

CONTENTS

Chapter I : Fundamental Concepts of Polymers	
I.1. Introduction	1
I.2. Historical	1
I.3. Definition	2
I.4. Polymer Nomenclature	3
I.5. Classification of Polymers	4
I.6. Classification of Polymers by Chemical Nature	4
I.7. According to the chain structure	4
a) Linear arrangement	5
1. Linear and one-dimensional polymers	5
2. Two-dimensional polymers	5
3. Three-dimensional polymers	6
b) Non-linear arrangement	6
1. Star polymer	6
2. Dendritic Polymers	7
3. Branched polymer	8
4. Crosslinked polymers	9
I.8. According to the number of motifs	9
I.8.1. Homopolymers	9
I.8.2. Copolymers	10
I.9. According to their origin	10
I.9.1. Natural polymers	10
I.9.2. Artificial (or regenerated) polymers	11
I.9.3. Synthetic polymers	11
I.10. According to thermal behavior	11
I.10.1. Thermoplastic	11
I.10.2. Thermodurcissable	12
I.10.3. Elastomers	12
I.10.4. Thermoplastic elastomers	13

I.11. According to technological uses	13
I.12. According to economic importance	13
I.13. According to use	14
I.14. According to lifecycle	14
I.15. Configuration isomerism	14
a) Tacticity	14
b) Cis-trans isomerism	15
I.16. Amorphous and crystalline polymer arrangement	16
I.16.1. Amorphous polymers	16
I.16.2. Crystalline polymers	16
I.17. Applications of polymers	18
Chapter II: Polymer synthesis methods	
II.1. Introduction	20
II.2. Step-growth polymerization	20
II.2.1. Polycondensation	20
II.2.2. Polyaddition	26
II.3. Chain Polymerization	27
II.3.1. Generalities	27
II.3.2. Radical Polymerization	28
II.3.2.1. Initiation	28
II.3.2.2. Propagation	30
II.3.2.3. Termination	30
II.4. Radical Polymerization Kinetics	33
II.5. Cationic Polymerization	36
II.5.1. Kinetics	37
II.6. Anionic polymerization	38
II.6.1. Kinetics	40
Chapter III: Characterization of macromolecules and behavior in solution	
II.7. Heterogeneous polymerization	41
III.1. Introduction	43

III.2. Average molecular weights of polymers	43
III.2.1. Average number molecular weight (\bar{M}_n)	43
III.2.2. Weight average molecular weight (\bar{M}_w)	44
III.2.3. Viscometric average molecular weight (\bar{M}_v)	44
III.2.4. Z-average molar mass (M_z)	45
III.2.5. Measurement	45
III.2.6. Degree of polymerization	46
III.2.7. Polydispersity index (PDI)	47
III.2.8. Techniques for determining average molar mass	47
III.3. Behavior in solution	48
III.3.1. Solvation	48
III.3.2. Flory-Huggins theory	49
III.3.3. The hydrodynamic volume of a polymer	50
III.3.4. calculated of hydrodynamic volume	52
III.4. The viscosity of a polymer	53
III.4.1. Measure the viscosity of a polymer	54
III.4.1.1. Intrinsic viscosity calculation	54
III.4.1.2. Viscosity calculation from concentration	54
III.4.1.3. Viscosity calculation from temperature	54
III.5. Structural analysis of polymers	55
III.5.1. UV-Visible spectroscopy	55
III.5.2. Infrared Spectroscopy (IR)	56
III.5.2.1. IR spectroscopy	56
III.5.3. Nuclear Magnetic Resonance Spectroscopy (NMR)	56
III.5.3.1. NMR	57
III.5.4. X-Ray Diffraction (XRD)	57
III.5.4.1. Interpret peaks	58
III.5.5. Raman Spectroscopy	58
III.5.5.1. Interpretation of Raman Spectra	59
III.6. Scanning Electron Microscopy (SEM)	60

III.7. Atomic Force Microscopy (AFM)	60
III.8. Differential Thermal Analysis (DTA)	61
III.8.1. Interpretation of DTA	62
III.9. Thermogravimetric Analysis (TGA)	63
III.9.1. Thermogravimetric Analysis interpretation	63
III.10. Differential Scanning Calorimetry (DSC)	64
III.10.1. Interpreting DSC results	65
III.11. Particle Size Analysis (PSA)	66
III.12. Size-exclusion chromatography (SEC)	67
Chapter IV: Thermal and mechanical behavior of polymers	
IV.1. Introduction	68
IV.2. Amorphous phase	68
IV.2.1 Amorphous phase in the rubbery state	69
IV.2.2 Amorphous phase in the glassy state	70
IV.2.3 Techniques d'analyse des polymères amorphes	70
IV.3. Phase crystalline	71
IV.3.1. Microstructure of the crystalline phase	71
IV.3.2 The crystalline network	71
IV.3.3 The crystalline lamellae:	72
IV.3.4. Determination of crystallinity	73
IV.3.4.1. By densimetry	73
IV.4. Semi-crystalline Polymers	75
IV.4.1. Crystalline Structure of Semi-Crystalline Polymers	75
IV.4.2. Properties of Semi-Crystalline Polymers	75
IV.4.3. Applications of Semi-Crystalline Polymers	75
IV.5. Thermal behavior: (glass transition)	76
IV.5.1. Glassy state	76
IV.5.2 Transition zone	77
IV.5.3 Rubber zone	77
IV.5.4 Fluid zone	78

IV.6. Viscoelasticity	78
IV.6.1 Viscoelastic Behavior of Polymers	79
IV.6.2 Mechanical Models	79
IV.6.3 Maxwell model	80
IV.7. Mechanical characterizations	81
IV.7.1 Tensile test	81
IV.7.2 Hardness test	83
IV.7.3 A loss of mass	84