

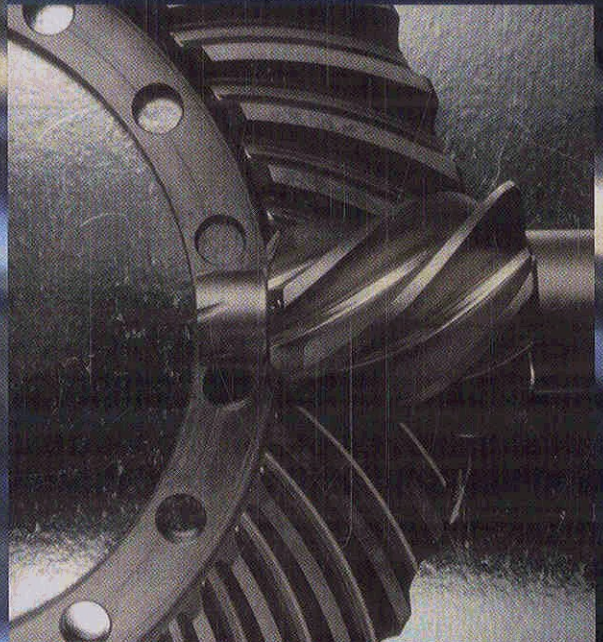
Metallurgy

Fundamentals

Fifth Edition

*Ferrous and
Nonferrous*

Daniel A. Brandt
J.C. Warner



Contents

Section One

Introduction to Metallurgy

Chapter 1

Practical Applications of Metallurgy 9

Metallurgy and Metallurgists 9

Practical Examples of Metallurgy in Modern Industry 10

Why Study Metallurgy? 12

Chapter 2

Metallurgical and Chemical Terminology 13

Basic Structure of Matter 13

Applying Chemical Terms to Steel 19

Section Two

Properties of Metals

Chapter 3

Hardness 21

What is Hardness? 21

Hardness Testing Methods 23

Comparing Hardness Testing Methods 40

Chapter 4

Material Properties 47

Mechanical Properties 47

Chemical Properties 59

Electrical Properties 60

Magnetic Properties 61

Thermal Properties 61

Comparison Charts of Metal Properties 65

Section Three

Ferrous Metallurgy

Chapter 5

What is Steel? 69

Composition of Steel 69

Steel Numbering System 69

Comparing Steel and Iron 70

Alloying Elements 71

Types of Steel 72

Cast Iron 81

Wrought Iron 86

Chapter 6

Manufacture of Iron and Steel 89

The Steel-Making Process 89

Iron Ore 91

Blast Furnace 93

Steel-Making Furnaces 98

Processing the Ingots 105

Continuous Casting 111

Manufacture of Cast Iron 113

Pollution Control 117

Chapter 7**Crystal Structure 119**

Space Lattice 120

Transformation Temperatures 123

Crystal Growth 124

Chapter 8**Failure and Deformation
of Metal 129**

Deformation 129

Ductility and Brittleness 129

Work Hardening 135

Chapter 9**Iron-Carbon Phase Diagram 137**

Structural Forms of Steel 137

Iron-Carbon Phase Diagram 139

Temperature Change and Mechanical
Properties 147**Chapter 10****Microstructural Analysis 153**

Microscopic Appearances 153

Sample Preparation Procedure 158

Chapter 11**Heat Treating and Quenching 163**

Heat Treating 163

Quenching 163

Quenching Mediums and Techniques 167

Summary of Quenching Methods 169

Practical Techniques Used in Quenching 171

Chapter 12**Annealing and Normalizing 177**

Overview of Annealing and Normalizing 177

Purposes for Annealing and Normalizing 178

Types of Annealing 179

Normalizing 183

Comparing Annealing, Normalizing, and
Quenching 184**Chapter 13****Isothermal Transformation
Diagrams 187**Introduction to Isothermal Transformation
Diagrams 187

Using I-T Diagrams 190

Industrial I-T Diagrams 195

Plotting I-T Diagrams 197

Comparing Isothermal Transformations 198

Chapter 14**Tempering 209**

Introduction to Tempering 209

Special Types of Tempering 211

Comparing Heat-Treating Methods 216

Chapter 15**Surface Hardening 219**

Introduction to Surface Hardening 219

Basic Surface-Hardening Methods 221

Surface-Hardening Processes 222

Section Four**Nonferrous Metallurgy****Chapter 16****Processing Nonferrous
Metals 235**

Introduction to Nonferrous Metallurgy 235

Atomic Structure of Metals 236

Alloying 238

Cold Working 239

Precipitation Hardening 242

Chapter 17**Aluminum and Aluminum
Alloys 249**

Introduction 249

Manufacturing Aluminum 249

Aluminum and Aluminum Alloy
Classifications 251

6 Contents

Applications of Aluminum 252
Changing the Properties of Aluminum 254

Chapter 18 Copper, Bronze, and Brass 259

Manufacture of Copper 259
Copper and Copper Alloy Designations 261
Changing the Properties of Copper 261

Chapter 19 Magnesium, Zinc, Tin, and Speciality Metals 267

Magnesium 267
Zinc 269

Tin 273
Nickel and Nickel Alloys 277
Titanium 278
Gold 280
Intermetallic Compounds 283

Glossary 285

Index 295