

MS/Ph.D. Qualifying Examination

Department of BCPS

Subject: Polymer Chemistry

Date: October 31, 2003

Time: 9 AM-12 AM

CLOSED BOOK

Instruction: There are THREE sections. You must use separate BLUE BOOK for each section. Write section number and question number on the cover of each blue book.

SECTION-1

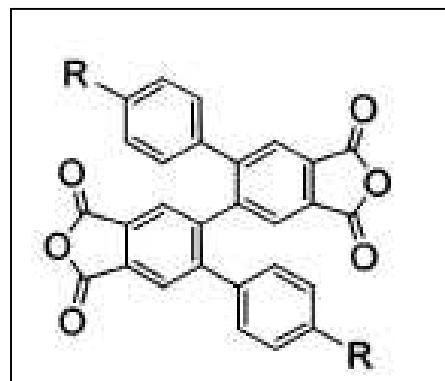
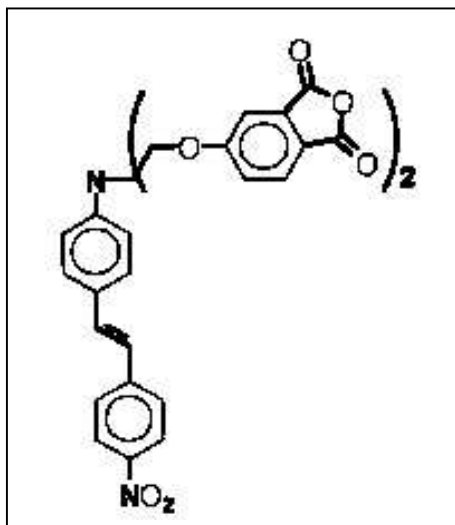
General Polymer Chemistry

1. Polystyrene homopolymer has a $T_g = 100^\circ\text{C}$, and polybutadiene has a $T_g = -90^\circ\text{C}$. Estimate the T_g of a 50/50 w/w statistical copolymer, poly(styrene-*stat*-butadiene).
2. Explain and illustrate an isotactic, a syndiotactic, and an atactic polymer.
3. What variables affect the solubility of a polymer?
4. How may the molecular weight be maximized in condensation polymerizations?
5. Predict the polymer formed from the ring opening polymerization of each. (a) Lactone (b) Lactam (c) Cyclic ether.
6. Compare condensation (step) polymerization to free-radical (addition) polymerization.
7. Ladder polymers are those in which two parallel polymer chains are connected at frequent and generally regular intervals by short chains acting as rungs. Name two common ladder polymers.
8. What are the two major structural requirements for a crystalline polymer?
9. Describe the following three behaviors by sketching the log of the shear stress versus the log of the shear rate. (a) Newtonian (b) Dilatant (c) Pseudoplastic.
10. Draw a typical stress-strain curve of a polymer and indicate each of the following of this curve. (a) Tensile strength (b) Elongation (c) Yield point (d) Modulus.

SECTION-2

Polymer Synthesis

- Carefully examine the following two monomers and answer separately the following questions for each:
 - Synthesize each monomer starting from any compounds containing no more than EIGHT carbon atoms.
 - You choose another suitable monomer to copolymerize these monomers. Suggest an application of the resulting polymers.



$\text{R} = \text{CH}_3$

SECTION-3

Polymer Characterization and Analysis

1. Draw a typical molecular weight distribution curve and label each of the following molecular weights: (a) Number-average molecular weight (b) Weight-average molecular weight (c) Viscosity-average molecular weight. Also write mathematical expressions for these molecular weights.
2. Describe the ratio of M_w/M_n for each of the following: (a) Polycondensation (b) Free-radical polymerization (c) Anionic polymerization.
3. Define the first and second order phase transitions and give one experimental method to differentiate between.
4. If you have a semi-crystalline polymer, what are two methods for measuring the degree of crystallinity?
5. If you are given three samples of polypropylene, one isotactic, one syndiotactic and one atactic, how could differential thermal analysis (DTA) be used to identify each of these samples?
6. Draw a typical diagram obtained from a differential scanning calorimeter (DSC) experiment on a polymer. Explain the diagram indicating what thermal and structural properties may be obtained from this diagram.
7. What is measured in thermogravimetric analysis, TGA? What information is obtained about the polymers?