Contents

1. Introduction 1

2. The Electronic Structure of Atoms and Molecules 17

2.1 Early Concepts of Atomic Structure and Bonding 17
2.2 Elements of Quantum Mechanics 21
2.3 Atomic Wave Functions and Energy Eigenvalues 27
2.4 Molecular Wave Functions and Energy Eigenvalues 32
2.5 Molecular Symmetry 47

3. The Electronic Structure of Crystalline Solids 69

3.1 The Structure and Symmetry of Crystals 69
3.2 Energy Bands 90
3.3 Defects in Crystalline Solids 109
3.4 Crystal Surfaces 126

4. Semiconductor Devices and Circuits 149

4.1 *P–N* Junctions 149
4.2 Bipolar Transistors 162
4.3 MIS Capacitors and Field-Effect Transistors 167
4.4 A CMOS Processing Sequence 177
4.5 Microwave Devices 180
4.6 Confined Heterostructures 185

5. Crystal Growth

5.1 Materials Purification and Synthesis 201
5.2 Equilibrium Conditions and Kinetic Limitations of Growth 227
5.3 The Fabrication of Substrate Crystals 243

6. Epitaxy and Dielectric Deposition

6.1 Chemical Vapor Deposition at Atmospheric Pressure 285
6.2 Low-Pressure and Plasma-Enhanced Vapor Deposition 304
6.3 Organometallic Chemical Vapor Deposition 316
6.4 Molecular Beam Epitaxy and Chemical Beam Epitaxy 331

7. Pattern Definition and Etching

7.1 Photolithographic Pattern Definition 351
7.2 Ultrahigh-Resolution Patterning 358
7.3 Wet Etching 371
7.4 Dry Etching 384

8. Oxidation, Doping, and Metallization

8.1 Thermal Oxidation and Dielectric Isolation of Silicon 405
8.2 Doping by Ion Implantation and Diffusion 427
8.3 Native Oxides on III–V Surfaces 454
8.4 Schottky Barriers 470
8.5 Ohmic Contacts and Interconnects 483

9. Optical Electronics 503

Appendix A: List of Abbreviations

Appendix B: Selected Tables

Subject Index