

CONTENTS

CHAPTER 22 THERMOCHEMICAL DIFFUSION PROCESSES	595
22.1 INTRODUCTION	595
22.2 DIFFUSION PROCESSES	595
22.2.1 LATTICE DIFFUSION	596
22.2.2 THE RATE OF DIFFUSION AND DIFFUSION DEPTH	597
22.2.3 DIFFUSION REMEDY	599
22.3 CARBURIZING (DIFFUSION OF CARBON)	600
22.3.1 VACUUM CARBURIZING	607
22.4 CARBONITRIDING	607
22.5 NITRIDING	611
22.5.1 PLASMA NITRIDING	614
22.5.2 EXPANDED LATTICE S-PHASE	614
22.5.3 NITROCARBURIZING	616
22.6 BORONIZING (BORIDING)	618
22.6.1 BORONIZING PROCESSES	619
22.6.2 INFLUENCE OF THE SUBSTRATE MATERIAL	620
22.6.3 PROCESS PARAMETERS	621
22.6.4 PROPERTIES OF BORONIZED COMPONENTS	622
22.7 CHROMIZING	623
22.8 SHERARDIZING	624
22.9 DIFFUSION ANNEALING	625
22.10 THE TOYOTA DIFFUSION PROCESS	628
22.11 INDUCTION HARDENING	630
22.12 RECOMMENDED ADDITIONAL READING	633
22.13 RELEVANT STANDARDS	633
CHAPTER 23 HOT-DIP GALVANIZING	637
23.1 INTRODUCTION	637
23.2 REGULAR HOT-DIP GALVANIZING	638
23.2.1 DRY GALVANIZING	638
23.2.2 WET GALVANIZING	640
23.3 GALVANIZING OF SHEETS	641
23.4 REACTIONS BETWEEN IRON AND ZINC	642

23.5	SIGNIFICANT PROCESS PARAMETERS	643
23.5.1	HOT ROLLED CONSTRUCTION STEELS	646
23.5.2	COLD ROLLED STEELS	647
23.5.3	OTHER STEEL TYPES	648
23.6	DECORATIVE COATINGS	649
23.7	THE PROPERTIES OF HOT-DIP GALVANIZED STEEL	651
23.8	CONSTRUCTION CONSIDERATIONS	652
23.9	STANDARDS	655
23.10	REFERENCES	656
23.11	RECOMMENDED ADDITIONAL READING	657
23.12	RELEVANT STANDARDS	657
CHAPTER 24	VITREOUS ENAMEL	659
24.1	INTRODUCTION	659
24.2	PROPERTIES AND STRUCTURE	660
24.3	MANUFACTURING OF ENAMELLED PRODUCTS	665
24.3.1	APPLICATION OF ENAMEL	666
24.4	QUALITY SPECIFICATIONS AND TEST METHODS	667
24.5	RECOMMENDED ADDITIONAL READING	667
24.6	RELEVANT STANDARDS	667
CHAPTER 25	THERMAL SPRAYING AND HARDFACING	671
25.1	INTRODUCTION	671
25.2	DIFFERENT TYPES OF THERMAL SPRAYING	673
25.2.1	FLAME SPRAYING	674
25.2.2	ARC SPRAYING	675
25.2.3	DETONATION SPRAYING	676
25.2.4	HIGH VELOCITY OXYGEN FUEL SPRAYING	677
25.2.5	PLASMA SPRAYING	678
25.2.6	COLD SPRAYING	681
25.2.7	COMPARISON OF THERMAL SPRAYING PROCESSES	683
25.2.8	APPLICATION OF THERMAL SPRAYING	688
25.3	LASER FUSING	690
25.4	HARDFACING	692
25.5	REFERENCES	702
25.6	RECOMMENDED ADDITIONAL READING	702
25.7	RELEVANT STANDARDS	703

CHAPTER 26 MECHANICAL PLATING	705
26.1 INTRODUCTION	705
26.2 THE PLATING PROCESS	706
26.2.1 MECHANICAL PLATING OF STEEL	707
26.3 REFERENCES	711
26.4 RECOMMENDED ADDITIONAL READING	711
26.5 RELEVANT STANDARDS	711
CHAPTER 27 INTRODUCTION TO PAINT	713
27.1 INTRODUCTION	713
27.1.1 KEY FACTORS FOR THE SUCCESSFUL USE OF PAINT	716
27.2 THE COMPONENTS OF PAINT	717
27.2.1 BINDERS	717
27.2.2 SOLVENTS	718
27.2.3 PIGMENTS	720
27.2.4 ADDITIVES	758
27.2.5 RHEOLOGY	759
27.3 PRODUCTION OF PAINT	760
27.4 REFERENCES	764
27.5 RECOMMENDED ADDITIONAL READING	765
27.6 RELEVANT STANDARDS	765
CHAPTER 28 CLASSIFICATION OF PAINTS	767
28.1 INTRODUCTION	767
28.2 PHYSICALLY DRYING PAINTS	769
28.2.1 GENERIC PROPERTIES OF PHYSICALLY DRYING PAINTS	769
28.2.2 TAR AND BITUMEN	770
28.2.3 CHLORINATED RUBBER	772
28.2.4 ACRYLIC	774
28.2.5 VINYL	775
28.2.6 NITROCELLULOSE	777
28.3 WATER-BORNE PAINTS	779
28.3.1 GENERIC PROPERTIES OF WATER-BORNE PAINTS	779
28.4 CHEMICALLY CURING PAINTS	782
28.4.1 GENERIC PROPERTIES OF CHEMICALLY CURING PAINTS	782
28.4.2 OXIDATIVELY CURING PAINTS	783
28.4.3 TWO-COMPONENT CURING PAINTS	788
28.4.4 HUMIDITY CURING PAINTS	799
28.4.5 HEAT CURING PAINTS	802

28.5	ALTERNATIVE CURING METHODS	805
28.5.1	ACID-CURING PAINTS	805
28.5.2	PEROXIDE-CURING PAINTS	805
28.5.3	UV-CURING PAINTS	805
28.6	REFERENCES	809
28.7	RECOMMENDED ADDITIONAL READING	809
28.8	RELEVANT STANDARDS	810
 CHAPTER 29 SPECIAL PAINTS AND APPLICATION METHODS		 813
29.1	INTRODUCTION	813
29.2	PAINT FOR CORROSION PREVENTION	813
29.2.1	THE BARRIER EFFECT	814
29.2.2	THE INHIBITING EFFECT	816
29.2.3	THE GALVANIC EFFECT (CATHODIC PROTECTION)	816
29.2.4	DIP-SPIN COATINGS	818
29.3	FOULING CONTROL PAINT	819
29.4	PASSIVE FIRE PROTECTION PAINT	824
29.5	SHOPPRIMERS	827
29.6	ELECTROCOATING PROCESSES	829
29.6.1	ANAPHORESIS	830
29.6.2	CATAPHORESIS	831
29.6.3	CHARACTERISTICS OF THE ELECTROCOATING PROCESS	833
29.6.4	PROCESS CONSIDERATIONS FOR ELECTROCOATING	834
29.7	AUTOPHORETIC LACQUERING PROCESSES	837
29.8	COIL-COATING PROCESSES	839
29.9	POWDER COATING PROCESSES	843
29.9.1	THERMOSETTING POWDER	845
29.9.2	THERMOPLASTIC POWDER	848
29.9.3	APPLICATION METHODS	848
29.10	REFERENCES	855
29.11	RECOMMENDED ADDITIONAL READING	855
 CHAPTER 30 PRETREATMENT PRIOR TO APPLICATION OF PAINT		 857
30.1	INTRODUCTION	857
30.1.1	SURFACE CONTAMINANTS	857
30.1.2	PRELIMINARY CLEANING METHODS	859
30.2	SANDBLASTING METHODS	859
30.2.1	VACUUM BLASTING	861

30.3	WET BLASTING METHODS	862
30.3.1	WATER CLEANING METHODS (WATER JETTING)	863
30.4	ABRASIVE MEDIA	866
30.5	STANDARDS	870
30.6	EVALUATION OF SURFACE ROUGHNESS	875
30.7	PREPARATION OF METAL SURFACES BEYOND STEEL	876
30.7.1	ALUMINUM	876
30.7.2	ZINC COATED STEEL	877
30.7.3	STAINLESS STEEL	877
30.8	PAINT ADHESION	878
30.8.1	SURFACE TENSION AND WETTING	878
30.8.2	ADHESION THEORIES	881
30.9	REFERENCES	883
30.10	RECOMMENDED ADDITIONAL READING	883
30.11	RELEVANT STANDARDS	884
CHAPTER 31	SELECTION OF PAINT SYSTEMS	887
31.1	INTRODUCTION	887
31.2	CORROSION CLASSES	889
31.3	PAINT SYSTEMS FOR CORROSION PROTECTION	891
31.3.1	CONVERSION COATINGS AS PRETREATMENT	897
31.4	TEST OF ORGANIC COATINGS	904
31.5	PAINT DEFECTS	905
31.6	RELEVANT STANDARDS	906
CHAPTER 32	MEASUREMENT OF »TOTAL VISUAL APPEARANCE«	911
32.1	INTRODUCTION	911
32.2	GLOSS	914
32.2.1	HAZE	919
32.3	COLOR	920
32.3.1	COLOR FORMATION	921
32.3.2	MIXING OF COLORS	923
32.4	REFERENCES	930
32.5	RECOMMENDED ADDITIONAL READING	930
32.6	RELEVANT STANDARDS	930

CHAPTER 33 QC; THICKNESS AND ADHESION OF COATINGS	933
33.1 INTRODUCTION	933
33.2 MEASURING THE THICKNESS OF COATINGS	934
33.2.1 WEIGHT GAIN UPON COATING	937
33.2.2 MECHANICAL MEASUREMENT	938
33.2.3 CHEMICAL MEASUREMENT	939
33.2.4 OPTICAL MEASUREMENT	939
33.2.5 ELECTROCHEMICAL MEASUREMENT	944
33.2.6 MAGNETIC MEASUREMENT	947
33.2.7 MAGNETIC-INDUCTIVE MEASUREMENT	948
33.2.8 EDDY-CURRENT MEASUREMENT	950
33.2.9 X-RAY FLUORESCENCE MEASUREMENT	952
33.2.10 BETA BACKSCATTER MEASUREMENT	955
33.2.11 ULTRASONIC MEASUREMENT	956
33.2.12 ELLIPSOMETRY	957
33.2.13 MEASUREMENT BEFORE CURING	958
33.3 QUANTIFYING COATING ADHESION	959
33.3.1 BENDING TEST	960
33.3.2 POLISHING TEST	962
33.3.3 CHISEL TEST	962
33.3.4 PULL TEST	962
33.3.5 FILE TEST	962
33.3.6 GRIND/SAW TEST	963
33.3.7 COOLING TEST	963
33.3.8 IMPACT/STROKE TEST	964
33.3.9 PEEL TEST	964
33.3.10 PUSH TEST	965
33.3.11 SCRIBE/GRID TEST	965
33.3.12 SCRATCH TESTER	968
33.3.13 DAIMLER-BENZ TEST	969
33.4 RECOMMENDED ADDITIONAL READING	971
33.5 RELEVANT STANDARDS	971
CHAPTER 34 MEASURING HARDNESS	975
34.1 INTRODUCTION	975
34.2 HARDNESS MEASUREMENT	975
34.2.1 MODELS FOR CORRELATING INDENTER AREA AND SURFACE HARDNESS	979
34.3 NANOINDENTATION	982

CHAPTER 35 CORROSION EVALUATION AND DURABILITY TESTING	985
35.1 INTRODUCTION	985
35.2 CORROSION AND DURABILITY TESTING	987
35.2.1 FIELD TESTING/WEATHERING	987
35.2.2 ACCELERATED LABORATORY TESTING	996
35.3 ADDITIONAL READING	1016
35.4 RELEVANT STANDARDS	1017
CHAPTER 36 CHARACTERIZATION OF SURFACES AND BULK MATERIALS	1021
36.1 INTRODUCTION	1021
36.2 THE INTERACTION OF ELECTRONS WITH MATTER	1023
36.3 THE INTERACTION OF PHOTONS WITH MATTER	1024
36.3.1 THE LOW ENERGY REGIME	1024
36.3.2 THE INTERMEDIATE ENERGY REGIME	1024
36.3.3 HIGH ENERGY REGIME	1025
36.4 OVERVIEW OF DIFFERENT ANALYSIS TECHNIQUES	1026
36.5 ELECTRON MICROSCOPY AND RELATED TECHNIQUES	1028
36.5.1 THE INTERACTION OF ELECTRONS WITH MATTER	1029
36.5.2 ELECTRON WAVE DUALISM	1032
36.5.3 INTRODUCTION TO SEM/TEM TECHNIQUES	1035
36.5.4 SCANNING ELECTRON MICROSCOPY	1038
36.5.5 SCANNING CONFOCAL ELECTRON MICROSCOPY	1041
36.5.6 REFLECTION ELECTRON MICROSCOPY	1043
36.5.7 SCANNING TRANSMISSION ELECTRON MICROSCOPY	1045
36.5.8 LOW-VOLTAGE ELECTRON MICROSCOPY	1046
36.5.9 ENVIRONMENTAL SCANNING ELECTRON MICROSCOPY	1046
36.5.10 CRYOGENIC-SEM	1048
36.5.11 FIB-SEM	1049
36.5.12 FIELD EMISSION GUN SCANNING ELECTRON MICROSCOPY	1052
36.5.13 TRANSMISSION ELECTRON MICROSCOPE	1053
36.6 ENERGY-DISPERSIVE X-RAY SPECTROSCOPY	1057
36.7 ELECTRON ENERGY LOSS SPECTROSCOPY	1061
36.8 X-RAY PHOTOELECTRON SPECTROSCOPY	1065
36.9 GLOW DISCHARGE OPTICAL EMISSION SPECTROSCOPY	1072
36.9.1 BASIC PRINCIPLE OF OPERATION	1072
36.9.2 EXAMPLES OF GDOES PROFILES	1074
36.10 SECONDARY ION MASS SPECTROSCOPY	1077
36.10.1 TIME-OF-FLIGHT SECONDARY ION MASS SPECTROMETRY	1079

36.11	X-RAY CHARACTERIZATION TECHNIQUES	1081
36.11.1	X-RAY DIFFRACTION	1082
36.11.2	X-RAY FLUORESCENCE	1089
36.12	HIGH ENERGY ION BEAM TECHNIQUES	1091
36.12.1	RUTHERFORD BACKSCATTERING SPECTROSCOPY	1095
36.12.2	PARTICLE INDUCED X-RAY EMISSION	1099
36.12.3	ELASTIC RECOIL DETECTION ANALYSIS	1104
36.12.4	NUCLEAR REACTION ANALYSIS	1105
36.13	SCANNING PROBE MICROSCOPY	1106
36.13.1	SCANNING TUNNELING MICROSCOPY	1107
36.13.2	ATOMIC FORCE MICROSCOPY	1114
36.14	SPECTROSCOPY	1120
36.14.1	ULTRAVIOLET-VISIBLE (UV-VIS) SPECTROSCOPY	1125
36.14.2	INFRARED SPECTROSCOPY (NEAR-IR, MID-IR AND FAR-IR)	1134
36.14.3	RAMAN	1148
36.14.4	ELLIPSOMETRY	1153
APPENDIX A THERMODYNAMIC CONSIDERATIONS		1161
A.1	INTRODUCTION	1161
A.2	ENTHALPY	1161
A.3	ENTROPY	1163
A.4	GIBB'S FREE ENERGY	1166
A.5	REFERENCES	1167
APPENDIX B REFERENCE DATA		1169
B.1	FUNDAMENTAL CONSTANTS	1169
B.2	ELECTROCHEMICAL EQUIVALENTS	1170
B.3	PERIODIC TABLE	1174
APPENDIX C POURBAIX DIAGRAMS		1177
C.1	INTRODUCTION	1177
C.2	DIAGRAMS	1186
C.3	REFERENCES	1209
INDEX		1211
THE AUTHORS		1237

