

Contents

Series Preface	xi
Preface	xiii
Acronyms, Abbreviations and Symbols	xv
About the Author	xxi
1 Introduction	1
1.1 Introduction	1
1.2 History	3
1.3 Thermoplastics	4
1.4 Thermosets	11
1.5 Elastomers	15
1.6 High-Performance Polymers	17
1.7 Copolymers	20
1.8 Blends	22
1.9 Composites	23
1.10 Additives	24
1.11 Speciality Polymers	24
1.11.1 Liquid Crystalline Polymers	25
1.11.2 Conducting Polymers	25
1.11.3 Thermoplastic Elastomers	26
1.11.4 Biomedical Polymers	27
1.11.5 Biodegradable Polymers	28
References	28

2 Identification	31
2.1 Introduction	31
2.2 Preliminary Identification Methods	31
2.2.1 Solubility	32
2.2.2 Density	33
2.2.3 Behaviour on Heating	33
2.3 Infrared Spectroscopy	37
2.4 Raman Spectroscopy	41
2.5 Nuclear Magnetic Resonance Spectroscopy	46
2.6 Ultraviolet-Visible Spectroscopy	52
2.7 Differential Scanning Calorimetry	55
2.8 Mass Spectrometry	58
2.9 Chromatography	60
2.10 Emission Spectroscopy	64
References	68
3 Polymerization	71
3.1 Introduction	71
3.2 Chain Polymerization	72
3.2.1 Free-Radical Chain Polymerization	72
3.2.2 Ionic Chain Polymerization	75
3.2.3 Coordination Polymerization	78
3.2.4 Ring-Opening Polymerization	79
3.2.5 Practical Methods of Chain Polymerization	80
3.3 Step Polymerization	83
3.3.1 Statistics	83
3.3.2 Kinetics	84
3.4 Copolymerization	87
3.5 Cross-Linking	89
3.6 Dilatometry	90
3.7 Infrared Spectroscopy	92
3.8 Raman Spectroscopy	92
3.9 Nuclear Magnetic Resonance Spectroscopy	95
3.10 Differential Scanning Calorimetry	95
3.11 Electron Spin Resonance Spectroscopy	95
3.12 Refractometry	98
References	100

4	Molecular Weight	103
4.1	Introduction	103
4.2	Molecular Weight Calculations	104
4.3	Viscometry	106
4.4	Chromatography	108
4.5	Ultracentrifugation	112
4.6	Osmometry	113
4.7	Light Scattering	115
4.8	End-Group Analysis	116
4.9	Turbidimetric Titration	118
	References	119
5	Structure	121
5.1	Introduction	121
5.2	Isomerism	122
5.3	Chain Dimensions	124
5.4	Crystallinity	126
5.5	Orientation	132
5.6	Blends	134
5.7	Thermal Behaviour	135
5.8	Dilatometry	140
5.9	Infrared Spectroscopy	141
5.10	Raman Spectroscopy	148
5.11	Nuclear Magnetic Resonance Spectroscopy	149
5.12	Thermal Analysis	152
	5.12.1 Differential Scanning Calorimetry	152
	5.12.2 Thermal Mechanical Analysis	155
	5.12.3 Dynamic Mechanical Analysis	157
5.13	Optical Microscopy	161
5.14	Transmission Electron Microscopy	163
5.15	X-Ray Diffraction	164
5.16	Neutron Scattering	169
	References	170
6	Surface Properties	173
6.1	Introduction	173
6.2	Infrared Spectroscopy	174

6.2.1	Attenuated Total Reflectance Spectroscopy	174
6.2.2	Specular Reflectance Spectroscopy	176
6.2.3	Diffuse Reflectance Spectroscopy	176
6.2.4	Photoacoustic Spectroscopy	178
6.3	Raman Spectroscopy	178
6.4	Photoelectron Spectroscopy	178
6.5	Secondary-Ion Mass Spectrometry	182
6.6	Inverse Gas Chromatography	183
6.7	Scanning Electron Microscopy	185
6.8	Surface Tension	186
6.9	Atomic Force Microscopy	187
6.10	Tribology	188
	References	189
7	Degradation	191
7.1	Introduction	191
7.2	Oxidative Degradation	192
7.3	Thermal Degradation	193
7.4	Radiation Degradation	195
7.5	Combustion	195
7.6	Dissolution	196
7.7	Infrared Spectroscopy	198
7.8	Raman Spectroscopy	199
7.9	Electron Spin Resonance Spectroscopy	199
7.10	Thermal Analysis	201
	7.10.1 Thermogravimetric Analysis	201
	7.10.2 Differential Scanning Calorimetry	205
	7.10.3 Thermal Mechanical Analysis	205
7.11	Pyrolysis Gas Chromatography	207
	References	208
8	Mechanical Properties	209
8.1	Introduction	209
8.2	Stress-Strain Behaviour	210
8.3	Viscous Flow	213
8.4	Viscoelasticity	215
	8.4.1 Creep	215
	8.4.2 Models	217
	8.4.3 Stress Relaxation	220
8.5	Elasticity	222
8.6	Processing Methods	224
8.7	Tensile Testing	227

<i>Contents</i>	ix
8.8 Flexural Testing	229
8.9 Tear-Strength Testing	229
8.10 Fatigue Testing	230
8.11 Impact Testing	231
8.12 Hardness Testing	231
8.13 Viscometry	232
8.14 Dynamic Mechanical Analysis	233
References	235
Responses to Self-Assessment Questions	237
Bibliography	263
Glossary of Terms	265
Units of Measurement and Physical Constants	269
Periodic Table	273
Index	275