

**NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY**

**DEPARTMENT OF TEXTILE TECHNOLOGY**

**END OF SECOND SEMESTER EXAMINATIONS – MAY 2011**

**TXT 1204 - POLYMER SCIENCE**

**TIME: 3 HOURS**

**TOTAL MARKS: 100**

**INSTRUCTIONS**

1. Answer **ANY FIVE** questions. Each question carries **20 marks**.
2. The first fifteen minutes should be spent reading the question paper and making notes.
3. Do not open your answer sheet until told to do so.
4. Marks will be awarded for skill in appreciating the scope of questions, clarity of argument and conciseness of presentation as well as for the knowledge displayed by

**QUESTION 1**

Polymer properties are dependent on a variety of factors. Fully justify this statement citing relevant examples. **(20)**

**QUESTION 2**

- (a). Draw three dimensional formulae to show isotactic and atactic forms of polyvinyl chloride (pvc). **(2)**
- (b). How will isotactic and atactic forms of PVC differ in their:
  - i. hardness and rigidity.
  - ii. resistance to heat. **(4)**
- (c). Explain your answers in (b) above in terms of intermolecular forces. **(4)**
- (d). Differentiate between step-growth polymerization and chain growth polymerization. Give one example of each. **(10)**

### **QUESTION 3**

- (a).
- i. Polyethene, PVC, polystyrene, polyacrylonitrile, PFTE, and natural rubber are examples of chain growth polymers. For each, give the structure of its monomer and polymer. (5)
  - ii. Nylon 6, Nylon 6.6, polyester, nomex , urea formaldehyde are examples of step growth polymers. For each, give the structure of its monomer and polymer. (5)
- (b). Taking styrene as an example, write chemical equations for the initiation, propagation, and termination steps involved in anionic polymerization of this monomer. (10)

### **QUESTION 4**

- (a). Bakelite is a polymer produced by heating a phenol and an aldehyde used for making electrical sockets and plugs. So too can polyester, polycarbonate, and acrylonitrile butadiene styrene (ABS). Explain the difference between Bakelite and these other materials. (4)
- (b). Acrylic fibre is often used for furnishing fabric or as a substitute for wool in sweaters.  
Write a balanced equation for its polymerization. Indicate what type of polymerization this is. (6)
- (c). What do you understand by  $T_g$  and  $T_m$  ? Explain how knowledge of these is helpful in understanding polymer properties relating to textile applications. (10)

### **QUESTION 5**

- a. Explain, giving one suitable example, the meaning of the each of the following terms:
- i. Monomer.
  - ii. Polymer.
  - iii. Macromolecule.
  - iv. Graft polymer. (4)
- b. Explain the following terms related to disposal of plastics.
- i. Biodegradable.
  - ii. Photodegradable.

iii. Water soluble. (9)

c. List seven (7) methods that may be used in characterizing polymer materials. (7)

### **QUESTION 6**

Kevlar is a polyamide made by Du Pont. It has some remarkable properties of melting, fire resistance, and a much higher tensile strength than steel.

- (a). Draw the structure of the two monomers required to make kevlar. Write a balanced equation for the reaction of the formation of Kevlar. Show and label the repeat unit in Kevlar. (6)
- (b). State the uses of Kevlar. (2)
- (c). Comment on the reasons for the suitability of Kevlar in the answers you have given for question (b) above in terms of molecular forces involved. (2)
- (d). List ways/tools and procedures that are commonly used for the characterization of polymers. (6)
- (e). What differentiates elastomers from other polymers? Give two examples of elastomers, one natural and the other synthetic. (4)

### **QUESTION 7**

- (a). Hand and aesthetic properties of textiles can be enhanced during finishing using some polymers. Discuss polymers, clearly stating relevant examples. (10)
- (b). What do you understand by the term degree of polymerization? (2)
- (c). Given that a polymer has a repeat unit of mass 104 and molar mass of 100000 g/mol, calculate the degree of polymerization. (8)

**END OF EXAMINATION QUESTION PAPER**