

Contents

Chapter 1 Introduction to Polymers..... 1

1.1 Additives.....5.

1.2 Permeation 6

1.3 Absorption12

1.4 Painting of Polymers15

1.5 Corrosion of Polymers 16

Chapter 2 Thermoplastic Polymers.....19

2.1 Joining of Thermoplastics..... 30

2.1.1 Use of Adhesive.....32

2.2 Acrylonitrile–Butadiene–Styrene (ABS)..... 37

2.3 Acrylics.....37

2.4 Chlorotrifluoroethylene (CTFE)..... 41

2.5 Ethylenechlorotrifluoroethylene (ECTFE)..... 46

2.6 Ethylene Tetrafluoroethylene (ETFE)..... 51

2.7 Fluorinated Ethylene–Propylene (FEP).....51

2.8 Polyamides (PA)..... 60

2.9 Polyamide–Imide (PAI)..... 65

2.10 Polybutylene (PB)..... 66

2.11 Polycarbonate (PC) 68

2.12 Polyetheretherketone (PEEK).....70

2.13 Polyether–Imide (PEI)..... 73

2.14 Polyether Sulfone (PES)..... 75

2.15 Perfluoralkoxy (PFA).....77

2.16 Polytetrafluoroethylene (PTFE)..... 81

2.17 Polyvinylidene Fluoride (PVDF).....82

2.18 Polyethylene (PE).....91

2.19 Polyethylene Terephthalate (PET).....100

2.20 Polyimide (PI).....102

2.21 Polyphenylene Oxide (PPO)..... 103

2.22 Polyphenylene Sulfide (PPS)..... 104

2.23 Polypropylene (PP).....108

2.24 Styrene–Acrylonitrile (SAN).....113

2.25 Polyvinylidene Chloride (PVDC)..... 114

2.26 Polysulfone (PSF)..... 118

2.27 Polyvinyl Chloride (PVC).....121

2.28 Chlorinated Polyvinyl Chloride (CPVC) 129

2.29 Chlorinated Polyether (CPE)..... 134

2.30	Polyacrylonitrile (PAN).....	134
2.31	Polyurethane (PUR).....	138
2.32	Polybutylene Terephthalate (PBT).....	141
2.33	Acetals.....	143
	References	146

Chapter 3	Thermoset Polymers.....	147
3.1	Corrosion of Thermosets.....	147
3.2	Joining of Thermosets.....	151
3.3	Ultraviolet Light Stability.....	151
3.4	Reinforcing Materials.....	151
3.4.1	Glass Fibers.....	152
3.4.1.1	E Glass	152
3.4.1.2	C Glass.....	152
3.4.1.3	S Glass.....	154
3.4.1.4	Glass Filaments	154
3.4.1.5	Chopped Strands	155
3.4.1.6	Glass Mats	155
3.4.1.7	Glass Fabrics	155
3.4.2	Polyester	155
3.4.3	Carbon Fiber	156
3.4.4	Aramid Fibers.....	156
3.4.5	Polyethylene Fibers	157
3.4.6	Paper	157
3.4.7	Cotton and Linen	158
3.5	Polyesters	158
3.5.1	General Purpose Polyesters	160
3.5.2	Isophthalic Polyesters.....	161
3.5.2.1	Typical Applications.....	165
3.5.3	Bisphenol A Fumarate Polyesters	166
3.5.3.1	Typical Applications.....	173
3.5.4	Halogenated Polyesters	173
3.5.4.1	Typical Applications.....	178
3.5.5	Terephthalate Polyesters (PET).....	178
3.5.5.1	Typical Applications.....	180
3.6	Epoxy Polyesters.....	180
3.6.1	Resin Types	181
3.6.2	Curing	182
3.6.2.1	Aromatic Amines.....	183
3.6.2.2	Aliphatic Amines.....	183
3.6.2.3	Catalytic Curing Agents	183
3.6.2.4	Acid Anhydrides	183
3.6.3	Corrosion Resistance.....	184
3.6.4	Typical Applications.....	184
3.7	Vinyl Esters	188

3.7.1	Typical Applications.....	194
3.8	Furans	194
3.8.1	Typical Applications.....	199
3.9	Phenolics.....	199
3.9.1	Typical Applications.....	199
3.10	Phenol-Formaldehyde.....	204
3.10.1	Typical Applications.....	204
3.11	Silicones	207
3.11.1	Typical Applications.....	210
3.12	Siloxirane.....	210
3.12.1	Typical Applications.....	211
3.13	Polyurethanes	211
3.13.1	Typical Applications.....	211
3.14	Melamines.....	211
3.14.1	Typical Applications.....	213
3.15	Alkyds.....	213
3.15.1	Typical Applications.....	213
3.16	Ureas (Aminos)	214
3.17	Allyls	214
3.18	Polybutadienes	215
3.19	Polyimides.....	218
3.19.1	Typical Applications.....	219
3.20	Cyanate Esters	219
	References	219

Chapter 4	Comparative Corrosion Resistance of Thermoplastic and Thermoset Polymers.....	221
	Reference	441

Chapter 5	Elastomers.....	443
5.1	Introduction	443
5.1.1	Importance of Compounding	445
5.1.2	Similarities of Elastomers and Thermoplastic Polymers ...	446
5.1.3	Differences between Elastomers and Thermoplasts	446
5.1.4	Causes of Failure.....	447
5.1.5	Selecting an Elastomer	448
5.1.6	Corrosion Resistance	451
5.1.7	Applications.....	452
5.1.8	Elastomer Designations	453
5.2	Natural Rubber.....	453
5.2.1	Resistance to Sun, Weather, and Ozone	454
5.2.2	Chemical Resistance	454
5.2.3	Applications.....	459
5.3	Isoprene Rubber (IR)	459
5.4	Neoprene (CR).....	460

5.4.1	Resistance to Sun, Weather, and Ozone	460
5.4.2	Chemical Resistance	460
5.4.3	Applications	465
5.5	Styrene–Butadiene Rubber (SBR, Buna-S, GR-S)	467
5.5.1	Resistance to Sun, Weather, and Ozone	467
5.5.2	Chemical Resistance	468
5.5.3	Applications	469
5.6	Nitrile Rubber (NBR, Buna-N)	470
5.6.1	Resistance to Sun, Weather, and Ozone	470
5.6.2	Chemical Resistance	470
5.6.3	Applications	470
5.7	Butyl Rubber (IIR) and Chlorobutyl Rubber (CIIR)	472
5.7.1	Resistance to Sun, Weather, and Ozone	472
5.7.2	Chemical Resistance	473
5.7.3	Applications	478
5.8	Chlorosulfonated Polyethylene Rubber (Hypalon)	478
5.8.1	Resistance to Sun, Weather, and Ozone	479
5.8.2	Chemical Resistance	479
5.8.3	Applications	479
5.9	Polybutadiene Rubber (BR)	484
5.9.1	Resistance to Sun, Weather, and Ozone	484
5.9.2	Chemical Resistance	484
5.9.3	Applications	486
5.10	Ethylene–Acrylic (EA) Rubber	486
5.10.1	Resistance to Sun, Weather, and Ozone	487
5.10.2	Chemical Resistance	487
5.10.3	Applications	487
5.11	Acrylate–Butadiene Rubber (ABR) and Acrylic Ester–Acrylic Halide (ACM) Rubbers	487
5.11.1	Resistance to Sun, Weather, and Ozone	487
5.11.2	Chemical Resistance	488
5.11.3	Applications	488
5.12	Ethylene–Propylene Rubbers (EPDM and EPT)	488
5.12.1	Resistance to Sun, Weather, and Ozone	489
5.12.2	Chemical Resistance	489
5.12.3	Applications	489
5.13	Styrene–Butadiene–Styrene (SBS) Rubber	497
5.13.1	Resistance to Sun, Weather, and Ozone	497
5.13.2	Chemical Resistance	497
5.13.3	Applications	497
5.14	Styrene–Ethylene–Butylene–Styrene (SEBS) Rubber	497
5.14.1	Resistance to Sun, Weather, and Ozone	498
5.14.2	Chemical Resistance	498
5.14.3	Applications	498
5.15	Polysulfide Rubbers (ST and FA)	498
5.15.1	Resistance to Sun, Weather, and Ozone	498

5.15.2	Chemical Resistance.....	499
5.15.3	Applications.....	502
5.16	Urethane Rubbers (AU).....	502
5.16.1	Resistance to Sun, Weather, and Ozone	503
5.16.2	Chemical Resistance.....	504
5.16.3	Applications	509
5.17	Polyamides.....	510
5.17.1	Resistance to Sun, Weather, and Ozone	511
5.17.2	Chemical Resistance.....	511
5.17.3	Applications	514
5.18	Polyester (PE) Elastomer	514
5.18.1	Resistance to Sun, Weather, and Ozone	515
5.18.2	Chemical Resistance.....	515
5.18.3	Applications	515
5.19	Thermoplastic Elastomers (TPE) Olefinic Type (TEO).....	518
5.19.1	Resistance to Sun, Weather, and Ozone	519
5.19.2	Chemical Resistance.....	519
5.19.3	Applications	519
5.20	Silicone (SI) and Fluorosilicone (FSI) Rubbers.....	519
5.20.1	Resistance to Sun, Weather, and Ozone	520
5.20.2	Chemical Resistance.....	520
5.20.3	Applications	523
5.21	Vinylidene Fluoride (HFP, PVDF).....	524
5.21.1	Resistance to Sun, Weather, and Ozone	525
5.21.2	Chemical Resistance.....	525
5.21.3	Applications	525
5.22	Fluoroelastomers (FKM).....	530
5.22.1	Resistance to Sun, Weather, and Ozone	531
5.22.2	Chemical Resistance.....	531
5.22.3	Applications	531
5.23	Ethylene–Tetrafluoroethylene (ETFE) Elastomer.....	537
5.23.1	Resistance to Sun, Weather, and Ozone	537
5.23.2	Chemical Resistance.....	537
5.23.3	Applications	541
5.24	Ethylene–Chlorotrifluoroethylene (ECTFE) Elastomer.....	541
5.24.1	Resistance to Sun, Weather, and Ozone	542
5.24.2	Chemical Resistance.....	542
5.24.3	Applications	546
5.25	Perfluoroelastomers (FPM).....	546
5.25.1	Resistance to Sun, Weather, and Ozone	548
5.25.2	Chemical Resistance.....	548
5.25.3	Applications	560
5.26	Epichlorohydrin Rubber	561
5.26.1	Resistance to Sun, Weather, and Ozone	561
5.26.2	Chemical Resistance.....	561
5.26.3	Applications.....	561

5.27 Ethylene–Vinylacetate Copolymer (EVM)..... 562

5.27.1 Resistance to Sun, Weather, and Ozone..... 562

5.27.2 Chemical Resistance..... 562

5.27.3 Applications..... 562

5.28 Chlorinated Polyethylene (CM)..... 562

5.28.1 Resistance to Sun, Weather, and Ozone..... 562

5.28.2 Chemical Resistance..... 562

5.28.3 Applications..... 562

Chapter 6 Comparative Corrosion Resistance
of Selected Elastomers **563**

Reference..... 575

Index 577