

CONTENTS

Part I SURFACE CHEMISTRY

1	INTRAMOLECULAR FORCES	3
1-1	General Introduction	3
1-2	Periodicity and Atomic Structure	6
1-3	Electronegativity and Bond Energy	15
1-4	Organic Molecules	22
1-5	Molecular Orbitals	27
1-6	Resonance Effects	33
1-7	Molar Properties	40
2	INTERMOLECULAR FORCES AND STRUCTURE	45
2-1	The Local Lattice	46
2-2	The Polymer Lattice	56
2-3	Hydrogen Bonding	64
2-4	Metallic Forces	70
2-5	The Balance of Intermolecular Forces	71
3	SOLUBILITY RELATIONSHIPS	84
3-1	Regular Solutions	84
3-2	High Polymer Solutions	99
3-3	Polymer Solubility Parameters	107
3-4	Cohesive Energy Density of Solvent Mixtures	108
4	SURFACES AND INTERFACES	117
4-1	Interfacial Thermodynamics	117
4-2	Surface Tension and Structure	121
4-3	Heat and Entropy of Surface Formation	131
4-4	Surface Tension of Binary Mixtures	137
4-5	Work of Adhesion	139
4-6	Wetting and Spreading Phenomena	143

5	SURFACE ENERGY CRITERIA OF ADHESION	149
5-1	Critical Surface Tension	149
5-2	Surface Tension of Polar and Nonpolar Solids	153
5-3	Criteria of Wetting and Adsorption	170
5-4	Criteria of Interdiffusion	175
5-5	Ionic-covalent Bonding Criteria	180

Part II RHEOLOGY

6	POLYMER STRUCTURE AND PROPERTIES	193
6-1	Conformations of a Linear Polymer Chain	193
6-2	Hindered Bond Rotation	197
6-3	Stereoregularity	199
6-4	Molecular Mechanisms of Relaxation	202
6-5	Thermal Transitions	206
6-6	Polymeric Adhesives	212
7	POLYMER PHYSICAL STATES	217
7-1	Lattice Properties at 0°K	217
7-2	Specific Heat Theory	222
7-3	Specific Heat Functions	232
7-4	Volume-Temperature-Pressure (V-T-P) Response	235
7-5	Internal Pressure of Polymers	246
7-6	Fractional Free Volume	248
8	LATTICE THEORY OF GLASS TRANSITION	255
8-1	Local Lattice Rearrangement	255
8-2	Internal Energy and Internal Pressure Effects	257
8-3	The Quasi-First-Order Thermodynamics	260
8-4	Ehrenfest Equations	265
8-5	Time Effects	269
8-6	Molecular Mechanism of Transition	272
8-7	Calculation of Glass Temperature	279

9	MOLECULAR DYNAMICS AND RHEOLOGY	286
9-1	Three-Dimensional Viscoelasticity	286
9-2	Stress-and-Strain Tensors	291
9-3	Viscosity of Liquids and Solids	295
9-4	Diffusion and Viscosity of Polymers ($M \leq 2M_e$)	305
9-5	Entanglements and Crosslinking	312
9-6	Viscoelastic Response	320

Part III BONDING AND FRACTURE

10	LINEAR VISCOELASTIC THEORY	327
10-1	Elemental Static, Transient, and Dynamic Response	328
10-2	Boltzmann Superposition	330
10-3	Relaxation Spectra	332
10-4	Retardation Spectra	335
10-5	Representation of Polymer Properties	338
10-6	Test Methods	343
	Appendix 10-1 Stress-strain behavior of a Maxwell element	345
	Appendix 10-2 Stress-strain behavior of a Voigt element	346
11	MECHANICAL PROPERTIES AND COHESION	349
11-1	Lattice Criteria of Fracture	349
11-2	Yield Stress of Glassy Polymers	360
11-3	Theory of High Viscoelastic Deformation	367
11-4	Viscous Failure Processes	370
11-5	Network Orientation	381
11-6	Polymer Failure Envelopes	388
12	THEORY OF ADHESION AND COHESION	396
12-1	Adsorption-Interdiffusion Processes	397
12-2	Soluble Diluent Effects	407
12-3	Polymer Composites and Microstructure	408
12-4	Adhesive Joint Properties	423
12-5	Molecular Design Factors	432
12-6	System Design Factors	441
	Appendix 12-1 Nomenclature	444

13	INTERFACIAL ADHESION AND ADHESIVE PERFORMANCE	450
13-1	Cohesive Bond Strength	451
13-2	Interfacial Bond Strength	456
13-3	The Locus of Failure	465
13-4	The Physical Chemistry of Peel Adhesion	471
13-5	Current Theories of Adhesion	487
	INDEX	499