## Contents

	Acro. Prefe	•	ix xi
1	Micr	oscopy with light and electrons	1
	1.1	Introduction 1	
	1.2	Methods of image formation 2	
	1.3	Pixels 3	
	1.4	The light-optical microscope 4	
	1.5	Magnification 7	
	1.6	Resolution 8	
	1.7	Depth of field and depth of focus 12	
		Aberrations in optical systems 14	
		Electrons versus light 16	
		Questions 19	
2	Elect	rons and their interaction with the specimen	20
	2.1	Introduction 20	
	2.2	Electrons 20	
	2.3	Generating a beam of electrons 24	
		Deflection of electrons - magnetic lenses 27	
		The scattering of electrons by atoms 29	
	2.6	· · · · · · · · · · · · · · · · · · ·	
	2.7	Inelastic scattering 31	
	2.8	_	
	2.9	• ••	
	2.10	Questions 38	

3	Electro	on diffraction	40
	3.1	The geometry of electron diffraction 41	
	3.2	Diffraction spot patterns 47	
	3.3	Use of the reciprocal lattice in diffraction analysis 51	
	3.4	Other types of diffraction pattern 58	
	3.5	Questions 64	
4	The ti	ransmission electron microscope	66
	4.1	The instrument 66	
	4.2	Contrast mechanisms 76	
	4.3	High voltage electron microscopy (HVEM) 108	
	4.4	Scanning transmission electron microscopy (STEM) 110	
	4.5	Preparation of specimens for TEM 110	
	4.6	Questions 121	
5	The s	canning electron microscope	122
	5.1	How it works 122	
	5.2	Obtaining a signal in the SEM 124	
	5,3	The optics of the SEM 131	
	5.4	The performance of the SEM 133	
	5.5	The ultimate resolution of the SEM 135	
	5.6	Topographic images 141	
	5.7	Compositional images 146	
	5.8	Crystallographic information from the SEM 149	
	5.9	The use of other signals in the SEM 153	
	5.10	Image acquisition, processing and storage 159	162
	5.11		102
	5.12	Low voltage microscopy 164	
	5.13	Environmental scanning electron microscopy (ESEM) 166	
	5.14	Questions 167	169
6		nical analysis in the electron microscope	100
	6.1	The generation of X-rays within a specimen 170	
	6.2	Detection and counting of X-rays 174	
	6.3	X-ray analysis of bulk specimens 184	
	6.4	X-ray analysis of thin specimens in the TEM 193	
	6.5		
	6.6		
	6.7	•	
	6.8	Questions 213	

Electron microscopy and other techniques		
7.1	Complementary imaging techniques 214	
7.2	Complementary analysis techniques – alternative analysis systems 225	
7.3	Complementary diffraction techniques 233	
7.4	Summary 234	
7.5	Questions 234	
Furti	236	
Ansv	238	
Index		243