

Contents

| | | | |
|--|------------|--|------------|
| Preface | vii | Chapter 5 Heat Transport in Cast House Processes | 93 |
| Chapter 1 Component Casting | 1 | 5.1 Introduction | 93 |
| 1.1 Introduction | 1 | 5.2 Natural Convection in Metal Melts | 93 |
| 1.2 Casting of Components | 1 | 5.3 Heat Transport in Ingot Casting | 96 |
| Chapter 2 Cast House Processes | 15 | 5.4 Water Cooling | 101 |
| 2.1 Introduction | 15 | 5.5 Heat Transport during Continuous Casting of Steel | 105 |
| 2.2 Ingot Casting | 15 | 5.6 Heat Transport in the ESR Process | 117 |
| 2.3 Continuous Casting | 18 | 5.7 Heat Transport in Near Net Shape Casting | 119 |
| 2.4 From Ladle to Chill-mould in Continuous Casting of Steel | 20 | 5.8 Heat Transport in Spray Casting | 129 |
| 2.5 Near Net Shape Casting | 23 | Summary | 131 |
| 2.6 The ESR Process | 27 | Exercises | 133 |
| Chapter 3 Casting Hydrodynamics | 29 | Chapter 6 Structure and Structure Formation in Cast Materials | 139 |
| 3.1 Introduction | 29 | 6.1 Introduction | 139 |
| 3.2 Basic Hydrodynamics | 29 | 6.2 Structure Formation in Cast Materials | 140 |
| 3.3 Gating Systems in Component Casting | 32 | 6.3 Dendrite Structure and Dendrite Growth | 143 |
| 3.4 Gating System in Ingot Casting | 37 | 6.4 Eutectic Structure and Eutectic Growth | 145 |
| 3.5 Gating System in Continuous Casting | 38 | 6.5 Cooling Curves and Structure | 156 |
| 3.6 Inclusion Control in Gating Systems – Ceramic Filters | 42 | 6.6 Unidirectional Solidification | 158 |
| 3.7 Maximum Fluidity Length | 44 | 6.7 Macrostructures in Cast Materials | 162 |
| Summary | 53 | 6.8 Macrostructures in Ingot Cast Materials | 168 |
| Exercises | 54 | 6.9 Macrostructures in Continuously Cast Materials | 173 |
| Chapter 4 Heat Transport during Component Casting | 59 | 6.10 Macrostructures in Near Net Shape Cast Materials | 174 |
| 4.1 Introduction | 59 | 6.11 Amorphous Metals | 174 |
| 4.2 Basic Concepts and Laws of Heat Transport | 60 | Summary | 178 |
| 4.3 Theory of Heat Transport in Casting of Metals and Alloys | 65 | Exercises | 180 |
| 4.4 Heat Transport in Component Casting | 77 | Chapter 7 Microsegregation in Alloys – Peritectic Reactions and Transformations | 183 |
| Summary | 86 | 7.1 Introduction | 183 |
| Exercises | 89 | 7.2 Cooling Curves, Dendritic Growth, and Microsegregation | 183 |
| | | 7.3 Scheil's Segregation Equation – a Model of Microsegregation | 185 |

| | | | |
|--|------------|---|------------|
| 7.4 Solidification Processes in Alloys | 189 | Chapter 10 Solidification and Cooling Shrinkage of Metals and Alloys | 311 |
| 7.5 Influence of Back Diffusion in the Solid Phase on Microsegregation of Alloys | 197 | 10.1 Introduction | 311 |
| 7.6 Solidification Processes and Microsegregation in Iron-base Alloys | 202 | 10.2 Solidification and Cooling Shrinkage | 311 |
| 7.7 Peritectic Reactions and Transformations in Binary Iron-base Alloys | 207 | 10.3 Concepts and Laws. Methods of Measurement | 314 |
| 7.8 Microsegregation in Multicomponent Alloys | 211 | 10.4 Solidification and Cooling Shrinkage during Casting | 316 |
| 7.9 Microsegregation and Peritectic Reactions and Transformations in Multicomponent Iron-base Alloys | 217 | 10.5 Solidification Shrinkage during Ingot Casting | 326 |
| Summary | 220 | 10.6 Solidification and Cooling Shrinkage during Continuous Casting | 335 |
| Exercises | 223 | 10.7 Thermal Stress and Crack Formation during Solidification and Cooling Processes | 342 |
| Chapter 8 Heat Treatment and Plastic Forming | 227 | Summary | 363 |
| 8.1 Introduction | 227 | Exercises | 366 |
| 8.2 Homogenization | 227 | Chapter 11 Macrosegregation in Alloys | 369 |
| 8.3 Dissolution of Secondary Phases | 234 | 11.1 Introduction | 369 |
| 8.4 Change of Casting Structure During Cooling and Plastic Deformation | 240 | 11.2 Macrosegregation due to Solidification Shrinkage | 370 |
| 8.5 Cooling Shrinkage and Stress Relief Heat Treatment | 244 | 11.3 Macrosegregation during Unidirectional Solidification | 378 |
| 8.6 Hot Isostatic Pressing | 245 | 11.4 Inverse Macrosegregation | 380 |
| Summary | 249 | 11.5 Macrosegregation during Continuous Casting | 383 |
| Exercises | 251 | 11.6 Centre Segregation during Continuous Casting | 386 |
| Chapter 9 Precipitation of Pores and Slag Inclusions during Casting Processes | 255 | 11.7 Freckles | 393 |
| 9.1 Introduction | 255 | 11.8 Macrosegregation during Horizontal Solidification | 400 |
| 9.2 Units and Laws | 256 | 11.9 Macroseggregations in Steel Ingots | 401 |
| 9.3 Precipitation of Gases in Metal Melts | 257 | Summary | 406 |
| 9.4 Precipitation of Inclusions in Metal Melts | 265 | Exercises | 408 |
| 9.5 Aluminium and Aluminium Alloys | 267 | Answers to Exercises | 411 |
| 9.6 Copper and Copper Alloys | 271 | Index | 423 |
| 9.7 Steel and Iron Alloys | 275 | | |
| 9.8 Cast Iron | 298 | | |
| 9.9 Nickel and Nickel-Base Alloys | 301 | | |
| Summary | 302 | | |
| Exercises | 306 | | |