

Contents

<i>List of Contributors</i>	ix
<i>Treatise Preface</i>	xi
<i>Preface</i>	xiii
1 Heavy Ion Charge States	
<i>Hans D. Betz</i>	
I. Introduction	2
II. Basic Processes and Mathematical Description of Charge Exchange	5
III. Experimental Aspects	11
IV. Electron Capture	16
V. Electron Loss	22
VI. Equilibrium Charge-State Distributions	26
VII. Gas and Solid Effects	35
References	37
2 Ionization Phenomena and Sources of Ions	
<i>G. D. Alton</i>	
I. Introduction	44
II. Ion Source Selection Considerations	46
III. Vapor Transport Methods	50
IV. Positive Ionization Phenomena and Sources	54
V. Negative Ionization Phenomena and Sources	128
VI. Ion Extraction and Optics of the Extraction Region	157
References	171
3 Radiation Physics as a Basis of Radiation Chemistry and Biology	
<i>Mitio Inokuti</i>	
I. What are the Problems of Radiation Physics?	179
II. Problems of Class I: How Do Radiations Degrade in Matter?	184
III. Problems of Class II: How Does Matter Change after Receiving Energy from Radiation?	194
IV. Some Notions of Radiation Chemistry and Biology	220
V. Concluding Remarks	228
References	229
4 Low Energy Ion Scattering and Atomic Diffraction	
<i>W. Heiland and E. Taglauer</i>	
I. Ion Scattering Spectrometry (ISS)	238
II. Scattering of Atomic Beams at Thermal Energies	250
References	258

5 High Energy Ion Scattering*L. C. Feldman*

I. Introduction	261
II. Physics of Ion Scattering in Amorphous Solids	262
III. Atomic Composition of Surface Layers	267
IV. MeV Ion Scattering in Single Crystals	274
V. Structure Analysis in Crystalline Solids	282
VI. Summary	297
References	297

6 Inelastic Surface Collisions*Edward W. Thomas*

I. Introduction	299
II. Ion-Induced Auger Spectra	300
III. Ion Neutralization at Surfaces	305
IV. Excitation of Projectiles	314
V. Optical Emission for Target Species	318
VI. Conclusion	322
References	323

7 Secondary Ion Mass Spectrometry*Peter Williams*

I. Introduction	327
II. The Sputtering Process	329
III. Sputtered Ion Emission: Phenomena and Models	336
IV. Instrumentation	348
V. Applications of Secondary Ion Mass Spectrometry	353
VI. Conclusion	374
References	375

8 The Time-of-Flight Atom Probe and Field Ion Microscopy*T. T. Tsong*

I. Introduction	380
II. Basic Principles	382
III. Field Ion Microscope and Atom-Probe FIM	384
IV. Atomic Processes on Solid Surfaces	392
V. Atom-Probe Analyses	399
VI. Summary	405
References	405

9 Ion-Induced X-Ray Emission*S. Raman*

I. Introduction	407
II. Coulomb Ionization	408
III. Proton-Induced X-Ray Emission (PIXE)	412
IV. Heavy-Ion-Induced X-Ray Emission	420
References	426

10 X-Ray Fluorescence Analysis*C. J. Sparks, Jr.*

I. Introduction	429
II. Development of the Physics	433
III. Development of the Analytical Application	436
IV. Comparison to Other Analytical Techniques	441
V. X-Ray Fluorescence Analysis in Industry	443
VI. Conclusions	446
References	447

11 Photoelectron and Auger Spectroscopy*Stig B. Hagström, Manfred O. Krause,
and Steven T. Manson*

I. Introduction	450
II. Description of the Processes	451
III. Experimental Considerations	464
IV. Applications	486
References	538

12 Ion Implantation in Semiconductors*James W. Mayer and Jozsef Gyulai*

I. Introduction	545
II. Depth Distributions in Implanted and Annealed Samples	547
III. Implantation Damage	551
IV. Electrical Activity	560
V. Recoil Implantation	563
VI. Annealing of Disorder by Irradiation	566
VII. Summary	571
References	571

13 Microfabrication*J. W. Coburn*

I. Introduction	577
II. Microfabrication Processes	578
III. Pattern Replication (Lithography)	582
IV. Pattern Transfer	597
V. Discussion	605
References	608

Index