

Contents

1	Introduction	1
	References	4
2	Corrosion Reactions and Corrosion Products	5
	References	10
3	Chemical Thermodynamics of Corrosion	11
3.1	Outline of Fundamentals	11
3.2	Calculating Gibbs Energies for Overall Reactions	19
3.3	Equilibrium Galvanic Cells	28
3.4	Galvanic Cells with Transference	32
3.5	More on Equilibrium Electrode Potentials	36
3.6	Calculating Elevated-Temperature Gibbs Energies	50
	References	54
4	The Electrolytic Mechanism of Corrosion	56
4.1	Overview	56
4.2	Reactions, Currents, and Potentials in Galvanic Cells	59
4.3	Measuring Current-Potential Curves	65
4.4	Uniform Corrosion: The Work of Wagner and Traud	69
	References	73
5	The Kinetics of Electrode Reactions	75
5.1	Hydrogen Deposition and Hydrogen Ionisation	75
5.2	Oxygen Reduction and Oxygen Evolution	91
5.3	Metal Dissolution and Metal Deposition	98
5.4	Closer Inspection of the Electrical Double Layer	113
	References	116
6	Uniform Electrolytic Corrosion	119
6.1	Acid and Neutral Solutions	119
6.2	Neutral and Alkaline Solutions	128
6.3	The Dependence of Corrosion Rates on Temperature	138
	References	142
7	Adsorption Inhibitors of Acid Iron Corrosion	144
	References	158

8	Corrosion of Homogeneous Alloys	159
8.1	Introduction	159
8.2	Uniform Dissolution.....	160
8.3	Selective Dissolution and Dealloying	165
8.4	Dealloying of Hume-Rothery Phases and of Martensites	186
	References	190
9	Rusting of Iron and Steel.....	193
	References	202
10	Passivity	204
10.1	Introduction	204
10.2	Iron in Acid Solutions	205
10.3	Iron in Weakly Acid, Neutral, and Alkaline Solutions	217
10.4	Chromium and Iron-Chromium Steels	228
10.5	Nickel, Molybdenum, and Stainless Steels	237
10.6	Amorphous and Nanocrystalline Alloys	241
10.7	Semiconducting Oxide Films, Spontaneous Passivation, and Passivating Inhibitors.....	244
10.8	Titanium, Aluminum	261
10.9	Zinc, Magnesium	276
10.10	Oxide Films on Steels in High-Temperature Aqueous Solutions	282
	References	285
11	Galvanic Corrosion Cells	294
11.1	Dissimilar Metal Contact Corrosion	294
11.1.1	Introduction	294
11.1.2	Cells with Homogeneous Distribution of Current and Potential	297
11.1.3	Contact Corrosion Cells with Coplanar Electrodes	302
11.2	Differential Aeration Cells.....	313
11.3	Modeling Concentration Fields in Galvanic Cells	319
	References	322
12	Pitting Corrosion	324
12.1	General Aspects	324
12.2	Breakdown of Passivity and Pit Nucleation	336
12.3	Growth of Pit Nuclei	342
12.4	More on Aluminum and Aluminum Alloys	349
12.4.1	Weakly Alkaline Solutions	349
12.4.2	Neutral and Acid Solutions	354
12.4.3	The Nature of the Pitting Potential	364

12.5	More on Iron, Nickel, and Stainless Steel	377
12.6	A Note on Crevice Corrosion.....	381
	References	384
13	Intercrystalline and Intracrystalline Corrosion	389
	References	399
14	Hydrogen Embrittlement	401
14.1	Introduction	401
14.2	HIC by High-Activity Hydrogen in Low Strength Steels	402
14.3	HISCC by Low-Activity Hydrogen in High-Strength Steels....	409
	References	418
15	Stress Corrosion Cracking	420
15.1	General Aspects	420
15.1.1	Introduction	420
15.1.2	Typical Results of SCC Testing	423
15.1.3	Modeling Stress Corrosion Mechanisms	429
15.2	Iron and Steels.....	452
15.2.1	Hydrogen-Induced SCC in High-Strength Steels	452
15.2.2	SCC of Mild Steel in Alkaline, Carbonate, and Nitrate Solutions	458
15.2.3	Stainless Steels.....	470
15.2.4	SCC in High-Temperature, High-Pressure Water	480
15.3	Titanium and Titanium Alloys.....	496
15.4	Precipitation Hardening Aluminum Alloys.....	503
15.5	General Aspects Continued.....	510
	References	516
16	Corrosion Fatigue.....	525
16.1	General Aspects	525
16.2	The Fracture Mechanical Approach	529
	References	541
17	Appendix	544
17.1	Anodic and Cathodic Protection	544
	References	548
17.2	Mass Transport by Diffusion	548
	References	554
17.3	Applications of Fracture Mechanics	554
	References	561
17.4	Electrode Impedance Spectroscopy.....	562
	17.4.1 Introduction	562

17.4.2 The Basic Equivalent Circuit	563
17.4.3 Real Electrode Impedances	566
17.4.4 Laplace and Fourier Transforms	569
17.4.5 Adsorption and Relaxation Impedance	572
17.4.6 Filmed and Coated Electrodes	574
17.4.7 Some Recent Contributions	579
References	580
17.5 Electrode Noise Spectroscopy.....	581
References	585
Index	587