Contents

List of Contributors ix
Preface xi

Chapter 1 Trends in MOS Integrated Circuit Technology
Thomas F. McNelly

I. Historical Perspective 1
II. Device Scaling 2
III. Trends in FET Design 3
IV. Isolation 5
V. Lithography 7
VI. Ion Implantation 8
VII. Dielectrics 8
VIII. Interconnect 9
IX. Contacts 10
X. Reliability 11
XI. BiCMOS 12
XII. Memory Technology 13
XIII. The Future 14
References 14

Chapter 2 Laser Beam Processing and Wafer-Scale Integration
Simon S. Cohen and Glenn H. Chapman

I. Introduction 19
II. Theoretical Considerations 23
III. Results for the LIDL Process 56
IV. Laser Beam Processing in IC Repair and Customization 84
References 108

Chapter 3 Electron Beam Processing

J. J. Muray

I. Introduction 113
II. Interaction of Electrons with Matter 114
III. Components for Electron Beam Machines 127
IV. Multibeam E-Beam Machines 141
V. Applications Involving Low Electron Energies 147
VI. Chemical Processing 150
References 155

Chapter 4 Ion Beam Techniques and Applications

L. R. Harriott

I. Introduction 157
II. Sources for Broad-Area Ion Beams 159
III. Sources for Submicrometer Beams 162
IV. Parallel Processing with Broad-Area Beams 169
V. Serial Processing with Finely Focused Beams 178
VI. Summary 202
References 203

Chapter 5 Silicon Molecular Beam Epitaxy: Capabilities and Trends

S. L. Delage

I. Introduction 208
II. Si MBE Technology 208
III. Growth Mechanisms and Surface Preparation 214
IV. Silicon Doping 221
V. Polycrystalline Silicon 235
VI. Application of Si MBE 237
VII. Conclusion 249
References 250

Chapter 6 Chemical Beam Epitaxy

W. T. Tsang

I. Introduction 256
II. CBE System Design 260
III. Substrate Preparation for Growth 273
IV. Growth Kinetics of CBE 274
V. Quality of Epilayers 306
VI. Growth of Epilayers Using Group Alkyls 323
VII. GaInAs/InP and GaAs/AlGaAs Quantum Wells and Superlattices 324
VIII. Doping Control 333
IX. Device Applications 341
X. Concluding Remarks 353
References 353

Chapter 7 Ion Implantation for VLSI
Nicholas R. White

I. Introduction 360
II. Commerical Ion Implanters 361
III. Ion Beam Production and Acceleration 369
IV. Implantation Physics 385
V. Problems Associated with Ion Implantation 394
VI. Endstation Design 411
VII. Ion Implanter System Design 425
References 435

Chapter 8 Incoherent Radiation and Its Applications (Visible, UV, X rays)
Dietrich Meyerhofer

I. Introduction 440
II. Pattern Replication 442
III. Optical Imaging 449
IV. Photolithographic Tools 455
V. Deep-UV Lithography 463
VI. X-ray Lithography 467
VII. Thermal Processing with Incoherent Radiation 472
VIII. Conclusion 475
References 475

Chapter 9 Electron Beam Testing: An Outline of Techniques
A. Gopinath

I. Introduction 477
II. Introduction to the Scanning Electron Microscope 479
III. Qualitative Voltage Contrast 483
IV. Voltage Contrast Linearization for Potential Measurements 485
V. Estimate of Minimum Measurable Voltage 501
VI. Observation of Fast Voltage Waveforms and Dynamic Voltage Distributions Using a Pulsed Beam Probe 507
VII. Electron Beam Pulsing in the Electron-Optical Column 509
VIII. Stroboscopic and Sampling Mode Operation 521
IX. Other Modes with Synchronous and Asynchronous Pulsed Beams 525
X. Summary 528
References 529

Index 531