformation of a solid material, having an ordered structure of aligned molecular chains, to a viscous liquid in which the structure is highly random. This phenomenon occurs, upon heating, at the melting temperature T_m

Glass transition temperature (T_g): The temperature at which the polymer experiences the transition from rubbery to rigid states is termed the glass transition temperature

6. Briefly explain how molecular weight and degree of crystallinity of semi crystalline polymer influences tensile strength of polymers.

Answer:

Tensile strength increases with increasing molecular weight. Mathematically tensile strength is the function of number average molecular weight and it can be expressed as

$$TS = TS_{\infty} - \frac{A}{M_n}$$

Where TS_{∞} is the tensile strength at infinite molecular weight and A is the constant

Degrees of crystallinity influences tensile strength positively. Increasing the crystallinity of polymer enhances the tensile strength.

7. Contrast compression and injection techniques that are used to form plastic materials.

Answer:

For compression molding, both heat and pressure are applied after the polymer and necessary additives are situated between the mold members. And, for injection molding (normally used for thermoplastic materials), the raw materials are impelled by a ram through a heating chamber, and finally into the die cavity.

8. a) What is the effect of heat treatment on semicrystalline polymers?
b) What happens when annealing temperature is increased for undrawn materials that are subjected to constant-time heat treatment?

Answer:

a) Heat treating of semicrystalline polymers leads to increase in the percent crystallinty, and crystal size and perfection and it also modifies the spherulite structures.

b) Increasing annealing temperature for undrawn materials that are subjected to constant-time heat treatment will lead to the following: (1) increase in yield strength (2) increase in tensile modulus and (3) a reduction in ductility.

9. State True or False
Regularity affects T_g of the polymer.

(_____)

Answer:
False, it affects T_m

10. Name any five types of polymer additives.

Answer:

Well known polymer additives are as follows:

1. Fillers
2. Plasticisers
3. Stabilizers
4. Lubricants
5. Colorants
6. Flame retardants

11. Which type of processing method is generally adopted to prepare plastic bottles?

Answer:

Injection blow molding

12. Cite four factors that determine what fabrication technique are used to form polymeric materials.

Answer:

Four factors that determine what fabrication technique is used to form polymeric materials are:
(1) Whether the polymer is thermoplastic or thermosetting
(2) If thermoplastic, the softening temperature
(3) Atmospheric stability
(4) The geometry and size of the finished product

13. For thermoplastic polymers, cite five factors that favor brittle fracture.

Answer:

For thermoplastic polymers, five factors that favor brittle fracture are as follows: (1) a reduction in temperature, (2) an increase in strain rate, (3) the presence of a sharp notch, (4) increased specimen thickness, and (5) modifications of the polymer structure.

14. Briefly explain how each of the following influences the tensile modulus of a semicrystalline polymer and why:

(a) Molecular weight
(b) Degree of crystallinity
(c) Deformation by drawing
(d) Annealing of an undeformed material
(e) Annealing of a drawn material

Answer:

(a) The tensile modulus is not directly influenced by a polymer's molecular weight.

(b) Tensile modulus increases with increasing degree of crystallinity for semicrystalline polymers. This is due to enhanced secondary interchain bonding which results from adjacent aligned chain segments as percent crystallinity increases. This enhanced interchain bonding inhibits relative interchain motion.

(c) Deformation by drawing also increases the tensile modulus. The reason for this is that drawing produces a highly oriented molecular structure, and a relatively high degree of interchain secondary bonding.

(d) When an undeformed semicrystalline polymer is annealed below its melting temperature, the tensile modulus increases.

(e) A drawn semicrystalline polymer that is annealed experiences a decrease in tensile modulus as a result of a reduction in chain-induced crystallinity, and a reduction in interchain bonding forces.

15. Cite the primary differences between addition and condensation polymerization techniques.

Answer:

For addition polymerization, the reactant species have the same chemical composition as the monomer species in the molecular chain. This is not the case for condensation polymerization, wherein there is a chemical reaction between two or more monomer species, producing the repeating unit. There is often a low molecular weight by-product for condensation polymerization; such is not found for addition polymerization.

16. Why fiber materials that are melt spun and then drawn must be thermoplastic? Cite two reasons.

Answer:

Fiber materials that are melt spun must be thermoplastic because: (1) In order to be melt spun, they must be capable of forming a viscous liquid when heated, which is not possible for thermosets. (2) During drawing, mechanical elongation is required; in as much as thermosetting materials are, in general, hard and relatively brittle, they are not easily elongated.