

# CONTENTS

<b>Preface</b>	<b>xi</b>
<b>List of Symbols and Abbreviations</b>	<b>xiii</b>
<b>PART I FUNDAMENTALS AND GENERAL APPROACHES</b>	
<b>Chapter 1 THEORY</b>	<b>3</b>
1.1 Basic Definitions	3
1.2 Dependence of Free Atom Distribution in Tubular Atomizers on Generator Outlet Functions	5
1.2.1 Well-stirred Tank Model	6
1.2.2 Plug Flow Model	7
1.2.3 Common Features of Well-stirred Tank and Plug Flow Models	9
1.2.4 Laminar Flow Model	9
1.2.5 Diffusion Coefficients	10
1.3 Dependence of Absorbance on the Free Atom Distribution in Tubular Atomizers	13
<b>Chapter 2 HYDRIDE GENERATION</b>	<b>17</b>
2.1 Hydride Release	18
2.2 Hydride Transport	25
2.3 Methods of Hydride Generation	27
2.4 Continuous Flow and Flow Injection—Outlet Generator Functions	29
2.5 Continuous Flow and Flow Injection—Experimental Approaches	33
2.6 Batch Mode	39
2.7 Collection in Absorbing Media	43
2.8 Pressure Collection	44
2.9 Cryogenic Trapping	44
2.10 Electrochemical Hydride Generation	48
2.11 Comparison of Sensitivity for Individual Hydride Generation Methods	49
<b>Chapter 3 HYDRIDE ATOMIZATION</b>	<b>51</b>
3.1 Chemical Equilibria in Hydride Atomizers	51
3.2 Inert Gas-Hydrogen Diffusion Flames	54
3.3 Graphite Furnaces	56
3.3.1 <i>In-situ</i> Trapping	56
3.3.2 On-line Atomization	58

3.4	Quartz-tube Atomizers	62
3.4.1	Design	63
3.4.2	Mechanism of Hydride Atomization in Flame-in-tube Atomizers	68
3.4.3	Mechanism of Hydride Atomization in Externally Heated Quartz Tubes	70
3.4.4	Fate of Free Analyte Atoms in Quartz-tube Atomizers	74
3.4.5	Description of Analyte Transfer in the Horizontal Bar-tube of Unheated Flame-in-tube Atomizers	77
3.4.6	Influence of External Heating	83
3.4.7	Influence of Atomization Parameters on the Sensitivity of Quartz-tube Atomizers	85
3.4.8	Thermochemical Hydride Generation	89
<b>Chapter 4</b>	<b>INTERFERENCES</b>	<b>91</b>
4.1	Influence of Nonspectral Interferences on the Signal Shape	94
4.2	Liquid Phase Interferences	96
4.2.1	Categorization of Matrix Interferences	96
4.2.2	Interferences of Strong Oxidants	98
4.2.3	Interferences of Transition and Noble Metals	98
4.2.4	Interferences of Other Species	102
4.2.5	Control of Matrix Interferences	102
4.3	Transport Interferences	105
4.4	Interferences in the Atomizer	106
4.4.1	Diffusion Flames	107
4.4.2	<i>In-situ</i> Trapping in Graphite Furnaces	109
4.4.3	On-line Atomization in Graphite Furnaces	110
4.4.4	Flame-in-tube Atomizers	111
4.4.5	Externally Heated Quartz Tubes	115
<b>Chapter 5</b>	<b>GENERAL ASSESSMENT OF HYDRIDE GENERATION AND ATOMIZATION METHODS</b>	<b>118</b>
5.1	Accuracy	118
5.2	Sensitivity	119
5.2.1	Microanalysis	119
5.2.2	Trace analysis	120
5.3	Other Criteria	121
5.4	Conclusion	121
<b>Chapter 6</b>	<b>OTHER VOLATILE COMPOUNDS</b>	<b>123</b>
6.1	Chelates	123
6.2	Alkyls	126

6.3	Carbonyls	127
6.4	Oxides and Halides	128
<b>Appendix to Part I ATOMIC ABSORPTION COEFFICIENT</b>		<b>129</b>
	Line Shapes	130
	Doppler Broadening	133
	Lorentz Broadening	134
	Combination of Lorentz and Doppler Broadening	136
	Self-absorption	137
	Hyperfine Splitting	137
	Assessment of the Magnitude of the Atomic Absorption Coefficient	139
	Atomic Absorption Coefficient of the Selenium 196 nm Line	142
	Atomic Absorption Coefficient of the Arsenic 193.7 nm Line	146
<b>PART II METHODOLOGY AND ANALYTICAL APPLICATIONS</b>		
<b>Chapter 7 ANTIMONY</b>		<b>151</b>
7.1	General Characteristics	151
7.2	Optimization of Instrumental and Chemical Parameters	152
7.3	Control of Interferences	159
7.4	Preconcentration and Separation Techniques	164
7.5	Speciation Studies	169
7.6	Analysis of Real Samples	172
	7.6.1 Environmental Samples	172
	7.6.2 Agricultural Samples	175
	7.6.3 Food and Beverages	178
	7.6.4 Biological and Clinical Samples	178
	7.6.5 Geochemical Samples	179
	7.6.6 Metallurgical and Industrial Samples	180
<b>Chapter 8 ARSENIC</b>		<b>182</b>
8.1	General Characteristics	182
8.2	Optimization of Instrumental and Chemical Parameters	184
8.3	Control of Interferences	193
	8.3.1 General Characteristics of Interferences	193
	8.3.2 Approaches to Interference Control	195
	8.3.3 Masking Additives and Buffers	199
8.4	Preconcentration and Separation Techniques	203
8.5	Speciation Studies	212
8.6	Analysis of Real Samples	222
	8.6.1 Environmental Samples	223
	8.6.2 Agricultural Samples	227
	8.6.3 Food and Beverages	229
	8.6.4 Biological and Clinical Samples	232

8.6.5	Geochemical Samples	237
8.6.6	Metallurgical and Industrial Samples	241
<b>Chapter 9</b>	<b>BISMUTH</b>	<b>246</b>
9.1	General Characteristics	246
9.2	Optimization of Instrumental and Chemical Parameters	247
9.3	Control of Interferences	251
9.4	Preconcentration and Separation Techniques	255
9.5	Speciation Studies	259
9.6	Analysis of Real Samples	260
9.6.1	Environmental Samples	260
9.6.2	Agricultural Samples	261
9.6.3	Food and Beverages	261
9.6.4	Biological and Clinical Samples	261
9.6.5	Geochemical Samples	262
9.6.6	Metallurgical and Industrial Samples	263
<b>Chapter 10</b>	<b>GERMANIUM</b>	<b>267</b>
10.1	General Characteristics	267
10.2	Optimization of Instrumental and Chemical Parameters	268
10.3	Control of Interferences	272
10.4	Preconcentration and Separation Techniques	275
10.5	Speciation Studies	278
10.6	Analysis of Real Samples	279
10.6.1	Environmental Samples	279
10.6.2	Agricultural Samples	280
10.6.3	Food	282
10.6.4	Biological and Clinical Samples	282
10.6.5	Geochemical Samples	282
10.6.6	Metallurgical and Industrial Samples	283
<b>Chapter 11</b>	<b>INDIUM</b>	<b>285</b>
11.1	General Characteristics	285
11.2	Optimization of Instrumental and Chemical Parameters	286
<b>Chapter 12</b>	<b>LEAD</b>	<b>288</b>
12.1	General Characteristics	288
12.2	Optimization of Instrumental and Chemical Parameters	290
12.3	Reaction Media and Control of Interferences	293
12.4	Preconcentration and Separation Techniques	297
12.5	Speciation Studies	301

12.6	Analysis of Real Samples	303
12.6.1	Environmental Samples	303
12.6.2	Agricultural Samples	304
12.6.3	Food and Beverages	305
12.6.4	Biological and Clinical Samples	306
12.6.5	Geochemical Samples	307
12.6.6	Metallurgical and Industrial Samples	307
<b>Chapter 13</b>	<b>SELENIUM</b>	<b>308</b>
13.1	General Characteristics	308
13.2	Optimization of Instrumental and Chemical Parameters	310
13.3	Control of Interferences	318
13.3.1	General Characteristics of Interferences	318
13.3.2	Approaches to Interference Control	321
13.3.3	Masking Additives and Buffers	323
13.4	Preconcentration and Separation Techniques	326
13.5	Speciation Studies	333
13.6	Analysis of Real Samples	339
13.6.1	Environmental Samples	339
13.6.2	Agricultural Samples	343
13.6.3	Food and Beverages	344
13.6.4	Biological and Clinical Samples	345
13.6.5	Geochemical Samples	349
13.6.6	Metallurgical and Industrial Samples	350
<b>Chapter 14</b>	<b>TELLURIUM</b>	<b>355</b>
14.1	General Characteristics	355
14.2	Optimization of Instrumental and Chemical Parameters	355
14.3	Control of Interferences	358
14.4	Preconcentration and Separation Techniques	359
14.5	Speciation Studies	364
14.6	Analysis of Real Samples	365
14.6.1	Environmental Samples	365
14.6.2	Agricultural Samples	367
14.6.3	Food	367
14.6.4	Biological and Clinical Samples	368
14.6.5	Geochemical Samples	368
14.6.6	Metallurgical and Industrial Samples	368
<b>Chapter 15</b>	<b>THALLIUM</b>	<b>371</b>
<b>Chapter 16</b>	<b>TIN</b>	<b>372</b>
16.1	General Characteristics	372
16.2	Optimization of Instrumental and Chemical Parameters	373

16.3	Control of Interferences	378
16.4	Preconcentration and Separation Techniques	380
16.5	Speciation Studies	384
16.6	Analysis of Real Samples	389
16.6.1	Environmental Samples	389
16.6.2	Agricultural Samples	392
16.6.3	Food and Beverages	393
16.6.4	Biological and Clinical Samples	393
16.6.5	Geochemical Samples	394
16.6.6	Metallurgical and Industrial Samples	395
<b>APPENDICES: INDEXES TO THE BIBLIOGRAPHY</b>		<b>397</b>
Appendix 1	Technique and Analyte Element	399
Appendix 2	Speciation	409
Appendix 3	Sample Matrix: HGAAS Applications	411
Appendix 4	Sample Matrix: Procedures other than HGAAS	420
Appendix 5	Other Keywords	425
<b>BIBLIOGRAPHY</b>		<b>430</b>
<b>INDEX</b>		<b>513</b>