
Contents

Selected Plastic/Elastomer Acronyms	xi
Preface	xii
Acknowledgments	xiv
About the Authors	xv
CHAPTER 1	
Tribology, Tribosystems, and Related Terminology	1
1.1 Wear of Materials	1
1.2 Tribology	3
1.3 Tribomaterials	4
1.4 Terminology	7
CHAPTER 2	
The Mechanisms and Manifestations of Friction	13
2.1 Historical Development of Concept	13
2.2 Friction Laws	15
2.3 Types of Friction and Mechanisms	19
2.4 Friction is Energy Dissipation	24
2.5 Rolling Friction	25
2.6 Friction Produced by Fluids	28
2.7 Measuring Friction Forces	29
2.8 Effect of Speed Force and Environment on Friction	33
2.9 Lubricated Friction	39
CHAPTER 3	
Dealing with Friction in Design Engineering	47
3.1 Use of Coefficients of Friction	49
3.2 Determination of Friction Coefficients for Tribosystems	52
3.3 Rolling Friction	58
3.4 Lubricated Tribosystems	62
3.5 Metal-to-Metal Friction	65
3.6 Plastic-to-Metal and Plastic-to-Plastic Friction	67
3.7 Elastomer Friction	70
3.8 Friction of Ceramics	71

3.9 Friction Materials	72
3.10 Additional Friction Guidelines	73

CHAPTER 4

Types of Wear and Erosion and Their Mechanisms 79

4.1 The Difference Between Wear and Erosion	79
4.2 Types of Erosion	80
4.3 Types of Wear	93
4.4 Tribocorrosion	115
4.5 Biotribology	116

CHAPTER 5

Tribotesting 121

5.1 The Need for Tribotesting	121
5.2 Tribotesting Methodology	124
5.3 General Considerations during Tribotesting	132
5.4 Erosion Testing	142
5.5 Adhesive Wear Testing	146
5.6 Abrasion Tests	155

CHAPTER 6

Tribological Properties of Copper Alloys 163

6.1 Copper Alloys in Tribological Applications	163
6.2 Mechanical Properties	165
6.3 Physical Properties	166
6.4 Forms Available	166
6.5 Friction	166
6.6 Adhesive Wear	168
6.7 Abrasive Wear	169
6.8 Erosion	172

CHAPTER 7

Tribological Properties of Cast Irons 179

7.1 Introduction	179
7.2 Metallurgy	180
7.3 Physical Properties	183
7.4 Mechanical Properties	183
7.5 Chemical Properties	183
7.6 Important Grades for Tribological Applications	184
7.7 Friction	186
7.8 Adhesive Wear	188
7.9 Abrasion Resistance	191
7.10 Erosion	194

CHAPTER 8

Tribological Properties of Steels	199
8.1 Introduction	199
8.2 Forms Available	200
8.3 Metallurgy	202
8.4 Physical Properties	206
8.5 Mechanical Properties	208
8.6 Friction	208
8.7 Adhesive Wear	209
8.8 Abrasive Wear	214
8.9 Erosion	218
8.10 Cast Steels	222

CHAPTER 9

Tribological Properties of Stainless Steel and Other Corrosion-Resisting Metals	227
9.1 Corrosion and Wear	227
9.2 Stainless Steels	228
9.3 Other Metals Used for Corrosion Service	244
9.4 Light Metals	259

CHAPTER 10

Tribological Properties of Ceramics, Cermets, and Cemented Carbides	271
10.1 Introduction	271
10.2 Ceramics	273
10.3 Cermets	288
10.4 Cemented Carbides	290

CHAPTER 11

Tribology of Plastics and Elastomers	301
11.1 Typical Uses	301
11.2 Plastics	304
11.3 Plastics for Abrasive Wear Applications	306
11.4 Friction in Plastic Tribosystems	308
11.5 Plastics for Adhesive Wear Applications	312
11.6 Plastic for Erosion Applications	319
11.7 Polymer Composites	320
11.8 Rubbers and Elastomers	322

CHAPTER 12

Material Modifications (Coatings, Treatments, etc.) for Tribological Applications	335
12.1 When to Use Material Modifications	335
12.2 The Spectrum of Modifications	336

12.3	Modifications to Harden Surfaces	338
12.4	Material Modifications for Improved Lubrication	342
12.5	Treatments for Appearance	349
12.6	Treatments for Corrosion Resistance	349
12.7	Treatments for Abrasion Resistance	350
12.8	Friction	350
12.9	Adhesive Wear Treatments	354
12.10	Treatments of Erosion	355

CHAPTER 13

Biotribology	363	
13.1	Introduction	363
13.2	Dental Tribology	364
13.3	Orthopedics	367
13.4	Sensing and Perception	374
13.5	Personal Care Products	377
13.6	Medical Devices	378
13.7	Eyewear Materials	381
13.8	Biocompatibility	385
13.9	Skin	386

CHAPTER 14

Tribology of Lubricants	391	
14.1	Oils	393
14.2	Greases	402
14.3	Solid Lubricants	403
14.4	Metalworking Fluids	406
14.5	Traction Fluids	407
14.6	Lubrication Fundamentals	408
14.7	Lubricant Life	415

CHAPTER 15

Selection of Materials for Tribosystems	421	
15.1	The Role of Tribology in Selection	421
15.2	Copper Alloys	423
15.3	Cast Irons	424
15.4	Steels	424
15.5	Stainless Steels and Corrosion-Resisting Metals	425
15.6	Nickel Alloys	426
15.7	Titanium Alloys	426
15.8	Gold and Silver	427
15.9	Zinc	427
15.10	Tin	427
15.11	Aluminum Alloys	427

15.12 Ceramics, Cermets, and Cemented Carbides	428
15.13 Plastics and Elastomers	430
15.14 Selection of Material Modifications	432
15.15 Lubricant Selection	433
15.16 Selection Methodology	435
15.17 Use of a Selection Matrix	440

APPENDIX

Symbols for Some Common Elements	445
Index	447