******

***Soran University-Faculty of Science-Chemistry Department***

**Programme for 3rd year Chemistry**

**Subject: Polymer Chemistry**

**Course Code:**

**Contact hours a week: 2 hours theoretical; 3 hours practical**

**Total Credit: 3 units**

**Academic year 2014-2015**

**Designed by: Dr.Fawzi Habeeb Jabrail**

**1.Introduction to polymeric materials**

1.1 Definitions

1.1.1 polymer ; Monomer; Copolymer; Terpolymer; Repeat unit ;

CRU ; Degree of polymerization

1.2 Polymer Structure

1.2.1 Polymer Architecture

1.2.1.1 Liner ; Branch ; Cross-link and Network Polymer

Chains

1.2.2 Chain Length

1.2.2.1 Degree of Polymerization ; Monodisperse Polymer ;

Polydisperse Polymer : Polydispersity Index

1.2.3 Monomer Arrangement in Coppolymers

1.2.3.1 Homo ; Alternate ; Periodic ; Statistical ; Block ;

And Graft Copolymers

1.2.4 Tacticity

1.2.4.1 Isotactic ; Syndiotactic ; Atactic and Eutactic Polymers

1.2.5 Crystallinity

1.2.5.1 Crystallization Mechanisms ; Degree of Crystallinity ;

Amorphousity

1.2.6 Mechanical Properties

1.2.6.1 Tensile Strength ; Young"s Modulus of Elasticity

1.2.7 Phase Behavior (thermal properties )

1.2.7.1 Thermoplastic and Thermosetting Polymers ; Melting

Point ;Softening point ;Glass transition temperature Tg

**2. Polymer Synthesis**

2.1 Introduction

2.2 Addition ( Chain – growth ) Polymerization

Radical ; Anionic ; Cationic and Coordination Polymerization

2.2.1 Free Radical Polymerization

2.2.1.1 Mechanism of Free Radical Polymerization

2.2.1.1.1 Initiation

2.2.1.1.2 Types of Initiation and the Initiators

2.2.1.1.3 Initiator Efficiency

2.2.1.1.4 Propagation

2.2.1.1.5 Termination

2.2.1.1.6 Chain Transfer

2.2.1.2 Methods of Radical Polymerization

2.2.1.2.1 Bulk ; Solution ; Suspension and Emulsion

polymerization

2.2.1.3 Controlled Radical Polymerization (CRP)

2.2.1.4 Kinetics

2.2.1.5 Thermodynamics

2.2.2 Anionic Polymerization

2.2.2.1 Initiation

2.2.2.1.1 Initiation by Electron Transfer

2.2.2.1.2 Initiation by Strong Anions

2.2.2.2 Propagation

2.2.2.3 Termination

2.2.2.4 Living Anionic Polymerization

2.2.2.5 Kinetics

2.2.3 Cationic Polymerization

2.2.3.1 Initiation

2.2.3.1.1 Classical Protonic Acids

2.2.3.1.2 Lewis Acids / Friedel-Crafts Catalysts

2.2.3.1.3 Carbenium Ion Salts

2.2.3.1.4 Ionizing Radiation

2.2.3.2 Propagation

2.2.3.2.1 Effect of Temperature

2.2.3.2.2 Effect of Solvent and Counterion

2.2.3.3 Termination

2.2.3.3.1 Chain Transfer

2.2.3.4 Cationic Ring-opening Polymerization

2.2.3.5 Kinetics

2.2.3.6 Living Polymerization

2.2.3.7 Some Important Addition Polymer Examples

2.2.4 Coordination Polymerization

2.2.4.1 Ziegler-Natta Catalyst

2.2.4.2 Mechanism of Ziegler-Natta Polymerization

2.3 Condensation (Step-growth) polymerization

2.3.1 Branched Polymers

2.3.2 Mechanism of Condensation Polymerization

2.3.2.1 Reaction of Carboxylic Acid Monomer and an Amine

Monomer

2.3.2.2 Reaction of Carboxylic Acid monomer and an Alcohol

Monomer

2.3.3 Differences Between Step-growth and Chain-growth polyme-

-rization

2.3.4 Classes of Step-growth Polymerization

2.3.5 Kinetics

2.3.5.1. Self-Catalyzed Polyesterification

2.3.5.2 External Catalyzed Polyesterification

2.3.6 Self Condensation

2.3.7 Some Important Condensation polymer Examples

2.4 Copolymer

2.4.1 Types of Copolymers

2.4.2 Copolymer Equation

**3. IUPAC Polymer Nomenclature**

3.1 Source- based Nomenclature

3.1.1 Homopolymers

3.1.2 Copolymers

3.1.3 Non-linear Polymers

3.2 Structure-based Nomenclature

***Objective:***

**The practical works**

**The practical works aim:**

**Learning Outcomes**

**Practical skills**

|  |  |
| --- | --- |
| ***Experiments*** | |
| 1 | Part (1):Thermal degradation of polymer (polystyrene) |
| 1 | Part(2):Preparation of polystyrene by addition  polymerization (free radical) |
| 2 | The sequential precipitation of polymers and molecular  weight appointment |
| 3 | Viscosity-Average Molecular Weight |
| 4 | Preparation of polyester by condensation polymerization |
| 5 | Vinyl Monomer Polymerization |
| 6 | Preparation of Urea-Formaldehyde resin |
| 7 | Emulsion polymerization of Acrylonitrile |
| 8 | Identification of polymers |
| 9 | Preparation of synthetic rubber (Thiokol) |
| 10 | Preparation of Rayon |
|  | References |

**Assessment**

**Midterm:**

**Two Midterm exams for theoretical: 2 x 10%**

**Homework and Quizzes: 5%**

**One Practical exam: 15%**

**Total Mark: 40%**

**Final Exam:**

**One final written exam for theoretical: 40%**

**One final Written/practical for practical exam: 15%**

**Total Mark: 60%**