

# Materials Handbook

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François Cardarelli

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# Materials Handbook

**A Concise Desktop Reference**

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 Springer

Dr. François Cardarelli,  
Principal Electrochemist, Materials  
Materials and Electrochemical Research (MER) Corp.  
7960 South Kolb Road  
Tucson, Arizona 85706  
USA  
phone: +1-520-574-1980 ext. 185  
fax: +1-520-574-1983  
e-mail: fcardarelli@mercorp.com  
URL: www.mercorp.com  
URL: www.francoiscardarelli.ca  
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## **Dedication for the First Edition**

The *Materials Handbook: A Concise Desktop Reference* is dedicated to my father, Antonio, and my mother, Claudine, to my sister, Elsa, and to my spouse Louise Saint-Amour for their love and support. I want also to express my thanks to my two parents and my uncle Consalvo Cardarelli, which in close collaboration have provided valuable financial support when I was a teenager to contribute to my first fully equipped geological and chemical laboratory and to my personal comprehensive scientific library. This was the starting point of my strong and extensive interest in both science and technology, and excessive consumption of scientific and technical literature.

*François Cardarelli*

## **Dedication for the Second Edition**

The *Materials Handbook: A Concise Desktop Reference* is dedicated to my father, Antonio, and my mother, Claudine, to my sister, Elsa, and to my wife Elizabeth I.R. Cardarelli for their love and support. I want also to express my thanks to my two parents and my uncle Consalvo Cardarelli, which in close collaboration have provided valuable financial support when I was a teenager to contribute to my first fully equipped geological and chemical laboratory and to my personal comprehensive scientific library. This was the starting point of my strong and extensive interest in both science and technology, and excessive consumption of scientific and technical literature.

*François Cardarelli*

## **Acknowledgements for the First Edition**

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## Units Policy

In this book the only units of measure used for describing physical quantities and properties of materials are those recommended by the *Système International d'Unités* (SI). For accurate conversion factors between these units and the other non-SI units (e.g., cgs, fps, Imperial, and US customary), please refer to the reference book by the same author:

Cardarelli, F. (2005) *Encyclopaedia of Scientific Units, Weights, and Measures. Their SI Equivalences and Origins*. Springer, London New York. ISBN 978-1-85233-682-1.

## Author Biography

Dr. François Cardarelli (Ph.D.)  
Born in Paris (France) February 17, 1966  
Canadian citizen

## Academic Background

- Ph.D., chemical engineering (Université Paul Sabatier, Toulouse, France, 1996)
- Postgraduate degree (DEA) in electrochemistry (Université Pierre et Marie Curie, Paris, 1992)
- M.Sc. (Maîtrise), physical chemistry (Université Pierre et Marie Curie, Paris, 1991)
- B.Sc. (Licence), physical chemistry (Université Pierre et Marie Curie, Paris, 1990)
- DEST credits in nuclear sciences and technologies (Conservatoire National des Arts et Métiers, Paris, 1988)

- Associate degree (DEUG B) in geophysics and geology (Université Pierre et Marie Curie, Paris, 1987)
- Baccalaureate C (mathematics, physics, and chemistry) (CNED, Versailles, France, 1985)

## Fields of Professional Activity

The author has worked in the following areas (in chronological order) since 1990.

- (1) Research scientist at the Laboratory of Electrochemistry (Université Pierre & Marie Curie, Paris, France) for the development of a nuclear detector device for electrochemical experiments involving radiolabeled compounds;
- (2) research scientist at the Institute of Marine Biogeochemistry (CNRS & École Normale Supérieure, Paris, France) for the environmental monitoring of heavy-metal pollution by electroanalytical techniques;
- (3) research scientist for the preparation by electrochemistry in molten salts of tantalum protective thin coatings for the chemical-process industries (sponsored by Electricité de France);
- (4) research scientist for the preparation and characterization of iridium-based industrial electrodes for oxygen evolution in acidic media at the Laboratory of Electrochemical Engineering (Université Paul Sabatier, Toulouse, France);
- (5) registered consultant in chemical and electrochemical engineering (Toulouse, France);
- (6) battery product leader in the technology department of ARGOTECH Productions, Boucherville (Québec), Canada, in charge of electric-vehicle, stationary, and oil-drilling applications of lithium polymer batteries;
- (7) materials expert and industrial electrochemist in the lithium department of ARGOTECH Productions, involved in both the metallurgy and processing of lithium metal anodes and the recycling of spent lithium polymer batteries;
- (8) materials expert and industrial electrochemist in the technology department of AVESTOR, Boucherville (Quebec), Canada, in charge of all strategic raw materials entering into the fabrication of lithium polymer batteries, as well as being in charge of the recycling process of spent lithium batteries;
- (9) principal chemist, materials, in the technology department of RIO TINTO Iron and Titanium, Sorel-Tracy (Québec), Canada working on the electrowinning of titanium metal from titania-rich slags and on other novel electrochemical processes;
- (10) principal electrochemist at Materials and Electrochemical Research (MER) Corp., Tuscon (Arizona, USA) working on the electrowinning of titanium metal powder from composite anodes and other materials related projects.



# Contents

Introduction .....	xxxvii
<b>1 Properties of Materials.....</b>	<b>1</b>
1.1 Physical Properties .....	1
1.1.1 Mass Density .....	1
1.1.2 Theoretical Density or X-ray Density of Solids .....	2
1.1.3 Apparent, Bulk, and Tap Densities .....	2
1.1.4 Specific Weight .....	3
1.1.5 Specific Gravity .....	3
1.1.6 Buoyancy and Archimedes' Principle.....	3
1.1.7 Pycnometers for Solids .....	4
1.1.8 Density of Mixtures .....	5
1.2 Mechanical Properties.....	6
1.2.1 Stress and Pressure.....	7
1.2.2 Strain.....	7
1.2.3 Elastic Moduli and Hooke's Law.....	7
1.2.4 The Stress–Strain Curve.....	8
1.2.5 Strain Hardening Exponent.....	11
1.2.6 Hardness.....	11
1.2.7 Resilience and Modulus of Resilience .....	15
1.2.8 Toughness .....	15
1.2.9 Maximum Allowable Stress .....	15
1.2.10 Fracture Toughness.....	16
1.2.11 Brittleness Indices .....	17
1.2.12 Creep.....	17
1.2.13 Ductile-Brittle Transition .....	18
1.2.14 Fatigue .....	18
1.2.15 Tribological and Lubricating Properties of Solids .....	19
1.2.15.1 Static Friction Coefficient .....	19
1.2.15.2 Sliding Friction Coefficient.....	20

1.2.16	Ashby's Mechanical Performance Indices.....	21
1.2.17	Order of Magnitude of Mechanical Properties of Solid Materials .....	21
1.3	Acoustical Properties.....	23
1.3.1	Velocity of Sound in Materials .....	23
1.3.2	Sound Intensity.....	23
1.3.3	Attenuation of Sound at a Given Distance from a Source .....	24
1.3.4	Damping Capacity of Solids and Loss Factor.....	24
1.4	Thermal Properties .....	25
1.4.1	Molar and Specific Heat Capacities.....	25
1.4.2	Coefficients of Thermal Expansion.....	26
1.4.3	Volume Expansion on Melting.....	27
1.4.4	Thermal Shock Resistance .....	27
1.4.5	Heat Transfer Processes .....	28
1.4.6	Thermal Conductivity .....	28
1.4.7	Thermal Diffusivity.....	29
1.4.8	Spectral Emissivity.....	30
1.4.9	Temperature and Latent Enthalpies of Fusion, Vaporization, and Sublimation .....	30
1.4.10	Order of Magnitude of Thermal Properties of Materials .....	32
1.5	Optical Properties .....	32
1.5.1	Index of Refraction .....	32
1.5.2	Total Reflection and Critical Angle.....	34
1.5.3	Specific and Molar Refraction .....	35
1.5.4	Refractivity .....	35
1.5.5	Dispersion.....	35
1.5.6	Coefficient of Dispersion.....	36
1.5.7	Abbe Number.....	36
1.5.8	Temperature Dependence of the Refractive Index.....	36
1.5.9	Anisotropic Materials.....	36
1.5.10	Birefringence .....	37
1.5.11	Albedo and Reflective Index.....	37
1.5.12	Electromagnetic Radiation Spectrum .....	38
1.5.13	Order of Magnitude of Optical Properties of Transparent Materials .....	38
1.5.14	Macroscopic Absorption of Light.....	39
1.5.14.1	Damping Constant.....	39
1.5.14.2	First Law of Absorption (Bouguer's Law).....	39
1.5.14.3	Second Law of Absorption (Beer-Lambert Law).....	40
1.5.14.4	Absorbance or Optical Density .....	40
1.5.15	Microscopic Absorption and Emission Processes.....	41
1.5.16	Einstein Coefficients.....	42
1.5.16.1	Einstein Coefficient of Absorption.....	42
1.5.16.2	Einstein Coefficient of Spontaneous Emission .....	43
1.5.16.3	Einstein Coefficient of Stimulated Emission.....	44
1.5.16.4	Relation Between Einstein Coefficients .....	44
1.5.16.5	Relations Between Einstein and Extinction Coefficients .....	45
1.5.17	Luminescence.....	45
1.5.17.1	Excitation.....	46
1.5.17.2	Internal Conversion.....	46
1.5.17.3	Fluorescence.....	46
1.5.17.4	Intercombination.....	46
1.5.17.5	Delayed Fluorescence.....	47
1.5.17.6	Phosphorescence .....	47

1.6	Other Properties.....	47
1.6.1	Biocompatibility .....	47
1.6.2	Electronegativity.....	48
1.6.3	Chemical Abstract Registry Number .....	50
1.7	Fundamental Constants .....	50
1.8	Conversion Factors.....	52
1.9	Further Reading .....	54
1.9.1	Mathematics and Statistics .....	54
1.9.2	Units and Conversion Tables .....	55
1.9.3	Physics .....	55
1.9.4	Physical Chemistry.....	55
1.9.5	Engineering Fundamentals.....	56
1.9.6	General Handbooks.....	56
1.9.7	Mechanical Properties.....	56
1.9.8	Electrical Properties .....	56
1.9.9	Thermal Properties.....	56
1.9.10	Metallurgy .....	57
1.9.11	Materials Science .....	57
<b>2</b>	<b>Ferrous Metals and Their Alloys.....</b>	<b>59</b>
2.1	Iron and Steels.....	59
2.1.1	Description and General Properties .....	59
2.1.2	Phase Transitions and Allotropism of Iron .....	64
2.1.3	Metallographic Etchants for Iron and Steels.....	66
2.1.4	History .....	66
2.1.5	Natural Occurrence, Minerals, and Ores.....	66
2.1.6	Mining and Mineral Dressing.....	70
2.1.7	Iron- and Steelmaking.....	71
2.1.8	Pure Iron Grades.....	73
2.1.9	The Iron-Carbon (Fe-C) and Iron-Cementite (Fe-Fe <sub>3</sub> C) Systems.....	73
2.1.10	Cast Irons .....	78
2.1.10.1	Gray Cast Iron or Graphitic Iron .....	79
2.1.10.2	White Cast Iron.....	79
2.1.10.3	Malleable Cast Irons.....	79
2.1.10.4	Ductile (Nodular) Cast Irons.....	79
2.1.10.5	High-Silicon Cast Irons.....	80
2.1.11	Carbon Steels (C-Mn Steels) .....	84
2.1.11.1	Plain Carbon Steels.....	85
2.1.11.2	Low-Alloy Steels .....	89
2.1.11.3	Cast Steels.....	95
2.1.12	Stainless Steels .....	95
2.1.12.1	Description and General Properties .....	95
2.1.12.2	Classification of Stainless Steels.....	96
2.1.12.3	Martensitic Stainless Steels.....	97
2.1.12.4	Ferritic Stainless Steels.....	97
2.1.12.5	Austenitic Stainless Steels.....	101
2.1.12.6	Duplex Stainless Steels .....	102
2.1.12.7	Precipitation-Hardening Stainless Steels .....	103
2.1.12.8	Cast Heat-Resistant Stainless Steels.....	103
2.1.12.9	Processing and Melting Process.....	103

	2.1.12.10	Simplified Selection of Stainless Steels .....	108
	2.1.12.11	Stainless Steel Application Guidelines.....	109
2.1.13		High-Strength Low-Alloy Steels (HSLA) .....	112
2.1.14		Ultrahigh-Strength Steels.....	115
2.1.15		Tool and Machining Steels.....	115
2.1.16		Maraging Steels .....	120
2.1.17		Iron-Based Superalloys .....	121
2.1.18		Iron Powders .....	122
	2.1.18.1	Water-Atomized Iron Powders .....	122
	2.1.18.2	Gas-Atomized Iron Powders .....	123
	2.1.18.3	Sponge-Reduced Iron.....	123
2.1.19		Further Reading .....	123
2.2		Nickel and Nickel Alloys .....	124
	2.2.1	Description and General Properties.....	124
	2.2.2	History .....	124
	2.2.3	Natural Occurrence, Minerals and Ores .....	125
	2.2.4	Processing and Industrial Preparation .....	126
	2.2.5	Nickel Alloys.....	127
	2.2.6	Nickel Alloys and Superalloys .....	128
	2.2.7	Nickel-Titanium Shape Memory Alloys .....	139
	2.2.7.1	History .....	139
	2.2.7.2	Fundamental .....	139
	2.2.7.3	Shape Memory Effect.....	140
	2.2.7.4	Superelasticity .....	140
	2.2.7.5	Fabrication .....	140
	2.2.8	Major Nickel Producers .....	141
2.3		Cobalt and Cobalt Alloys.....	141
	2.3.1	Description and General Properties.....	141
	2.3.2	History .....	142
	2.3.3	Natural Occurrence, Minerals and Ores .....	143
	2.3.4	Processing and Industrial Preparation .....	144
	2.3.4.1	Cobalt as a Byproduct of Nickel Processing.....	144
	2.3.4.2	Electrowinning of Cobalt .....	144
	2.3.5	Properties of Cobalt Alloys and Superalloys .....	145
	2.3.6	Corrosion Resistance of Stellites .....	148
	2.3.7	Industrial Applications and Uses .....	148
	2.3.8	Major Cobalt Producers .....	149
2.4		Manganese and Manganese-Based Alloys .....	149
	2.4.1	Description and General Properties.....	149
	2.4.2	History .....	151
	2.4.3	Natural Occurrence, Minerals, and Ores .....	152
	2.4.4	Processing and Industrial Preparation .....	153
	2.4.4.1	Mining and Beneficiation of Manganese Ores .....	153
	2.4.4.2	Preparation of Pure Manganese Metal .....	153
	2.4.4.3	Ferromanganese and Silicomanganese.....	155
	2.4.5	Industrial Applications and Uses .....	156
	2.4.5.1	Metallurgical Uses .....	156
	2.4.5.2	Nonmetallurgical Uses .....	156
	2.4.6	Major Manganese Producers .....	157

<b>3</b>	<b>Common Nonferrous Metals.....</b>	<b>159</b>
3.1	Introduction .....	159
3.2	Aluminum and Aluminum Alloys.....	159
3.2.1	Description and General Properties .....	159
3.2.2	History .....	164
3.2.3	Natural Occurrence, Minerals, and Ores.....	165
3.2.4	Processing and Industrial Preparation.....	166
3.2.4.1	The Bayer Process.....	166
3.2.4.2	The Hall–Heroult Process for Electrowinning Aluminum .....	168
3.2.4.3	Secondary Aluminum Production and Recycling of Aluminum Drosses .....	169
3.2.5	Properties of Aluminum Alloys .....	170
3.2.5.1	Aluminum Alloy Standard Designations .....	171
3.2.5.2	Wrought Aluminum Alloys.....	172
3.2.5.3	Cast Aluminum Alloys .....	172
3.2.6	Industrial Applications and Uses.....	176
3.2.7	Major Aluminum Producers and Dross Recyclers .....	177
3.2.8	Further Reading.....	178
3.3	Copper and Copper Alloys.....	179
3.3.1	Description and General Properties .....	179
3.3.2	Natural Occurrence, Minerals, and Ores.....	179
3.3.3	Processing and Industrial Preparation.....	180
3.3.4	Properties of Copper Alloys.....	181
3.3.4.1	UNS Copper-Alloy Designation .....	181
3.3.4.2	Wrought Copper Alloys.....	183
3.3.4.3	Cast Copper Alloys .....	183
3.3.5	Major Copper Producers.....	187
3.3.6	Further Reading.....	187
3.4	Zinc and Zinc Alloys.....	187
3.4.1	Description and General Properties .....	187
3.4.2	History .....	188
3.4.3	Natural Occurrence, Minerals, and Ores.....	188
3.4.4	Processing and Industrial Preparation.....	189
3.4.4.1	Beneficiation of Zinc Ore .....	189
3.4.4.2	The Roasting Process .....	190
3.4.4.3	Mercury Removal .....	191
3.4.4.4	Hydrometallurgical Process .....	191
3.4.4.5	Pyrometallurgical Process .....	192
3.4.4.6	Treatment of Ferrite Residue .....	193
3.4.5	Industrial Applications and Uses.....	195
3.4.6	Properties of Zinc Alloys.....	196
3.5	Lead and Lead Alloys.....	196
3.5.1	Description and General Properties .....	196
3.5.2	History .....	199
3.5.3	Natural Occurrence, Minerals, and Ores.....	199
3.5.4	Beneficiation and Mineral Dressing .....	199
3.5.5	Processing and Industrial Preparation.....	199
3.5.6	Industrial Applications and Uses.....	201
3.5.7	Properties of Lead Alloys .....	201
3.5.8	Further Reading.....	201

3.6	Tin and Tin Alloys .....	204
3.6.1	Description and General Properties.....	204
3.6.2	History .....	205
3.6.3	Natural Occurrence, Minerals, and Ores .....	205
3.6.4	Processing and Industrial Preparation .....	206
3.6.4.1	Mining and Beneficiation.....	206
3.6.4.2	Processing and Smelting.....	207
3.6.5	Industrial Applications and Uses .....	208
3.6.6	Properties of Tin Alloys.....	208
3.7	Low-Melting-Point or Fusible Alloys.....	209
3.7.1	Further Reading .....	211
<b>4</b>	<b>Less Common Nonferrous Metals .....</b>	<b>213</b>
4.1	Alkali Metals.....	213
4.1.1	Lithium .....	217
4.1.1.1	Description and General Properties.....	217
4.1.1.2	History .....	219
4.1.1.3	Natural Occurrence, Minerals, and Ores.....	220
4.1.1.4	Processing and Industrial Preparation .....	223
4.1.1.5	Industrial Applications and Uses.....	228
4.1.1.6	Lithium Mineral and Chemical Prices .....	230
4.1.1.7	Lithium Mineral, Carbonate, and Metal Producers.....	230
4.1.1.8	Further Reading .....	231
4.1.2	Sodium .....	232
4.1.2.1	Description and General Properties.....	232
4.1.2.2	History .....	233
4.1.2.3	Natural Occurrence, Minerals, and Ores.....	233
4.1.2.4	Processing and Industrial Preparation .....	234
4.1.2.5	Industrial Applications and Uses .....	235
4.1.2.6	Transport, Storage, and Safety .....	236
4.1.2.7	Major Producers of Sodium Metal.....	236
4.1.2.8	Further Reading .....	236
4.1.3	Potassium .....	237
4.1.3.1	Description and General Properties.....	237
4.1.3.2	History .....	238
4.1.3.3	Natural Occurrence, Minerals, and Ores.....	238
4.1.3.4	Processing and Industrial Preparation .....	238
4.1.3.5	Industrial Applications and Uses.....	239
4.1.3.6	Further Reading .....	239
4.1.4	Rubidium.....	239
4.1.4.1	Description and General Properties.....	239
4.1.4.2	History .....	240
4.1.4.3	Natural Occurrence, Minerals, and Ores.....	240
4.1.4.4	Processing and Industrial Preparation .....	240
4.1.4.5	Industrial Applications and Uses.....	240
4.1.4.6	Major Rubidium Producers .....	241
4.1.4.7	Further Reading .....	241
4.1.5	Cesium .....	241
4.1.5.1	Description and General Properties.....	241
4.1.5.2	History .....	241
4.1.5.3	Natural Occurrence, Minerals, and Ores.....	242

	4.1.5.4	Processing and Industrial Preparation.....	242
	4.1.5.5	Industrial Applications and Uses.....	242
	4.1.5.6	Cesium Metal Producers.....	243
	4.1.5.7	Further Reading.....	243
	4.1.6	Francium .....	243
4.2	Alkaline-Earth Metals.....		243
	4.2.1	Beryllium .....	244
	4.2.1.1	Description and General Properties .....	244
	4.2.1.2	History.....	244
	4.2.1.3	Natural Occurrence, Minerals, and Ores.....	248
	4.2.1.4	Mining and Mineral Dressing .....	248
	4.2.1.5	Processing and Industrial Preparation.....	248
	4.2.1.6	Industrial Applications and Uses.....	249
	4.2.1.7	Major Beryllium Metal Producers.....	250
	4.2.1.8	Further Reading.....	250
	4.2.2	Magnesium and Magnesium Alloys.....	250
	4.2.2.1	Description and General Properties .....	250
	4.2.2.2	History.....	251
	4.2.2.3	Natural Occurrence, Minerals, and Ores.....	251
	4.2.2.4	Processing and Industrial Preparation.....	252
	4.2.2.5	Properties of Magnesium Alloys.....	255
	4.2.2.6	Industrial Applications and Uses.....	255
	4.2.2.7	Recycling of Magnesium Scrap and Drosses .....	255
	4.2.2.8	Major Magnesium Metal Producers .....	259
	4.2.2.9	Further Reading.....	260
	4.2.3	Calcium.....	260
	4.2.3.1	Description and General Properties .....	260
	4.2.3.2	History.....	260
	4.2.3.3	Natural Occurrence, Minerals, and Ores.....	260
	4.2.3.4	Processing and Industrial Preparation.....	261
	4.2.3.5	Industrial Applications and Uses.....	261
	4.2.3.6	Calcium Metal Producers .....	262
	4.2.3.7	Further Reading.....	262
	4.2.4	Strontium .....	262
	4.2.4.1	Description and General Properties .....	262
	4.2.4.2	History.....	263
	4.2.4.2	Natural Occurrence, Minerals, and Ores.....	263
	4.2.4.3	Processing and Industrial Preparation.....	263
	4.2.4.4	Industrial Applications and Uses.....	263
	4.2.5	Barium .....	263
	4.2.5.1	Description and General Properties .....	263
	4.2.5.2	History.....	264
	4.2.5.2	Natural Occurrence, Minerals, and Ores.....	264
	4.2.5.3	Processing and Industrial Preparation.....	264
	4.2.5.4	Industrial Applications and Uses.....	264
	4.2.6	Radium .....	264
	4.2.6.1	Description and General Properties .....	264
	4.2.6.2	History.....	265
	4.2.6.3	Natural Occurrence .....	265
	4.2.6.4	Processing and Industrial Preparation.....	265
	4.2.6.5	Industrial Applications and Uses.....	265

4.3	Refractory Metals.....	266
4.3.1	General Overview.....	266
4.3.1.1	Common Properties .....	266
4.3.1.2	Corrosion Resistance.....	271
4.3.1.3	Cleaning, Descaling, Pickling, and Etching.....	271
4.3.1.4	Machining of Pure Reactive and Refractory Metals .....	273
4.3.1.5	Pyrophoricity of Refractory Metals.....	273
4.3.2	Titanium and Titanium Alloys .....	274
4.3.2.1	Description and General Properties.....	274
4.3.2.2	History .....	276
4.3.2.3	Natural Occurrence, Minerals, and Ores.....	276
4.3.2.4	Mining and Mineral Dressing.....	280
4.3.2.5	Titanium Slag and Slagging .....	281
4.3.2.6	Synthetic Rutilites .....	283
4.3.2.7	Titanium Dioxide (Titania) .....	286
4.3.2.8	Titanium Sponge.....	288
4.3.2.9	Ferrotitanium.....	296
4.3.2.10	Titanium Metal Ingot .....	297
4.3.2.11	Titanium Metal Powder .....	298
4.3.2.12	Commercially Pure Titanium.....	301
4.3.2.13	Titanium Alloys .....	302
4.3.2.14	Corrosion Resistance.....	313
4.3.2.15	Titanium Metalworking .....	319
4.3.2.16	Titanium Machining.....	320
4.3.2.17	Titanium Joining.....	320
4.3.2.18	Titanium Etching, Descaling, and Pickling.....	320
4.3.2.19	Titanium Anodizing .....	321
4.3.2.20	Industrial Applications and Uses.....	322
4.3.2.21	Major Producers of Titanium Metal Sponge and Ingot .....	324
4.3.2.22	World and International Titanium Conferences.....	325
4.3.2.23	Further Reading .....	325
4.3.3	Zirconium and Zirconium Alloys.....	326
4.3.3.1	Description and General Properties.....	326
4.3.3.2	History .....	327
4.3.3.3	Natural Occurrence, Minerals, and Ores.....	328
4.3.3.4	Mining and Mineral Dressing.....	328
4.3.3.5	Processing and Industrial Preparation .....	329
4.3.3.6	Zirconium Alloys .....	331
4.3.3.7	Corrosion Resistance.....	333
4.3.3.8	Zirconium Machining .....	333
4.3.3.9	Industrial Uses and Applications.....	334
4.3.3.10	Zirconium Metal Producers.....	334
4.3.3.11	Further Reading .....	334
4.3.4	Hafnium and Hafnium Alloys .....	336
4.3.4.1	Description and General Properties.....	336
4.3.4.2	History .....	336
4.3.4.3	Natural Occurrence, Minerals, and Ores.....	337
4.3.4.4	Processing and Industrial Preparation .....	337
4.3.4.5	Industrial Applications and Uses.....	337
4.3.4.6	Major Hafnium Metal Producers .....	337
4.3.4.7	Further Reading .....	338



4.3.5	Vanadium and Vanadium Alloys.....	338
4.3.5.1	Description and General Properties .....	338
4.3.5.2	History .....	339
4.3.5.3	Natural Occurrence, Minerals, and Ores.....	339
4.3.5.4	Processing and Industrial Preparation.....	340
4.3.5.5	Industrial Applications and Uses.....	342
4.3.5.6	Major Vanadium Producers .....	342
4.3.5.7	Further Reading.....	342
4.3.6	Niobium and Niobium Alloys .....	343
4.3.6.1	Description and General Properties .....	343
4.3.6.2	History .....	344
4.3.6.3	Natural Occurrence, Minerals, and Ores.....	345
4.3.6.4	Processing and Industrial Preparation.....	346
4.3.6.5	Properties of Niobium Alloys.....	347
4.3.6.6	Niobium Metalworking.....	347
4.3.6.7	Niobium Machining .....	347
4.3.6.8	Niobium Joining and Welding .....	349
4.3.6.9	Niobium Cleaning, Pickling, and Etching.....	349
4.3.6.10	Industrial Applications and Uses.....	350
4.3.6.11	Major Producers of Niobium Metal.....	350
4.3.6.12	Further Reading.....	350
4.3.7	Tantalum and Tantalum Alloys .....	353
4.3.7.1	Description and General Properties .....	353
4.3.7.2	History .....	354
4.3.7.3	Natural Occurrence, Minerals, and Ores.....	355
4.3.7.4	Processing and Industrial Preparation.....	356
4.3.7.5	Properties of Tantalum Alloys .....	357
4.3.7.6	Tantalum Metalworking .....	357
4.3.7.7	Tantalum Machining.....	359
4.3.7.8	Tantalum Joining.....	359
4.3.7.9	Tantalum Cleaning and Degreasing .....	360
4.3.7.10	Tantalum Cladding and Coating Techniques .....	361
4.3.7.11	Industrial Applications and Uses.....	365
4.3.7.12	Major Tantalum Metal Producers.....	366
4.3.7.13	Further Reading.....	367
4.3.8	Chromium and Chromium Alloys .....	367
4.3.8.1	Description and General Properties .....	367
4.3.8.2	History .....	368
4.3.8.3	Natural Occurrence, Minerals, and Ores.....	368
4.3.8.4	Processing and Industrial Preparation.....	369
4.3.8.5	Industrial Applications and Uses.....	372
4.3.8.6	Major Chromite and Ferrochrome Producers.....	372
4.3.8.7	Further Reading.....	372
4.3.9	Molybdenum and Molybdenum Alloys.....	373
4.3.9.1	Description and General Properties .....	373
4.3.9.2	History .....	373
4.3.9.3	Natural Occurrence, Minerals, and Ores.....	374
4.3.9.4	Processing and Industrial Preparation.....	374
4.3.9.5	Properties of Molybdenum Alloys .....	375
4.3.9.6	Molybdenum Metalworking.....	377
4.3.9.7	Molybdenum Joining .....	377
4.3.9.8	Molybdenum Machining .....	378

	4.3.9.9	Molybdenum Cleaning, Etching, and Pickling .....	380
	4.3.9.10	Industrial Applications and Uses .....	380
	4.3.9.11	World Molybdenum Metal Producers .....	384
	4.3.9.12	Further Reading .....	384
4.3.10		Tungsten and Tungsten Alloys .....	385
	4.3.10.1	Description and General Properties.....	385
	4.3.10.2	History .....	386
	4.3.10.3	Natural Occurrence, Minerals, and Ores.....	386
	4.3.10.4	Processing and Industrial Preparation .....	387
	4.3.10.5	Properties of Tungsten Alloys .....	387
	4.3.10.6	Industrial Applications and Uses .....	387
	4.3.10.7	Major Tungsten Metal and Hardmetal Producers.....	389
	4.3.10.8	Further Reading .....	391
4.3.11		Rhenium and Rhenium Alloys .....	391
	4.3.11.1	Description and General Properties.....	391
	4.3.11.2	History .....	392
	4.3.11.3	Natural Occurrence, Minerals, and Ores.....	392
	4.3.11.4	Processing and Industrial Preparation .....	393
	4.3.11.5	Industrial Applications and Uses .....	393
4.4		Noble and Precious Metals.....	393
	4.4.1	Silver and Silver Alloys.....	396
	4.4.1.1	Description and General Properties.....	396
	4.4.1.2	History .....	397
	4.4.1.3	Natural Occurrence, Minerals, and Ores.....	397
	4.4.1.4	Processing and Industrial Preparation .....	397
	4.4.1.5	Silver Alloys.....	398
	4.4.1.6	Industrial Applications and Uses .....	398
	4.4.1.7	Further Reading .....	400
	4.4.2	Gold and Gold Alloys.....	400
	4.4.2.1	Description and General Properties.....	400
	4.4.2.2	History .....	401
	4.4.2.3	Natural Occurrence, Minerals, and Ores.....	402
	4.4.2.4	Mineral Dressing, and Mining.....	402
	4.4.2.5	Processing and Industrial Preparation .....	403
	4.4.2.6	Gold Alloys .....	404
	4.4.2.7	Industrial Applications and Uses .....	406
	4.4.2.8	Major Gold Producers and Suppliers.....	406
4.5		Platinum-Group Metals.....	407
	4.5.1	General Overview.....	407
	4.5.2	Natural Occurrence, Chief Minerals, and Ores .....	408
	4.5.3	Common Physical and Chemical Properties.....	409
	4.5.4	The Six Platinum Group Metals .....	409
	4.5.4.1	Ruthenium.....	409
	4.5.4.2	Rhodium .....	413
	4.5.4.3	Palladium.....	413
	4.5.4.4	Osmium .....	414
	4.5.4.5	Iridium .....	414
	4.5.4.6	Platinum .....	415
	4.5.5	PGM Alloys.....	416

4.5.6	PGMs Corrosion Resistance .....	417
4.5.6.1	Industrial Applications and Uses.....	420
4.5.6.2	Major Producers and Suppliers of PGMs .....	421
4.5.7	Further Reading.....	422
4.6	Rare-Earth Metals.....	422
4.6.1	Description and General Properties .....	422
4.6.2	History .....	423
4.6.3	Natural Occurrence, Minerals, and Ores.....	425
4.6.4	Processing and Industrial Preparation.....	427
4.6.5	Industrial Applications and Uses.....	429
4.6.6	Major Producers and Suppliers of Rare Earths .....	431
4.6.7	Further Reading.....	432
4.6.8	Scandium (Sc) .....	433
4.6.8.1	Description and General Properties .....	433
4.6.8.2	History.....	433
4.6.8.3	Natural Occurrence, Minerals, and Ores.....	433
4.6.8.4	Processing and Industrial Preparation.....	434
4.6.8.5	Industrial Applications and Uses.....	434
4.6.8.6	Scandium Metal, Alloys, and Chemicals .....	435
4.7	Uranides.....	436
4.7.1	Uranium .....	438
4.7.1.1	Description and General Properties .....	438
4.7.1.2	History.....	439
4.7.1.3	Natural Occurrence, Minerals, and Ores.....	440
4.7.1.4	Mineral Dressing and Mining .....	441
4.7.1.5	Processing and Industrial Preparation.....	442
4.7.1.6	Industrial Applications and Uses.....	446
4.7.1.7	Further Reading.....	447
4.7.2	Thorium.....	447
4.7.2.1	Description and General Properties .....	447
4.7.2.2	History.....	447
4.7.2.3	Natural Occurrence, Minerals, and Ores.....	448
4.7.2.4	Processing and Industrial Preparation.....	449
4.7.2.5	Industrial Applications and Uses.....	451
4.7.2.6	Further Reading.....	452
4.7.3	Plutonium.....	452
4.7.3.1	Description and General Properties .....	452
4.7.3.2	History.....	453
4.7.3.3	Natural Occurrence, Minerals, and Ores.....	454
4.7.3.4	Processing and Industrial Preparation.....	454
<b>5</b>	<b>Semiconductors.....</b>	<b>455</b>
5.1	Band Theory of Bonding in Crystalline Solids.....	455
5.2	Electrical Classification of Solids .....	456
5.3	Semiconductor Classes.....	457
5.3.1	Intrinsic or Elemental Semiconductors.....	457
5.3.2	Doped Extrinsic Semiconductors.....	458
5.3.3	Compound Semiconductors.....	459
5.3.4	Grimm–Sommerfeld Rule.....	459
5.4	Concentrations of Charge Carriers .....	460

5.5	Transport Properties .....	461
5.5.1	Electromigration .....	461
5.5.2	Diffusion .....	462
5.5.3	Hall Effect .....	462
5.6	Physical Properties of Semiconductors .....	463
5.7	Industrial Applications and Uses .....	463
5.8	Common Semiconductors.....	463
5.8.1	Silicon.....	463
5.8.2	Germanium.....	469
5.8.3	Boron.....	470
5.8.4	Other Semiconductors.....	471
5.9	Semiconductor Wafer Processing .....	471
5.9.1	Monocrystal Growth.....	472
5.9.2	Wafer Production .....	473
5.10	The P-N Junction .....	475
5.11	Further Reading .....	475
<b>6</b>	<b>Superconductors .....</b>	<b>477</b>
6.1	Description and General Properties.....	477
6.2	Superconductor Types.....	478
6.2.1	Type I Superconductors .....	478
6.2.2	Type II Superconductors.....	480
6.2.3	High-critical-temperature Superconductors .....	481
6.2.4	Organic Superconductors .....	482
6.3	Basic Theory .....	482
6.4	Meissner–Ochsenfeld Effect.....	483
6.5	History.....	483
6.6	Industrial Applications and Uses .....	485
6.7	Further Reading .....	485
<b>7</b>	<b>Magnetic Materials.....</b>	<b>487</b>
7.1	Magnetic Physical Quantities.....	487
7.1.1	Magnetic Field Strength and Magnetomotive Force .....	487
7.1.2	Magnetic Flux Density and Magnetic Induction.....	488
7.1.3	Magnetic Flux.....	489
7.1.4	Magnetic Dipole Moment .....	490
7.1.5	Magnetizability, Magnetization, and Magnetic Susceptibility .....	491
7.1.6	Magnetic Force Exerted on a Material .....	492
7.1.7	Magnetic Force Exerted by Magnets.....	493
7.1.8	Magnetic Energy Density Stored .....	493
7.1.9	Magnetoresistance .....	494
7.1.10	Magnetostriction.....	494
7.1.11	Magnetocaloric Effect.....	495
7.1.12	SI and CGS Units Used in Electromagnetism.....	498
7.2	Classification of Magnetic Materials .....	498
7.2.1	Diamagnetic Materials .....	499
7.2.2	Paramagnetic Materials.....	500
7.2.3	Ferromagnetic Materials .....	501
7.2.4	Antiferromagnetic Materials .....	503
7.2.5	Ferrimagnetic Materials .....	504

7.3	Ferromagnetic Materials .....	504
7.3.1	B-H Magnetization Curve and Hysteresis Loop .....	504
7.3.2	Eddy-Current Losses .....	506
7.3.3	Induction Heating .....	507
7.3.4	Soft Ferromagnetic Materials .....	507
7.3.5	Hard Magnetic Materials .....	510
7.3.6	Magnetic Shielding and Materials Selection .....	512
7.4	Industrial Applications of Magnetic Materials .....	516
7.5	Further Reading .....	516
<b>8</b>	<b>Insulators and Dielectrics .....</b>	<b>519</b>
8.1	Physical Quantities of Dielectrics .....	519
8.1.1	Permittivity of Vacuum .....	519
8.1.2	Permittivity of a Medium .....	519
8.1.3	Relative Permittivity and Dielectric Constant .....	520
8.1.4	Capacitance .....	520
8.1.5	Temperature Coefficient of Capacitance .....	520
8.1.6	Charging and Discharging a Capacitor .....	521
8.1.7	Capacitance of a Parallel-Electrode Capacitor .....	521
8.1.8	Capacitance of Other Capacitor Geometries .....	521
8.1.9	Electrostatic Energy Stored in a Capacitor .....	522
8.1.10	Electric Field Strength .....	522
8.1.11	Electric Flux Density .....	522
8.1.12	Microscopic Electric Dipole Moment .....	522
8.1.13	Polarizability .....	523
8.1.14	Macroscopic Electric Dipole Moment .....	523
8.1.15	Polarization .....	523
8.1.16	Electric Susceptibility .....	524
8.1.17	Dielectric Breakdown Voltage .....	524
8.1.18	Dielectric Absorption .....	524
8.1.19	Dielectric Losses .....	525
8.1.20	Loss Tangent or Dissipation Factor .....	525
8.1.21	Dielectric Heating .....	526
8.2	Physical Properties of Insulators .....	526
8.2.1	Insulation Resistance .....	526
8.2.2	Volume Electrical Resistivity .....	526
8.2.3	Temperature Coefficient of Electrical Resistivity .....	527
8.2.4	Surface Electrical Resistivity .....	528
8.2.5	Leakage Current .....	528
8.2.6	SI and CGS Units Used in Electricity .....	529
8.3	Dielectric Behavior .....	530
8.3.1	Electronic Polarization .....	530
8.3.2	Ionic Polarization .....	531
8.3.3	Dipole Orientation .....	531
8.3.4	Space Charge Polarization .....	531
8.3.5	Effect of Frequency on Polarization .....	531
8.3.6	Frequency Dependence of the Dielectric Losses .....	532
8.4	Dielectric Breakdown Mechanisms .....	532
8.4.1	Electronic Breakdown or Corona Mechanism .....	533
8.4.2	Thermal Discharge or Thermal Mechanism .....	533
8.4.3	Internal Discharge or Intrinsic Mechanism .....	533

8.5	Electrostriction .....	533
8.6	Piezoelectricity .....	534
8.7	Ferroelectrics .....	534
8.8	Aging of Ferroelectrics .....	538
8.9	Classification of Industrial Dielectrics .....	538
8.9.1	Class I Dielectrics or Linear Dielectrics .....	538
8.9.2	Class II Dielectrics or Ferroelectrics .....	539
8.10	Selected Properties of Insulators and Dielectric Materials .....	539
8.11	Further Reading .....	542
<b>9</b>	<b>Miscellaneous Electrical Materials .....</b>	<b>543</b>
9.1	Thermocouple Materials .....	543
9.1.1	The Seebeck Effect .....	543
9.1.2	Thermocouple .....	544
9.1.3	Properties of Common Thermocouple Materials .....	545
9.2	Resistors and Thermistors .....	548
9.2.1	Electrical Resistivity .....	548
9.2.2	Temperature Coefficient of Electrical Resistivity .....	548
9.3	Electron-emitting Materials .....	552
9.4	Photocathode Materials .....	553
9.5	Secondary Emission .....	554
9.6	Electrolytes .....	555
9.7	Electrode Materials .....	556
9.7.1	Electrode Materials for Batteries and Fuel Cells .....	556
9.7.2	Intercalation Compounds .....	559
9.7.3	Electrode Materials for Electrolytic Cells .....	561
9.7.3.1	Industrial Cathode Materials .....	563
9.7.3.1.1	Low-Carbon Steel Cathodes .....	563
9.7.3.1.2	Aluminum Cathodes .....	563
9.7.3.1.3	Titanium Cathodes .....	564
9.7.3.1.4	Zirconium Cathodes .....	565
9.7.3.1.5	Nickel Cathodes .....	565
9.7.3.1.6	Mercury Cathode .....	565
9.7.3.2	Industrial Anode Materials .....	565
9.7.3.2.1	Precious- and Noble-Metal Anodes .....	568
9.7.3.2.2	Lead and Lead-Alloy Anodes .....	569
9.7.3.2.3	Carbon Anodes .....	572
9.7.3.2.4	Lead Dioxide (PbO <sub>2</sub> ) .....	573
9.7.3.2.5	Manganese Dioxide (MnO <sub>2</sub> ) .....	575
9.7.3.2.6	Spinel (AB <sub>2</sub> O <sub>4</sub> )- and Perovskite (ABO <sub>3</sub> )-Type Oxides .....	575
9.7.3.2.7	Ebonex®(Ti <sub>4</sub> O <sub>7</sub> and Ti <sub>5</sub> O <sub>9</sub> ) .....	576
9.7.3.2.8	Noble-Metal-Coated Titanium Anodes (NMCT) .....	578
9.7.3.2.9	Platinized Titanium and Niobium Anodes (70/30 Pt/Ir) .....	579
9.7.3.2.10	Dimensionally Stable Anodes (DSA®) for Chlorine Evolution .....	580
9.7.3.2.11	Dimensionally Stable Anodes (DSA®) for Oxygen .....	581
9.7.3.2.12	Synthetic Diamond Electrodes .....	585

9.7.4	Electrodes for Corrosion Protection and Control .....	586
9.7.4.1	Cathodes for Anodic Protection .....	586
9.7.4.2	Anodes for Cathodic Protection.....	587
9.7.5	Electrode Suppliers and Manufacturers .....	589
9.8	Electrochemical Galvanic Series.....	590
<b>10</b>	<b>Ceramics, Refractories, and Glasses.....</b>	<b>593</b>
10.1	Introduction and Definitions .....	593
10.2	Raw Materials for Ceramics, Refractories and Glasses .....	594
10.2.1	Silica.....	594
10.2.1.1	Quartz, Quartzite, and Silica Sand .....	595
10.2.1.2	Diatomite.....	595
10.2.1.3	Fumed Silica.....	595
10.2.1.4	Silica Gels and Sol-Gel Silica.....	595
10.2.1.5	Precipitated Silica .....	595
10.2.1.6	Microsilica.....	596
10.2.1.7	Vitreous or Amorphous Silica.....	596
10.2.2	Aluminosilicates .....	596
10.2.2.1	Fireclay .....	597
10.2.2.2	China Clay .....	598
10.2.2.3	Ball Clay.....	598
10.2.2.4	Other Refractory Clays.....	599
10.2.2.5	Andalusite, Kyanite, and Sillimanite .....	599
10.2.2.6	Mullite.....	600
10.2.3	Bauxite and Aluminas .....	600
10.2.3.1	Bauxite .....	600
10.2.3.2	Alumina Hydrates .....	603
10.2.3.3	Transition Aluminas (TrA) .....	606
10.2.3.4	Calcined Alumina .....	606
10.2.3.5	Tabular Alumina .....	607
10.2.3.6	White Fused Alumina .....	608
10.2.3.7	Brown Fused Alumina .....	608
10.2.3.8	Electrofused Alumina-Zirconia.....	609
10.2.3.9	High-Purity Alumina .....	609
10.2.4	Limestone and Lime .....	610
10.2.5	Dolomite and Doloma.....	610
10.2.5.1	Dolomite.....	610
10.2.5.2	Calcined and Dead Burned Dolomite (Doloma) .....	611
10.2.6	Magnesite and Magnesia.....	612
10.2.6.1	Magnesite .....	612
10.2.6.2	Caustic Seawater and Calcined Magnesia .....	612
10.2.6.3	Dead Burned Magnesia .....	613
10.2.6.4	Electrofused Magnesia .....	614
10.2.6.5	Seawater Magnesia Clinker.....	614
10.2.7	Titania.....	614
10.2.7.1	Rutile.....	614
10.2.7.2	Anatase .....	616
10.2.7.3	Brookite.....	616
10.2.7.4	Anosovite.....	616
10.2.7.5	Titanium Sesquioxide .....	617
10.2.7.6	Titanium Monoxide or Hongquiite .....	617

	10.2.7.7	Titanium Hemioxide .....	618
	10.2.7.8	Andersson–Magnéli Phases .....	618
10.2.8		Zircon and Zirconia .....	618
	10.2.8.1	Zircon.....	618
	10.2.8.2	Zirconia.....	618
10.2.9		Carbon and Graphite .....	623
	10.2.9.1	Description and General Properties.....	623
	10.2.9.2	Natural Occurrence and Mining .....	623
	10.2.9.3	Industrial Preparation and Processing.....	625
	10.2.9.4	Industrial Applications and Uses.....	625
10.2.10		Silicon Carbide .....	625
	10.2.10.1	Description and General Properties.....	625
	10.2.10.2	Industrial Preparation.....	626
	10.2.10.3	Grades of Silicon Carbide.....	628
10.2.11		Properties of Raw Materials Used in Ceramics, Refractories, and Glasses .....	628
10.3		Traditional Ceramics .....	629
10.4		Refractories.....	630
	10.4.1	Classification of Refractories .....	630
	10.4.2	Properties of Refractories .....	631
	10.4.3	Major Refractory Manufacturers.....	634
10.5		Advanced Ceramics .....	635
	10.5.1	Silicon Nitride .....	635
	10.5.1.1	Description and General Properties.....	635
	10.5.1.2	Industrial Preparation and Grades .....	635
	10.5.2	Silicon Aluminum Oxynitride (SiAlON) .....	636
	10.5.3	Boron Carbide .....	637
	10.5.3.1	Description and General Properties.....	637
	10.5.3.2	Industrial Preparation.....	637
	10.5.3.3	Industrial Applications and Uses.....	637
	10.5.4	Boron Nitride .....	637
	10.5.4.1	Description and General Properties.....	637
	10.5.4.2	Industrial Preparation.....	638
	10.5.4.3	Industrial Applications and Uses.....	638
	10.5.5	Titanium Diboride.....	638
	10.5.5.1	Description and General Properties.....	638
	10.5.5.2	Industrial Preparation and Processing.....	639
	10.5.5.3	Industrial Applications and Uses.....	639
	10.5.6	Tungsten Carbides and Hardmetal .....	639
	10.5.6.1	Description and General Properties.....	639
	10.5.6.2	Industrial Preparation.....	640
	10.5.6.3	Industrial Applications and Uses.....	640
	10.5.7	Practical Data for Ceramists and Refractory Engineers.....	641
	10.5.7.1	Temperature of Color.....	641
	10.5.7.2	Pyrometric Cone Equivalents.....	641
10.6		Standards for Testing Refractories.....	643
10.7		Properties of Pure Ceramics (Borides, Carbides, Nitrides, Silicides, and Oxides).....	647
10.8		Further Reading .....	670
	10.8.1	Traditional and Advanced Ceramics .....	670
	10.8.2	Refractories.....	670



10.9	Glasses.....	671
10.9.1	Definitions.....	671
10.9.2	Physical Properties of Glasses .....	671
10.9.3	Glassmaking Processes.....	671
10.9.4	Further Reading.....	676
10.10	Proppants .....	677
10.10.1	Fracturing Techniques in Oil-Well Production .....	677
10.10.1.1	Hydraulic Fracturing.....	677
10.10.1.2	Pressure Acidizing.....	678
10.10.2	Proppant and Frac Fluid Selection Criteria .....	678
10.10.2.1	Proppant Materials.....	678
10.10.2.2	Frac Fluids.....	679
10.10.2.3	Properties and Characterization of Proppants .....	679
10.10.2.4	Classification of Proppant Materials .....	679
10.10.2.5	Production of Synthetic Proppants .....	682
10.10.2.6	Properties of Commercial Proppants .....	683
10.10.2.7	Proppant Market .....	687
10.10.2.8	Proppant Producers .....	687
10.10.3	Further Reading.....	689
<b>11</b>	<b>Polymers and Elastomers .....</b>	<b>691</b>
11.1	Fundamentals and Definitions .....	691
11.1.1	Definitions.....	691
11.1.2	Additives and Fillers.....	692
11.1.3	Polymerization and Polycondensation.....	693
11.2	Properties and Characteristics of Polymers .....	694
11.2.1	Molar Mass and Relative Molar Mass .....	694
11.2.2	Average Degree of Polymerization .....	695
11.2.3	Number-, Mass- and Z-Average Molar Masses .....	695
11.2.4	Glass Transition Temperature.....	697
11.2.5	Structure of Polymers.....	697
11.3	Classification of Plastics and Elastomers .....	697
11.4	Thermoplastics.....	697
11.4.1	Naturally Occurring Resins .....	697
11.4.1.1	Rosin.....	697
11.4.1.2	Shellac.....	699
11.4.2	Cellulosics.....	699
11.4.2.1	Cellulose Nitrate .....	699
11.4.2.2	Cellulose Acetate (CA) .....	700
11.4.2.3	Cellulose Propionate (CP) .....	700
11.4.2.4	Cellulose Xanthate.....	700
11.4.2.5	Alkylcelluloses .....	701
11.4.3	Casein Plastics.....	701
11.4.4	Coumarone-Indene Plastics .....	702
11.4.5	Polyolefins or Ethenic Polymers .....	702
11.4.5.1	Polyethylene (PE) .....	702
11.4.5.2	Polypropylene (PP) .....	703
11.4.5.3	Polybutylene (PB).....	704
11.4.6	Polymethylpentene (PMP).....	704

11.4.7	Polyvinyl Plastics .....	704
11.4.7.1	Polyvinyl Chlorides (PVCs) .....	704
11.4.7.2	Chlorinated Polyvinylchloride (CPVC) .....	705
11.4.7.3	Polyvinyl Fluoride (PVF) .....	705
11.4.7.4	Polyvinyl Acetate (PVA) .....	705
11.4.8	Polyvinylidene Plastics .....	705
11.4.8.1	Polyvinylidene Chloride (PVDC) .....	705
11.4.8.2	Polyvinylidene Fluoride (PVDF) .....	706
11.4.9	Styrenics .....	706
11.4.9.1	Polystyrene (PS) .....	706
11.4.9.2	Acrylonitrile Butadiene Styrene (ABS) .....	706
11.4.10	Fluorinated Polyolefins (Fluorocarbons) .....	707
11.4.10.1	Polytetrafluoroethylene (PTFE) .....	707
11.4.10.2	Fluorinated Ethylene Propylene (FEP) .....	708
11.4.10.3	Perfluorinated Alkoxy (PFA) .....	708
11.4.10.4	Polychlorotrifluoroethylene (PCTFE) .....	708
11.4.10.5	Ethylene-Chlorotrifluoroethylene Copolymer (ECTFE)....	709
11.4.10.6	Ethylene-Tetrafluoroethylene Copolymer (ETFE) .....	709
11.4.11	Acrylics and Polymethyl Methacrylate (PMMA) .....	709
11.4.12	Polyamides (PA) .....	710
11.4.13	Polyaramides (PAR) .....	710
11.4.14	Polyimides (PI) .....	710
11.4.15	Polyacetals (PAC) .....	711
11.4.16	Polycarbonates (PC) .....	711
11.4.17	Polysulfone (PSU) .....	711
11.4.18	Polyphenylene Oxide (PPO) .....	712
11.4.19	Polyphenylene Sulfide (PPS) .....	712
11.4.20	Polybutylene Terephthalate (PBT) .....	712
11.4.21	Polyethylene Terephthalate (PET) .....	712
11.4.22	Polydiallyl Phthalate (PDP) .....	713
11.5	Thermosets .....	713
11.5.1	Aminoplastics .....	713
11.5.2	Phenolics .....	714
11.5.3	Acrylonitrile-Butadiene-Styrene (ABS) .....	714
11.5.4	Polyurethanes (PUR) .....	715
11.5.5	Furan Plastics .....	715
11.5.6	Epoxy Resins (EP) .....	715
11.6	Rubbers and Elastomers .....	715
11.6.1	Natural Rubber (NR) .....	716
11.6.2	Trans-Polyisoprene Rubber (PIR) .....	716
11.6.3	Polybutadiene Rubber (BR) .....	716
11.6.4	Styrene Butadiene Rubber (SBR) .....	717
11.6.5	Nitrile Rubber (NR) .....	717
11.6.6	Butyl Rubber (IIR) .....	717
11.6.7	Chloroprene Rubber (CPR) .....	717
11.6.8	Chlorosulfonated Polyethylene (CSM) .....	718
11.6.9	Polysulfide Rubber (PSR) .....	718
11.6.10	Ethylene Propylene Rubbers .....	718
11.6.11	Silicone Rubber .....	719
11.6.12	Fluoroelastomers .....	719
11.7	Physical Properties of Polymers .....	720
11.8	Gas Permeability of Polymers .....	734

11.9	Chemical Resistance of Polymers.....	734
11.10	IUPAC Acronyms of Polymers and Elastomers.....	745
11.11	Economic Data on Polymers and Related Chemical Intermediates .....	746
11.11.1	Average Prices of Polymers .....	746
11.11.2	Production Capacities, Prices and Major Producers of Polymers and Chemical Intermediates.....	747
11.12	Further Reading .....	750
<b>12</b>	<b>Minerals, Ores and Gemstones .....</b>	<b>751</b>
12.1	Definitions .....	751
12.2	Mineralogical, Physical and Chemical Properties .....	756
12.2.1	Mineral Names.....	756
12.2.2	Chemical Formula and Theoretical Chemical Composition .....	757
12.2.3	Crystallographic Properties .....	757
12.2.4	Habit or Crystal Form .....	758
12.2.5	Color .....	759
12.2.6	Diaphaneity or Transmission of Light.....	760
12.2.7	Luster .....	760
12.2.8	Cleavage and Parting.....	760
12.2.9	Fracture .....	761
12.2.10	Streak .....	761
12.2.11	Tenacity .....	761
12.2.12	Density and Specific Gravity .....	762
12.2.13	Mohs Hardness .....	762
12.2.14	Optical Properties.....	765
12.2.15	Static Electricity and Magnetism.....	766
12.2.16	Luminescence.....	766
12.2.17	Piezoelectricity and Pyroelectricity .....	766
12.2.18	Play of Colors and Chatoyancy .....	767
12.2.19	Radioactivity .....	767
12.2.20	Miscellaneous Properties .....	767
12.2.21	Chemical Reactivity.....	767
12.2.22	Pyrognostic Tests or Fire Assays.....	768
12.2.22.1	The Flame Test.....	768
12.2.22.2	The Fusibility Test .....	770
12.2.22.3	The Reduction on Charcoal.....	771
12.2.22.4	Tests with Cobalt Nitrate and Sulfur Iodide .....	771
12.2.22.5	The Closed Tube Test.....	772
12.2.22.6	The Open Tube Test .....	774
12.2.22.7	The Bead Tests .....	775
12.2.23	Heavy-Media or Sink-float Separations in Mineralogy .....	776
12.2.23.1	Selection of Dense Media.....	777
12.2.23.2	Common Heavy Liquids Used in Mineralogy .....	777
12.3	Strunz Classification of Minerals .....	777
12.4	Dana's Classification of Minerals.....	779
12.5	Gemstones .....	781
12.5.1	Diamond.....	783
12.5.1.1	Introduction.....	783
12.5.1.2	Diamond Types.....	784
12.5.1.3	Diamond Physical and Chemical Properties .....	784
12.5.1.4	Diamond: Origins and Occurrence.....	786

	12.5.1.5	Industrial Applications .....	787
	12.5.1.6	Diamond Prices.....	788
	12.5.1.7	Treatments .....	788
	12.5.1.8	Diamond Shaping and Valuation.....	788
12.5.2	Beryl Gem Varieties .....		789
	12.5.2.1	Emerald.....	790
	12.5.2.2	Aquamarine.....	791
	12.5.2.3	Morganite .....	792
	12.5.2.4	Heliodor.....	792
	12.5.2.5	Goshenite.....	792
12.5.3	Corundum Gem Varieties .....		792
	12.5.3.1	Ruby .....	794
	12.5.3.2	Sapphire.....	794
12.5.4	Synthetic Gemstones .....		795
	12.5.4.1	Synthesis from Melts .....	795
	12.5.4.2	Synthesis from Solutions .....	796
	12.5.4.3	Diamond Synthesis.....	797
12.6	IMA Acronyms of Rock-forming Minerals .....		798
12.7	Mineral and Gemstone Properties Table .....		800
12.8	Mineral Synonyms .....		868
12.9	Further Reading .....		878
	12.9.1	Crystallography.....	878
	12.9.2	Optical Mineralogy .....	879
	12.9.3	Mineralogy.....	880
	12.9.4	Industrial Minerals .....	881
	12.9.5	Ores .....	881
	12.9.6	Gemstones .....	882
	12.9.7	Heavy Liquids and Mineral Dressing.....	883
<b>13</b>	<b>Rocks and Meteorites .....</b>		<b>885</b>
13.1	Introduction .....		885
13.2	Structure of the Earth's Interior .....		886
13.3	Different Type of Rocks.....		889
13.4	Igneous Rocks .....		890
	13.4.1	Classification of Igneous Rocks.....	891
		13.4.1.1 Crystals Morphology and Dimensions .....	892
		13.4.1.2 Mineralogy.....	892
		13.4.1.3 Coloration.....	894
	13.4.2	Texture of Igneous Rocks.....	895
	13.4.3	Chemistry of Igneous Rocks .....	896
	13.4.4	General Classification of Igneous Rocks .....	899
	13.4.5	Vesicular and Pyroclastic Igneous Rocks .....	904
13.5	Sedimentary Rocks .....		904
	13.5.1	Sediments .....	906
	13.5.2	Residual Sedimentary Rocks.....	906
	13.5.3	Detritic or Clastic Sedimentary Rocks .....	907
	13.5.4	Chemical Sedimentary Rocks .....	908
	13.5.5	Biogenic Sedimentary Rocks .....	909
	13.5.6	Chemical Composition.....	910

13.6	Metamorphic Rocks .....	910
13.6.1	Classification of Metamorphic Rocks .....	911
13.6.2	Metamorphic Grade .....	911
13.6.3	Metamorphic Facies .....	912
13.7	Ice .....	912
13.8	Meteorites .....	914
13.8.1	Definitions .....	914
13.8.2	Modern Classification of Meteorites .....	914
13.8.3	Tektites, Impactites, and Fulgurites .....	920
13.9	Properties of Common Rocks .....	921
13.10	Further Reading .....	925
<b>14</b>	<b>Soils and Fertilizers .....</b>	<b>927</b>
14.1	Introduction .....	927
14.2	History .....	928
14.3	Pedogenesis .....	929
14.3.1	Weathering and Alteration of Minerals and Clays Formation .....	929
14.3.2	Incorporation of Organic Matter .....	929
14.3.3	Mass Transfer between Horizons .....	930
14.3.3.1	Descending Processes .....	930
14.3.3.2	Ascending Processes .....	931
14.4	Soil Morphology .....	931
14.4.1	Major Horizons .....	931
14.4.2	Transitional Horizons .....	931
14.4.3	Subdivisions of Master Horizons .....	932
14.5	Soil Properties .....	936
14.5.1	Horizon Boundaries .....	936
14.5.2	Coloration of Soils .....	936
14.5.2	Soil Texture .....	938
14.5.4	Soil Structure .....	941
14.5.5	Consistency .....	944
14.5.6	Roots .....	945
14.5.7	Acidity (pH) and Effervescence .....	945
14.6	Soil Taxonomy .....	945
14.6.1	USDA Classification of Soils .....	945
14.6.2	FAO Classification of Soils .....	948
14.6.3	French Classification of Soils .....	954
14.6.4	ASTM Civil Engineering Classification of Soils .....	956
14.7	Soil Identification .....	957
14.8	ISO and ASTM Standards .....	958
14.9	Physical Properties of Common Soils .....	961
14.10	Fertilizers .....	961
14.10.1	Nitrogen Fertilizers .....	962
14.10.2	Phosphorus Fertilizers .....	963
14.10.3	Potassium Fertilizers .....	964
14.10.4	Role of Micronutrients in Soils .....	965
14.11	Further Reading .....	966
<b>15</b>	<b>Cements, Concrete, Building Stones and Construction Materials .....</b>	<b>967</b>
15.1	Introduction .....	967
15.1.1	Nonhydraulic Cements .....	968

15.2	Portland Cement .....	968
15.2.1	History .....	969
15.2.2	Raw Materials for Portland Cement.....	969
15.2.3	Processing of Portland Cement .....	970
15.2.4	Portland Cement Chemistry .....	971
15.2.5	Portland Cement Nomenclature .....	973
15.3	Aggregates.....	974
15.3.1	Coarse Aggregates.....	975
15.3.2	Fine Aggregates.....	976
15.4	Mineral Admixtures.....	976
15.5	Mortars and Concrete.....	976
15.5.1	Definitions.....	976
15.5.2	Degradation Processes .....	977
15.6	Ceramics for Construction.....	978
15.7	Building Stones.....	979
15.7.1	Limestones and Dolomites.....	979
15.7.2	Sandstones.....	979
15.7.3	Basalt .....	979
15.7.4	Granite .....	979
15.8	Further Reading .....	981
<b>16</b>	<b>Timbers and Woods.....</b>	<b>983</b>
16.1	General Description .....	983
16.2	Properties of Woods .....	985
16.2.1	Moisture Content .....	985
16.2.2	Specific Gravity and Density.....	986
16.2.3	Drying and Shrinkage.....	987
16.2.4	Mechanical Properties .....	987
16.2.5	Thermal Properties .....	988
16.2.6	Electrical Properties.....	989
16.2.7	Heating Values and Flammability.....	989
16.2.8	Durability and Decay Resistance.....	990
16.3	Properties of Hardwoods and Softwoods .....	990
16.4	Applications.....	997
16.5	Wood Performance in Various Corrosives.....	997
16.6	Further Reading .....	998
<b>17</b>	<b>Fuels, Propellants and Explosives.....</b>	<b>999</b>
17.1	Introduction and Classification.....	999
17.2	Combustion Characteristics.....	999
17.2.1	Enthalpy of Combustion .....	999
17.2.1.1	Stoichiometric Combustion Ratios .....	1001
17.2.1.2	Low (Net) and High (Gross) Heating Values .....	1001
17.2.1.3	Air Excess .....	1002
17.2.1.4	Dulong's Equations and Other Practical Equations .....	1002
17.2.1.5	Adiabatic Flame Temperature .....	1003
17.2.1.6	Wobbe Index for Gaseous Fuels.....	1003
17.3	Solid Fuels: Coals and Cokes.....	1004
17.4	Liquid Fuels .....	1008
17.5	Gaseous Fuels .....	1009

17.6	Prices of Common Fuels .....	1011
17.7	Propellants.....	1011
17.7.1	Liquid Propellants .....	1011
17.7.1.1	Petroleum-based Propellants .....	1012
17.7.1.2	Cryogenic Propellants.....	1012
17.7.1.3	Hypergolic Propellants .....	1012
17.7.2	Solid Propellants.....	1014
17.8	Explosives.....	1015
17.9	Further Reading.....	1018
17.9.1	Fuels and Combustion .....	1018
17.9.2	Propellants and Explosives.....	1018
<b>18</b>	<b>Composite Materials.....</b>	<b>1019</b>
18.1	Definitions.....	1019
18.2	Properties of Composites.....	1021
18.2.1	Density.....	1021
18.2.2	Tensile Strength and Elastic Moduli.....	1022
18.2.3	Specific Heat Capacity.....	1023
18.2.4	Thermal Conductivity.....	1023
18.2.5	Thermal Expansion Coefficient.....	1024
18.3	Fabrication Processes for Monofilaments.....	1024
18.4	Reinforcement Materials.....	1025
18.4.1	Glass Fibers .....	1025
18.4.2	Boron Fibers.....	1025
18.4.3	Carbon Fibers.....	1026
18.4.4	Polyethylene Fibers .....	1027
18.4.5	Polyaramide Fibers.....	1027
18.4.6	Ceramic Oxide Fibers.....	1028
18.4.7	Silicon Carbide Fibers .....	1028
18.5	Polymer Matrix Composites (PMCs).....	1029
18.6	Metal Matrix Composites (MMCs) .....	1031
18.7	Ceramic Matrix Composites (CMCs).....	1033
18.8	Carbon–Carbon Composites (CCs) .....	1034
18.9	Further Reading.....	1035
<b>19</b>	<b>Gases .....</b>	<b>1037</b>
19.1	Properties of Gases .....	1037
19.1.1	Pressure .....	1037
19.1.2	The Boyle–Mariotte Law.....	1039
19.1.3	Charles and Gay-Lussac’s Law .....	1040
19.1.4	The Avogadro–Ampere Law.....	1040
19.1.5	Normal and Standard Conditions.....	1040
19.1.6	Equation of State of Ideal Gases.....	1041
19.1.7	Dalton’s Law of Partial Pressure .....	1041
19.1.8	Equations of State of Real Gases .....	1042
19.1.8.1	Van der Waals Equation of State .....	1042
19.1.8.2	Virial Equation of State.....	1043
19.1.9	Density and Specific Gravity of Gases .....	1044
19.1.10	Barometric Equation .....	1045
19.1.11	Isobaric Coefficient of Cubic Expansion .....	1046

19.1.12	Compressibility Factor .....	1046
19.1.13	Isotherms of Real Gases and Critical Constants .....	1046
19.1.14	Critical Parameters .....	1047
19.1.15	The Principle of Corresponding States .....	1048
19.1.16	Microscopic Properties of Gas Molecules.....	1048
19.1.17	Molar and Specific Heat Capacities.....	1049
19.1.18	Dynamic and Kinematic Viscosities .....	1049
19.1.19	Solubility of Gases in Liquids .....	1050
19.1.20	Gas Permeability of Polymers.....	1051
19.1.21	Dielectric Properties of Gases, Permittivity and Breakdown Voltage .	1052
19.1.22	Psychrometry and Hygrometry.....	1054
19.1.23	Vapor Pressure.....	1054
19.1.23.1	Absolute Humidity or Humidity Ratio.....	1054
19.1.23.2	Mass Fraction of Water Vapor or Specific Humidity.....	1056
19.1.23.3	Relative Humidity.....	1056
19.1.23.4	Humid Heat.....	1056
19.1.23.5	Humid or Specific Volume .....	1056
19.1.23.6	Dry-Bulb Temperature.....	1057
19.1.23.7	Wet-Bulb Temperature .....	1057
19.1.23.8	Wet-Bulb Depression .....	1057
19.1.23.9	Dew Point Temperature .....	1057
19.1.23.10	Specific Enthalpy .....	1057
19.1.23.11	Latent Heat of Fusion .....	1057
19.1.23.12	Latent Heat of Vaporization .....	1058
19.1.23.13	Refractivity of Moist Air.....	1058
19.1.23.14	Psychrometric Charts.....	1058
19.1.23.15	Psychrometric Equations.....	1058
19.1.24	Flammability of Gases and Vapors .....	1062
19.1.24.1	Flammability Limits .....	1062
19.1.24.2	Explosive Limits.....	1062
19.1.24.3	Autoignition Temperature.....	1063
19.1.24.4	Ignition Energy .....	1063
19.1.24.5	Maximum Explosion Pressure.....	1063
19.1.24.6	Maximum Rate of Pressure Rise .....	1063
19.1.24.7	High and Low Heating Values.....	1063
19.1.25	Toxicity of Gases and Threshold Limit Averages .....	1064
19.2	Physico-Chemical Properties of Major Gases.....	1064
19.3	Monographies on Major Industrial Gases .....	1074
19.3.1	Air.....	1074
19.3.2	Nitrogen .....	1075
19.3.3	Oxygen .....	1076
19.3.4	Hydrogen.....	1078
19.3.5	Methane .....	1086
19.3.6	Carbon Monoxide.....	1087
19.3.7	Carbon Dioxide.....	1089
19.3.8	Helium and Noble Gases .....	1090
19.3.8.1	Neon.....	1091
19.3.8.2	Argon .....	1092
19.3.8.3	Krypton.....	1092
19.3.8.4	Xenon.....	1092
19.3.8.5	Radon.....	1092
19.4	Halocarbons.....	1093



19.5	Hydrates of Gases and Clathrates.....	1094
19.6	Materials for Drying and Purifying Gases .....	1095
19.6.1	Drying Agents and Dessiccants.....	1095
19.6.2	Molecular Sieves .....	1095
19.6.3	Getters and Scavengers .....	1099
19.7	Producers and Manufacturers of Major Industrial Gases.....	1100
19.8	Further Reading .....	1101
<b>20</b>	<b>Liquids .....</b>	<b>1103</b>
20.1	Properties of Liquids .....	1103
20.1.1	Density and Specific Gravity .....	1103
20.1.2	Hydrometer Scales.....	1104
20.1.3	Dynamic and Kinematic Viscosities .....	1104
20.1.3.1	Shear Stress .....	1105
20.1.3.2	Shear Rate.....	1105
20.1.3.3	Absolute or Dynamic Viscosity.....	1105
20.1.3.4	Kinematic Viscosity.....	1105
20.1.3.5	Temperature Dependence of the Dynamic Viscosity .....	1106
20.1.4	Classification of Fluids .....	1106
20.1.5	The Hagen–Poiseuille Equation and Pressure Losses.....	1106
20.1.5.1	Pressure Drop .....	1106
20.1.5.2	Friction Losses .....	1106
20.1.6	Sedimentation and Free settling.....	1109
20.1.7	Vapor Pressure.....	1110
20.1.8	Surface Tension, Wetting and Capillarity .....	1110
20.1.8.1	Surface Tension .....	1110
20.1.8.2	Temperature Dependence and Order of Magnitude of Surface Tension .....	1112
20.1.8.3	Parachor and Walden’s Rule .....	1113
20.1.8.4	Wetting .....	1113
20.1.8.5	Contact Angle .....	1113
20.1.8.6	Young’s Equation .....	1113
20.1.8.7	Work of Cohesion, Work of Adhesion and Spreading Coefficient .....	1114
20.1.8.8	Two Liquids and a Solid.....	1115
20.1.8.9	Antonoff’s Rule .....	1116
20.1.8.10	Capillarity and the Young–Laplace Equation.....	1116
20.1.8.11	Jurin’s Law.....	1116
20.1.8.12	Measurements of Surface Tension.....	1117
20.1.9	Colligative Properties of Nonvolatile Solutes .....	1118
20.1.9.1	Raoult’s Law for Boiling Point Elevation .....	1118
20.1.9.2	Raoult’s Law and Freezing Point Depression .....	1119
20.1.9.3	Van’t Hoff Law for Osmotic Pressure.....	1120
20.1.10	Flammability of Liquids.....	1121
20.2	Properties of Most Common Liquids .....	1121
20.3	Monographies on Liquids .....	1121
20.3.1	Properties of Water and Heavy Water.....	1121
20.3.2	Properties of Liquid Acids and Bases .....	1168
20.3.3	Properties of Heavy Liquids (Heavy Media).....	1171
20.3.3.1	Dense Halogenated Organic Solvents.....	1171
20.3.3.2	Dense Aqueous Solutions of Inorganic Salts .....	1172

20.3.3.3	Low Temperature of Molten Inorganic Salts .....	1174
20.3.3.4	Dense Emulsions and Suspensions .....	1174
20.3.3.5	Paramagnetic Liquid Oxygen .....	1175
20.4	Properties of Liquid Metals.....	1175
20.5	Properties of Molten Salts .....	1177
20.6	Properties of Heat Transfer Fluids .....	1178
20.7	Colloidal and Dispersed Systems.....	1180
20.8	Further Reading .....	1180
<b>A</b>	<b>Background Data for the Chemical Elements.....</b>	<b>1181</b>
A.1	Periodic Chart of the Elements .....	1181
A.2	Historical Names of the Chemical Elements .....	1181
A.3	UNS Standard Alphabetical Designation.....	1181
A.4	Names of Transfermium Elements 101–110.....	1184
A.5	Selected Physical Properties of the Elements .....	1185
A.6	Geochemical Classification of the Elements.....	1185
<b>B</b>	<b>NIST Thermochemical Data for Pure Substances.....</b>	<b>1195</b>
<b>C</b>	<b>Natural Radioactivity and Radionuclides .....</b>	<b>1201</b>
C.1	Introduction .....	1201
C.2	Mononuclidic Elements.....	1202
C.3	Nuclear Decay Series.....	1202
C.4	Non-Series Primordial Radionuclides .....	1205
C.5	Cosmogenic Radionuclides.....	1206
C.6	NORM and TENORM .....	1206
C.7	Activity Calculations.....	1207
C.7.1	Activity of a Material Containing One Natural Radionuclide .....	1207
C.7.2	Activity of a Material Containing Natural U and Th.....	1207
<b>D</b>	<b>Crystallography and Crystallochemistry.....</b>	<b>1209</b>
D.1	Direct Space Lattice Parameters .....	1209
D.2	Symmetry Elements .....	1210
D.3	The Seven Crystal Systems .....	1211
D.4	Conversion of a Rhombohedral to a Hexagonal Lattice .....	1211
D.5	The 14 Bravais Space Lattices .....	1211
D.6	Characteristics of Close-Packed Arrangements.....	1211
D.7	The 32 Classes of Symmetry.....	1212
D.8	Strukturbericht Structures .....	1215
D.9	The 230 Space Groups.....	1221
D.10	Crystallographic Calculations.....	1228
D.10.1	Theoretical Crystal Density.....	1228
D.10.2	Lattice Point and Vector Position .....	1228
D.10.3	Scalar Product .....	1228
D.10.4	Vector or Cross Product.....	1228
D.10.5	Mixed Product and Cell Multiplicity.....	1229
D.10.6	Unit Cell Volume .....	1230
D.10.7	Plane Angle between Lattice Planes .....	1230
D.11	Interplanar Spacing .....	1231
D.12	Reciprocal Lattice Unit Cell .....	1232

<b>E</b>	<b>Transparent Materials for Optical Windows</b> .....	<b>1233</b>
<b>F</b>	<b>Corrosion Resistance of Materials Towards Various Corrosive Media</b> .....	<b>1237</b>
<b>G</b>	<b>Economic Data for Metals, Industrial Minerals and Electricity</b> .....	<b>1245</b>
	G.1 Prices of Pure Elements.....	1245
	G.2 World Annual Production of Commodities.....	1248
	G.3 Economic Data for Industrial Minerals .....	1249
	G.4 Prices of Electricity in Various Countries .....	1254
<b>H</b>	<b>Geological Time Scale</b> .....	<b>1255</b>
<b>I</b>	<b>Materials Societies</b> .....	<b>1257</b>
	<b>Bibliography</b> .....	<b>1269</b>
	1 General Desk References.....	1269
	1.1 Scientific and Technical Writing.....	1269
	1.2 Chemicals .....	1270
	1.3 Plant Cost Estimation and Process Economics .....	1270
	1.4 Thermodynamic Tables .....	1271
	1.5 Phase Diagrams.....	1271
	2 Dictionaries and Encyclopedias .....	1272
	3 Comprehensive Series in Material Sciences .....	1272
	<b>Index</b> .....	<b>1277</b>

# Introduction

Despite the wide availability of several comprehensive series in materials sciences and metallurgy, it is difficult to find grouped properties either on metals and alloys, traditional and advanced ceramics, refractories, polymers and elastomers, composites, minerals and rocks, soils, woods, cement, and building materials in a single-volume source book.

Actually, the purpose of this practical and concise reference book is to provide key scientific and technical materials properties and data to materials scientists, metallurgists, engineers, chemists, and physicists as well as to professors, technicians, and students working in a broad range of scientific and technical fields.

The classes of materials described in this handbook are as follows:

- (i) metals and their alloys;
- (ii) semiconductors;
- (iii) superconductors;
- (iv) magnetic materials;
- (v) dielectrics and insulators;
- (vi) miscellaneous electrical materials (e.g., resistors, thermocouples, and industrial electrode materials);
- (vii) ceramics, refractories, and glasses;
- (viii) polymers and elastomers;
- (ix) minerals, ores, and gemstones;
- (x) rocks and meteorites;
- (xi) soils and fertilizers;
- (xii) timbers and woods;
- (xiii) cement and concrete;
- (xiv) building materials;
- (xv) fuels, propellants, and explosives;

- (xvi) composites;
- (xvii) gases;
- (xviii) liquids.

Particular emphasis is placed on the properties of the most common industrial materials in each class. The physical and chemical properties usually listed for each material are as follows:

- (i) physical (e.g., density, viscosity, surface tension);
- (ii) mechanical (e.g., elastic moduli, Poisson's ratio, yield and tensile strength, hardness, fracture toughness);
- (iii) thermal (e.g., melting and boiling point, thermal conductivity, specific heat capacity, coefficients of thermal expansion, spectral emissivities);
- (iv) electrical (e.g., resistivity, relative permittivity, loss tangent factor);
- (v) magnetic (e.g., magnetization, permeability, retentivity, coercivity, Hall constant);
- (vi) optical (e.g., refractive indices, reflective index, dispersion, transmittance);
- (vii) electrochemical (e.g., Nernst standard electrode potential, Tafel slopes, specific capacity, overpotential);
- (viii) miscellaneous (e.g., relative abundances, electron work function, thermal neutron cross section, Richardson constant, activity, corrosion rate, flammability limits).

Finally, detailed appendices provide additional information (e.g., properties of the pure chemical elements, thermochemical data, crystallographic calculations, radioactivity calculations, prices of metals, industrial minerals and commodities), and an extensive bibliography completes this comprehensive guide. The comprehensive index and handy format of the book enable the reader to locate and extract the relevant information quickly and easily. Charts and tables are all referenced, and tabs are used to denote the different sections of the book. It must be emphasized that the information presented here is taken from several scientific and technical sources and has been meticulously checked and every care has been taken to select the most reliable data.