

CONTENTS

CONTRIBUTORS	xiii
FOREWORD	xv
PREFACE	xvii
CONTENTS OF VOLUME 16, PARTS A AND B	xix
CONTRIBUTORS TO VOLUME 16, PARTS A AND B	xxiii
VOLUMES IN SERIES	xxv

11. Viscoelastic and Steady-State Rheological Response by DONALD J. PLAZEK

11.0. Introduction	1
11.1. Linear Viscoelastic Behavior	3
11.1.1. Definitions and Background	3
11.1.2. Instrumentation	21
11.2. Steady-State Response	44
11.2.1. Practical Solids	44
11.2.2. Viscoelastic Liquids	45
11.3. Nonlinear Viscoelastic Behavior	46

11.3.1. Nonlinear Steady-State Behavior of Viscoelastic Liquids	47
11.3.2. Nonlinear Transient and Dynamic Properties	49
11.4. Pressure Effects on Viscoelastic Behavior	51
11.5. Sample Handling	52
11.5.1. Molding	52
11.5.2. Solution Mixing	56
11.5.3. Molecular Weight Blending	57
11.5.4. Film Casting	57
12. Further Mechanical Techniques	
12.1. Ultrasonic Measurements by BRUCE HARTMANN	
12.1.1. Introduction	59
12.1.2. Immersion Apparatus	60
12.1.3. Other Experimental Techniques	75
12.1.4. Molecular Interpretation	79
12.1.5. Conclusions	89
12.2. Static High-Pressure Measurements on Polymers by R. W. WARFIELD	
12.2.1. Introduction	91
12.2.2. Types of Equipment	92
12.2.3. Response of Polymers to Static High Pressure	104
12.3. Stress–Strain Yield Testing of Solid Polymers by JOHN L. RUTHERFORD AND NORMAN BROWN	
12.3.1. Introduction	117
12.3.2. Definitions	117

CONTENTS

vii

12.3.3. Methods for Measuring Strain	119
12.3.4. Test Method	121
12.3.5. Significance of Results	129

13. Production and Measurement of Orientation by IAN L. HAY

13.1. Introduction	137
13.2. The Production of Orientation	138
13.3. Description of Orientation	146
13.4. Measurement of Orientation	150
13.4.1. Wide-Angle X-Ray Diffraction	150
13.4.2. Birefringence	161
13.4.3. Sonic Modulus	167
13.4.4. Infrared Dichroism	173
13.4.5. Small-Angle X-Ray Scattering	175

14. ESR Study of Polymer Fracture by TOSHIHIKO NAGAMURA

14.1. Introduction	185
14.2. Basic Theory and Experimental Techniques	186
14.2.1. Principle of ESR Method	186
14.2.2. Radical Concentration	187
14.2.3. System for Observing Mechanically Generated Radicals	188

14.3. Radical Formation by Mechanical Fracture of Polymers	195
14.3.1. Radical Species	195
14.3.2. Reaction and Location of Radicals	197
14.3.3. Radical Concentration and Fracture Surface . .	202
14.4. Radical Formation during Tensile Deformation and Fracture of Oriented Crystalline Polymers.	203
14.4.1. Radical Species	203
14.4.2. Reactivity and Location of Radicals	205
14.4.3. Radical Concentration.	206
14.4.4. Constant-Rate and Stepwise Stretching	207
14.4.5. Effects of Temperature and Heat-Treatment .	210
14.4.6. Effects of Strain Rate and Cyclic Loading. . .	212
14.5. Fracture in Elastomers	213
14.5.1. Ozone-Stress Cracking	214
14.5.2. Low-Temperature Deformation of Preoriented Rubbers and Granular Filled Rubbers.	216
14.6. Molecular Mechanism of Deformation and Fracture of Polymers	217
14.6.1. Some Models of Polymer Fracture and Polymer Morphology	217
14.6.2. Molecular Models of Deformation and Fracture Mainly Based on ESR Results	219
14.7. Limitations of ESR Method and Comparison with Associated Studies	225
14.7.1. Problems in ESR Investigations	225
14.7.2. Other Methods for Studying Micromechanism of Polymer Deformation and Fracture.	226
15. Methods by Studying Crazing by NORMAN BROWN	
15.1. Introduction	233
15.2. Structure	237

15.2.1. Optical Methods	237
15.2.2. Electron Microscopy	242
15.2.3. The Stress Field	245
15.3. Initiation and Growth	249
15.3.1. Stress Criteria for Initiation	249
15.3.2. Growth of Crazes.	252
15.4. Environmental Effects in Liquids and Gases.	255
15.5. Relationship of Crazing to Macroscopic Mechanical Behavior	262
15.5.1. The Stress–Strain Curve	263
15.5.2. Creep	265
15.5.3. The Size Effect.	268
15.5.4. Shear Flow and Crazing.	269
15.5.5. Fracture.	270
15.5.6. High-Impact-Strength Polymers	271
16. Polymeric Alloys by J. ROOVERS	
16.1. Introduction	275
16.2. Thermodynamics	276
16.2.1. Polymer Mixtures	276
16.2.2. Block Copolymers	278
16.2.3. Polymer–Polymer Interphase	282
16.2.4. Segmental Polymer–Polymer Interaction Parameter	283
16.3. Direct Observation	287
16.3.1. Visual Observation	287
16.3.2. Optical Microscopy	288
16.3.3. Electron Microscopy	291

16.4. Scattering Techniques	299
16.4.1. Small-Angle Light Scattering (SALS)	299
16.4.2. Small-Angle X-Ray Scattering (SAXS)	300
16.4.3. Small-Angle Neutron Scattering (SANS)	305
16.5. Glass Transition Temperature Measurements	306
16.5.1. T_g of Mixtures of Polymers	307
16.5.2. T_g of Block Copolymers	311
16.6. Conclusion	314
17. Permeation, Diffusion, and Sorption of Gases and Vapors by R. M. FELDER AND G. S. HUVARD	
17.1. Introduction	315
17.2. Historical Perspective	316
17.2.1. Theory	316
17.2.2. Experimental Methods	319
17.3. Phenomenology	324
17.3.1. Correlation and Estimation of Transport and Solubility Coefficients	325
17.3.2. Effects of Polymer Composition and Morphology on Transport Rates	328
17.3.3. Transport of Water Vapor	331
17.3.4. Concentration-Dependent Fickian Diffusion in Rubbery Polymers	332
17.3.5. Dual-Mode Sorption and Diffusion in Glassy Polymers	333
17.3.6. Anomalous Transport of Vapors in Glassy Polymers	334
17.3.7. Two-Stage Sorption of Swelling Penetrants in Glassy Polymers	337

17.4. Categories of Experimental Methods	338
17.5. Pressure Measurement and Temperature Control.	340
17.6. Sorption Methods	342
17.6.1. Experiments and Data	342
17.6.2. Calculations	343
17.6.3. Experimental Methods	349
17.7. Integral Permeation (Closed Receiving Volume) Methods	356
17.7.1. Experiments and Data	356
17.7.2. Calculations	357
17.7.3. Experimental Methods	362
17.8. Differential Permeation and Weighing Cup (Open Receiving Volume) Methods	367
17.8.1. Experiments and Data	367
17.8.2. Calculations	369
17.8.3. Experimental Methods	371
17.9. Sources and Minimization of Errors	372
17.9.1. Operating Procedures	372
17.9.2. Data Analysis	373
17.9.3. System Dynamics	375
18. Electrical Methods	
18.1. Dielectric Constant and Loss by RICHARD H. BOYD	
18.1.1. Introduction	379
18.1.2. Phenomenology of Dielectrics	381
18.1.3. Experimental Procedures	395

18.2. Static Electricity	
by D. KEITH DAVIES	
18.2.1. Introduction	422
18.2.2. Methods of Measuring Charge	424
18.2.3. Contact Electrification	428
18.2.4. Radiation Charging	435
18.2.5. Charge Migration	439
18.3. Electric Breakdown	
by B. R. VARLOW	
18.3.1. Introduction	443
18.3.2. Mechanisms of Breakdown	444
18.3.3. Specimen Preparation	451
18.3.4. Experimental Methods	462
18.3.5. High-Field Conduction	489
AUTHOR INDEX	499
SUBJECT INDEX	519

