

Contents

Introduction	ix
List of Contributors	xi
The Basics of Epitaxy	1
<i>D W Pashley</i>	
1 Introduction	1
2 The geometry of epitaxy	2
3 Growth mechanisms of epitaxial layers	5
4 The formation of imperfections in epitaxial deposits	10
5 Semiconductor epitaxy	13
6 References	15
Metal Organic Chemical Vapour Deposition (MOCVD) for the Preparation of Semiconductor Materials and Devices	17
<i>J O Williams</i>	
1 Introduction	17
2 The MOCVD process	19
3 Attainment of high purity semiconducting materials	22
4 Doping of III–V epilayers during MOVPE	22
5 Heteroepitaxy	23
6 Ternary and quaternary materials	26
7 Low dimensional structures and devices	27
8 Novel precursors for III–V growth	29
9 Crystallography—controlled growth	31
10 Conclusion	32
11 References	32
Growth of Thin Films and Heterostructures of III–V Compounds by Molecular Beam Epitaxy	35
<i>C T Foxon and B A Joyce</i>	
1 Introduction	35
2 Basic technology of MBE	36
3 Fundamental aspects of MBE	39
4 Surface studies	46

5	Growth dynamics	47
6	Growth of high purity structures by MBE	55
7	Quantum wells (QWs) and superlattices (SLs)	59
8	Dopant incorporation	61
9	Acknowledgements	63
10	References	63

Scanning Electron Microscopy (SEM) Microcharacterisation of Semiconducting Materials and Devices 65

D B Holt

1	Scanning electron microscopy	65
2	Resolution	68
3	Electron beam diameter and current	68
4	Energy dissipation volume	69
5	Emissive mode	70
6	X-ray mode	75
7	Cathodoluminescence mode	76
8	Charge collection mode (EBIC, EBIV)	78
9	Scanning transmission electron microscopy	79
10	Barrier electro-voltaic effect	80
11	Phenomenological theory of EBIC contrast	81
12	References and further reading	85

Depth Profiling of Semiconductor Materials by Secondary Ion Mass Spectrometry

J B Clegg

1	Introduction	87
2	Principle of SIMS	88
3	Projectile–target interactions	89
4	Instrumental aspects	91
5	Depth profile quantification	92
6	Depth profiling applications	94
7	Final remarks	102
8	References	103

Localised Vibrational Mode Spectroscopy of Impurities in Semiconductor Crystals

R C Newman

1	Introduction	105
2	Theoretical background	105
3	The strength of an LVM line	110
4	The effect of the charge state on the LVM frequency	110
5	Experimental details	111
6	Examples of LVM absorption	112

7	Scope of technique and sensitivity	114
8	References	117

Point Defect Studies using Electron Paramagnetic Resonance

R C Newman

1	Introduction	119
2	Diamagnetic semiconductor crystals	120
3	Paramagnetic resonance from an unpaired spin	121
4	Experimental details	123
5	Hyperfine interactions and shallow impurities	125
6	Antisite defects in GaAs and GaP	127
7	Orbital angular momentum	130
8	Centres with $S > \frac{1}{2}$	131
9	Discussion	132
10	References	133

Photoluminescence Characterisation

E C Lightowers

1	Introduction	135
2	Experimental methods and equipment	137
3	Impurities and defects in silicon	141
4	Near band-edge luminescence from GaAs and InP	155
5	Luminescence from quantum well structures	158
6	References	163

Hall, Magnetoresistance and Infrared Conductivity Measurements

R A Stradling

1	Introduction	165
2	Resistivity tensor and the influence of sample geometry on Hall measurements	165
3	Multiple carrier effects	169
4	Case study	171
5	Longitudinal magnetoresistance	173
6	Quantum transport effects	173
7	Cyclotron resonance	178
8	Plasma edge measurements	180
9	Infrared studies of electronic absorption from impurities	181
10	Acknowledgements	183
11	Appendix	184
12	References	185

Characterisation of Semiconductors by Capacitance Methods*D W Palmer*

- 1 Introduction
- 2 Semiconductor p-n and Schottky junctions
- 3 C - V profiling
- 4 Deep level transient spectroscopy (DLTS)
- 5 Studies of semiconductor heterostructures
- 6 Summary
- 7 References

High Resolution Electron Microscopy of Semiconductors*J L Hutchison*

- 1 Introduction
- 2 How a high resolution image is formed in the electron microscope
- 3 Practical limitations
- 4 Applications of HREM to semiconductors
- 5 What for the future?
- 6 Conclusion
- 7 References

Subject Index