

Contents

1. Introduction	1
2. Definitions and Nomenclature	5
3. Mathematical Relationships for the Fundamental Microstructural Parameters	15
– Volume fractions	15
– Boundary area density and specific boundary area	20
– Size and spacing	22
– Degree of orientation	24
– Degree of interconnectedness (contiguity)	26
– Other parameters	27
– Relationships between parameters	28
– Use of simple geometrical models	29
– Appendix: Derivation of the equation $S_v = 2P_L$	30
4. Complex Microstructural Parameters	33
– Shape factors	33
– Size distributions	39
– Mean curvature	42
– Angle	42
– Topological parameters	43
– Arrangement	44
5. The Analysis of Projected Images and Stereometric Evaluation	47
6. Mathematical Morphology	55
7. Review of Measurement Techniques	67
– Image	68
– Identification of microstructural features	68
– Measurement and output	70
– Standard charts	72
– Frame edge errors	73
– Cost	76
8. Visual Comparative Methods and Manual Counting	79
– Comparative methods (standard charts)	79
– Simple counting and measuring techniques	83
– Appendix: Determination of volume fraction, specific boundary area and mean linear size	91

9. Semi-Automatic Electronic Instruments	93
– Linear analysers	93
– Digitizing tablets	94
– Interactive television systems and image storage	96
– Further semi-automatic image analysers	97
10. Fully Automatic Electronic Instruments	99
– Mode of operation	100
– Apparatus	101
– Measuring with fully automatic instruments	105
– Detection	115
– Measurement of the distinguishable grey shades	119
– Measurement of resolution	120
– Measurement using several signals	123
– Image storage	124
– Future developments	125
– Commercial instruments	126
11. Criteria for the Choice of Measuring Instrumentation	127
– Task	127
– Image formation	127
– Detection	128
– Measurement	128
– Choice of instrument	129
12. Selection and Preparation of Specimens	133
– Specimen selection	134
– Preparation	138
13. Statistical Methods for the Evaluation of Experimental Data	149
– Frequency and distribution	150
– Mean, variance and standard deviation	153
– Combination of errors	156
– Fitting experimental values to straight lines and other functions (regression analysis)	157
– Assessment of mean values and correlation coefficients with approximately equal standard deviations	158
– Testing distributions	160

14. Applications in Research and Industry	163
– Examples from steel research and technology	164
– Applications in powder metallurgy	174
– Further examples of applications in metals research	180
– Relationships between microstructure and properties	192
15. General References	197
16. References for the Individual Chapters	203
17. Subject Index	229
18. Name Index	233