Chapter 5 Homework: Polymer and Polymer Composite Processing

Due: 10/28/24

Available Points: 50

1. **What is the definition of a composite material? List and explain the <u>two classifications</u> of a composite. Give an example of each classification. (5 points)**

A composite is a heterogeneous substance consisting of two or more consolidated materials that does not lose the characteristics of each component. The two classifications are reinforced polymer composites made with fibrous materials; and filled polymers: A polymer composite made with particulate fillers. An example of a reinforced polymer is fiberglass reinforced polyester. An example of a filled polymer composite is clay-filled polyethylene.

Slides 79 & 80

2. **Name 7 advantages of composite materials. (7 points)**

1) Reinforcement of the resin resulting in increased tensile, flexural, compression, and impact strength, rigidity, and combinations of these
2) Increased size stability
3) Improved fire retardancy
4) Corrosion protection
5) Improved electrical properties, reduction of dielectric constant
6) Coloring
7) Improved processability; controlled viscosities, good mixing, and controlled orientation of fibers.

3. **Is the following material a composite? Yes or No? (9 points)** Consolidated, Heterogeneous Mixture

a. Rigid-rod polymers molecularly dispersed in PMMA Yes
b. Blend of two miscible polymers No
c. Phase-separated diblock copolymer No
d. Tire made of carbon black and polybutadiene Yes
e. Cotton fiber consolidated by phenol resin Yes
f. Sugar/Water mixture No
g. Mica and polyethylene powder mixture No
h. Bullet proof jacket made of liquid crystal molecule, Kevlar No
i. Consolidated two immiscible polymers No

4. **True or False? <u>Correct the false statements.</u> (4 points)**
   a. A ~~roving~~ Extender is a type of filler that is used to reduce the amount of plastic required and provides almost no reinforcement effect. False, this describes an extender
   b. Nanofillers that achieve effective dispersion are more efficient than traditional fillers at improving polymer properties. True, small amt reinforcement → significant property improvement
   c. The hierarchy of reinforcing fibers from thinnest to thickest is filament < strand < roving. True
      bundled filaments a type of strands
   d. A polymer is considered an engineering plastic if its mechanical properties are maintained around ~~200°C~~ 150°C. False, this is almost super engineering plastic, engineering plastics are around 150°C.

5. **Give one example of a naturally occurring composite, mineral filler, and synthetic fiber. Explain the usefulness of mineral fillers and synthetic fibers for composite preparation. (4 points)**

Naturally occuring composite: Tendon, bone, bamboo, wood
Mineral fillers: Silica, mica, calcium carbonate
Synthetic fibers: Glass fibers and carbon fibers
Mineral fillers are useful as they help reduce cost, can improve processability, they can improve mechanical and thermal properties, and can reduce density.
Synthetic fibers are useful for improving strength/stiffness, durability, and the creation of strong but lightweight composites.

The following list contains all the processes that could be answers to the following questions

- Injection Molding ✓
- Transfer Molding
- Vacuum Assisted Transfer Molding
- Extrusion
- Pultrusion
- Filament Winding ✓
- Hand Lay-Up ✓
- Spray-Up
- Compression Molding ✓
- Resin Transfer Molding
- Reaction Injection Molding ✓

6. **What process does each description characterize? (7 points)**
   a. Laying down fabrics made of reinforcement fibers and then painting the matrix resin layer by layer Hand Lay-Up

   b. Uses a hydraulic press to form the composite into shape Compression molding

   c. The closed mold composite processing method that allows manufacturing of a very large object Resin Transfer Molding / VARTM

   d. Fiber/resin mixture is fed into the hopper and transferred into a heated barrel, screws rotate to apply a high shear process and molten resin is pushed forward and injected with a high pressure into the mold cavity through the runner and gate Extrusion

   e. A bundle of fiber rovings are passed through a wet resin bath, squeezed into a desired shape, passed through a heated die, and cured into a final composite Pultrusion

   f. The processing technique that offers the shortest cycle time Reaction Injection Molding

   g. Resin-wet rovings are wound around a mandrel, and the mandrel is cured to a solid composite Filament Winding

7. **Which of these processes are highly automated? Circle 3. (3 points)**
   a. Hand Lay-up
   b. Transfer Molding
   c. Pultrusion
   d. Filament Winding
   e. RIM
   f. Extrusion

8. **Which of these processes can be used for nanocomposite processing? Circle 3. (3 points)**
   a. Spray-Up
   b. Compression Molding
   c. Injection Molding
   d. Transfer Molding
   e. Extrusion
   f. Pultrusion

9. **You are asked to manufacture the following products. Choose one technique to use. (5 points)**
   a. A life size statue of yourself.
      Spray-up molding
   b. An arrow used for archery.
      Pultrusion
   c. HDPE pipe (5 cm diameter, 250 m long)
      Extrusion
   d. A high-pressure railway tank car
      Filament winding
   e. A latest design snowmobile
      Reaction Injection Molding

Multiple Choice. Select a processing method based on each of the desired properties (3 points)

10. **The composite processing technique suitable for the highest strength composites**
    a. Compression Molding
    b. Filament Winding
    c. Pultrusion
    d. Injection Molding

11. The processing method for the most versatile design flexibility of the mold shape using continuous fiber reinforcement

a. Hand-Lay Up
b. Pultrusion
c. Thermoforming
d. Extrusion

12. Best method for processing a very intricate shaped object with a thermoplastic polymer.

a. Compression Molding
b. Spray-Up Molding
c. Pultrusion
d. Injection Molding