Inorganic Reactions and Methods
Volume 16
# Contents of Volume 16

How to Use this book ................................................. xiii
Preface to the Series ................................................. xix
Editorial Consultants to the Series ................................. xxiii
Contributors to Volume 16 .......................................... xxv

## 14. Reactions Catalyzed by Inorganic Compounds .......................... 1

### 14.1. Introduction: Principles of Catalysis .............................. 2

14.1.1. Catalysis as a Kinetic Phenomenon ............................... 2
14.1.2. Basic Processes in Molecular Catalysis .......................... 5
14.1.2.1. Electron Transfer ........................................... 5
14.1.2.2. Ligand Dissociation and Association Processes .......... 7
14.1.2.2.1. Heterolytic Ligand Dissociation. ........................ 7
14.1.2.2.2. Homolytic Ligand Dissociation. ........................ 9
14.1.2.3. Promotion of Nucleophilic Reactions by Electron Withdrawal from Reactants ......................... 10
14.1.2.4. Catalysis of Electrophilic Reactions by Proton Loss from a Coordinated Ligand ......................... 11
14.1.2.5. Oxidative Addition/Reductive Elimination Reactions ......... 13
14.1.2.5.1. One-Electron Oxidative Addition. ........................ 14
14.1.2.5.2. Two-Electron Oxidative Addition. ........................ 15
14.1.2.5.3. Free Radical Chain Mechanism of Oxidative Addition. 18
14.1.2.6. Insertion Reactions ......................................... 19

### 14.2. Types of Catalysts ............................................. 21

14.2.1. Introduction .................................................. 21
14.2.2. Solid Catalysts .............................................. 22
14.2.2.1. Metallic Catalysts ........................................ 22
14.2.2.1.1. Metal Crystals and Films. ............................ 22
14.2.2.1.2. Supported Metal Catalysts. ............................ 23
### Contents of Volume 16

14.2.2.2. Metal Oxide and Metal Sulfide Catalysts 26
14.2.3. Soluble Catalysts 32
14.2.3.1. Selectivity Advantages 32
14.2.3.2. Process Engineering and Product Recovery Problems 34
14.2.4. Supported Metal Complexes 36
14.2.4.1. Polymeric Supports 36
14.2.4.2. Metal Oxide Supports 40
14.2.5. Phase Transfer Catalysis 41
14.2.6. Catalysis in Microscopic Phases 43
14.2.7. Production of Catalysts and Supports 45
14.2.7.1. General Principles 45
14.2.7.2. Methods of Production of Nonmetal Catalysts and Supports 51
14.2.7.2.1. Precipitation and Gel Formation 51
14.2.7.2.2. Impregnation 55
14.2.7.2.3. Natural Materials, Leaching, Carbon Supports 56
14.2.7.3. Methods of Production of Supported Metal Catalysts 56
14.2.7.4. Relationships between Catalyst Production and Performance 60

### 14.3. Hydrogenation Reactions 65

14.3.1. Introduction 65
14.3.2. Dihydrogen Activation 65
14.3.2.1. Homolytic Cleavage to Give Metal-Hydrides 66
14.3.2.2. Heterolytic Cleavage to Give Metal-Hydrides 71
14.3.2.3. Molecular Hydrogen Complexes 77
14.3.3. Classes of Soluble Catalysts 79
14.3.3.1. Rhodium(I) Catalysts 80
14.3.3.2. Cobalt Cyanide Systems 89
14.3.3.3. Cobalt Carbonyl Catalysts 92
14.3.3.4. Chromium(0) Carbonyl Catalysts 94
14.3.3.5. Ziegler Catalysts 97
14.3.3.6. Ruthenium(II) Catalysts 99
14.3.4. Hydrogenation of Aliphatic C—C Functions 102
14.3.4.1. In Simple Olefins 102
14.3.4.1.1. Isolated Double Bonds 102
14.3.4.1.2. Olefins Conjugated to Carbonyl, Nitrile, Nitro 114
14.3.4.1.3. Vinyl Functions 121
14.3.4.2. In Conjugated Dienes 123
14.3.4.3. In Unconjugated Dienes 132
### Contents of Volume 16

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.3.4.4</td>
<td>In Acetylenes and Cumulenes</td>
<td>137</td>
</tr>
<tr>
<td>14.3.4.4.1</td>
<td>In Triple Bonds.</td>
<td>137</td>
</tr>
<tr>
<td>14.3.4.4.2</td>
<td>In Allenes and Cumulenes.</td>
<td>144</td>
</tr>
<tr>
<td>14.3.4.5</td>
<td>By Asymmetric Hydrogenation</td>
<td>145</td>
</tr>
<tr>
<td>14.3.5</td>
<td>Hydrogenation of Arenes</td>
<td>157</td>
</tr>
<tr>
<td>14.3.5.1</td>
<td>By Cobalt Catalysts</td>
<td>157</td>
</tr>
<tr>
<td>14.3.5.2</td>
<td>By Ruthenium Catalysts</td>
<td>159</td>
</tr>
<tr>
<td>14.3.5.3</td>
<td>by Rhodium Catalysts</td>
<td>162</td>
</tr>
<tr>
<td>14.3.5.4</td>
<td>By Palladium and Platinum Catalysts</td>
<td>165</td>
</tr>
<tr>
<td>14.3.5.5</td>
<td>By Miscellaneous Catalysts</td>
<td>170</td>
</tr>
<tr>
<td>14.3.6</td>
<td>Hydrogenation of C==O Functions</td>
<td>172</td>
</tr>
<tr>
<td>14.3.6.1</td>
<td>In Aldehydes</td>
<td>172</td>
</tr>
<tr>
<td>14.3.6.1.1</td>
<td>Saturated Aliphatic Aldehydes.</td>
<td>172</td>
</tr>
<tr>
<td>14.3.6.1.2</td>
<td>Aromatic Aldehydes.</td>
<td>174</td>
</tr>
<tr>
<td>14.3.6.1.3</td>
<td>Selectivity.</td>
<td>175</td>
</tr>
<tr>
<td>14.3.6.2</td>
<td>In Ketones</td>
<td>178</td>
</tr>
<tr>
<td>14.3.6.2.1</td>
<td>Hydrogenation to the Carbinol.</td>
<td>178</td>
</tr>
<tr>
<td>14.3.6.2.2</td>
<td>Hydrogenolysis and Miscellaneous Reactions.</td>
<td>180</td>
</tr>
<tr>
<td>14.3.6.2.3</td>
<td>Selectivity.</td>
<td>183</td>
</tr>
<tr>
<td>14.3.6.2.4</td>
<td>Stereochemistry and Asymmetric Hydrogenation.</td>
<td>185</td>
</tr>
<tr>
<td>14.3.6.3</td>
<td>In Carboxyl Derivatives</td>
<td>193</td>
</tr>
<tr>
<td>14.3.6.4</td>
<td>By Transfer Hydrogenation</td>
<td>198</td>
</tr>
<tr>
<td>14.3.7</td>
<td>Hydrogenation of Other Functional Groups</td>
<td>202</td>
</tr>
<tr>
<td>14.3.7.1</td>
<td>Nitriles</td>
<td>202</td>
</tr>
<tr>
<td>14.3.7.1.1</td>
<td>Hydrogenation to Primary Amines.</td>
<td>203</td>
</tr>
<tr>
<td>14.3.7.1.2</td>
<td>Coupling Reactions.</td>
<td>205</td>
</tr>
<tr>
<td>14.3.7.1.3</td>
<td>Reductive Hydrolysis.</td>
<td>206</td>
</tr>
<tr>
<td>14.3.7.1.4</td>
<td>Hydrogenolysis and Cyclizations.</td>
<td>207</td>
</tr>
<tr>
<td>14.3.7.2</td>
<td>Nitro Compounds</td>
<td>209</td>
</tr>
<tr>
<td>14.3.7.2.1</td>
<td>Hydrogenation to the Amine.</td>
<td>209</td>
</tr>
<tr>
<td>14.3.7.2.2</td>
<td>Selective and Partial Reductions.</td>
<td>211</td>
</tr>
<tr>
<td>14.3.7.2.3</td>
<td>Side Reactions in Polyfunctional Molecules.</td>
<td>214</td>
</tr>
<tr>
<td>14.3.7.3</td>
<td>Miscellaneous</td>
<td>216</td>
</tr>
</tbody>
</table>

## 14.4. Addition Reactions

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.4.1</td>
<td>Introduction</td>
<td>218</td>
</tr>
<tr>
<td>14.4.2</td>
<td>Hydrosilylation of Olefins and Acetylenes</td>
<td>218</td>
</tr>
<tr>
<td>14.4.2.1</td>
<td>By Platinum Catalysts</td>
<td>218</td>
</tr>
<tr>
<td>14.4.2.2</td>
<td>By Rhodium and Nickel Catalysts</td>
<td>225</td>
</tr>
<tr>
<td>14.4.2.3</td>
<td>By Other Transition Metal Catalysts</td>
<td>229</td>
</tr>
<tr>
<td>14.4.3</td>
<td>Hydrosilylation of Conjugated Dienes</td>
<td>233</td>
</tr>
</tbody>
</table>
## Contents of Volume 16

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.4.3.1.</td>
<td>By Platinum Catalysts</td>
<td>234</td>
</tr>
<tr>
<td>14.4.3.2.</td>
<td>By Palladium and Nickel Catalysts</td>
<td>235</td>
</tr>
<tr>
<td>14.4.3.3.</td>
<td>By Rhodium, Cobalt, and Chromium Catalysts</td>
<td>239</td>
</tr>
<tr>
<td>14.4.4.</td>
<td>Hydrosilylation of Carbonyl Compounds</td>
<td>240</td>
</tr>
<tr>
<td>14.4.4.1.</td>
<td>By Transition Metal Catalysts</td>
<td>241</td>
</tr>
<tr>
<td>14.4.4.2.</td>
<td>Stereoselective and Chemoselective Reactions</td>
<td>243</td>
</tr>
<tr>
<td>14.4.4.3.</td>
<td>Asymmetric Synthesis</td>
<td>247</td>
</tr>
<tr>
<td>14.4.5.</td>
<td>Hydrosilylation of Carbon-Nitrogen Double Bonds</td>
<td>255</td>
</tr>
<tr>
<td>14.4.5.1.</td>
<td>Of Imines</td>
<td>255</td>
</tr>
<tr>
<td>14.4.5.2.</td>
<td>Of Isocyanates, Carbodiimides, and Nitriles</td>
<td>257</td>
</tr>
<tr>
<td>14.4.6.</td>
<td>Hydrocyanation of Olefins and Dienes</td>
<td>259</td>
</tr>
<tr>
<td>14.4.6.1.</td>
<td>By Nickel Catalysts</td>
<td>260</td>
</tr>
<tr>
<td>14.4.6.2.</td>
<td>By Palladium Catalysts</td>
<td>265</td>
</tr>
<tr>
<td>14.4.6.3.</td>
<td>By Copper Catalysts</td>
<td>266</td>
</tr>
<tr>
<td>14.4.6.4.</td>
<td>By Cobalt Catalysts</td>
<td>267</td>
</tr>
</tbody>
</table>

### 14.5. Olefin Transformations

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.5.1.</td>
<td>Isomerization</td>
<td>269</td>
</tr>
<tr>
<td>14.5.1.1.</td>
<td>Allylic Hydrogen Transfer</td>
<td>269</td>
</tr>
<tr>
<td>14.5.1.1.1.</td>
<td>By Palladium Catalysts</td>
<td>269</td>
</tr>
<tr>
<td>14.5.1.1.2.</td>
<td>By Iron Catalysts</td>
<td>270</td>
</tr>
<tr>
<td>14.5.1.2.</td>
<td>Metal Hydride Addition—Elimination</td>
<td>271</td>
</tr>
<tr>
<td>14.5.1.2.1.</td>
<td>By Cobalt Carbonyl Catalysts</td>
<td>271</td>
</tr>
<tr>
<td>14.5.1.2.2.</td>
<td>By Ruthenium Catalysts</td>
<td>274</td>
</tr>
<tr>
<td>14.5.1.2.3.</td>
<td>By Platinum Catalysts</td>
<td>274</td>
</tr>
<tr>
<td>14.5.1.3.</td>
<td>Skeletal Rearrangement</td>
<td>275</td>
</tr>
<tr>
<td>14.5.2.</td>
<td>Olefin Dimerization and Oligomerization</td>
<td>276</td>
</tr>
<tr>
<td>14.5.2.1.</td>
<td>Introduction</td>
<td>276</td>
</tr>
<tr>
<td>14.5.2.2.</td>
<td>Linear Dimerization and Oligomerization of Monoolefins</td>
<td>278</td>
</tr>
<tr>
<td>14.5.2.2.1.</td>
<td>Mechanistic Aspects</td>
<td>278</td>
</tr>
<tr>
<td>14.5.2.2.2.</td>
<td>By Group 4 and 5 Metal Catalysts</td>
<td>280</td>
</tr>
<tr>
<td>14.5.2.2.3.</td>
<td>By Nickel Catalysts</td>
<td>282</td>
</tr>
<tr>
<td>14.5.2.2.4.</td>
<td>By Other Group 8—10 Metal Catalysts</td>
<td>287</td>
</tr>
<tr>
<td>14.5.2.3.</td>
<td>Cyclooligomerization of Monoolefins</td>
<td>289</td>
</tr>
<tr>
<td>14.5.2.4.</td>
<td>Linear Dimerization and Oligomerization of 1,3-Diolefini</td>
<td>290</td>
</tr>
<tr>
<td>14.5.2.4.1.</td>
<td>By Palladium Catalysts</td>
<td>290</td>
</tr>
<tr>
<td>14.5.2.4.2.</td>
<td>By Nickel Catalysts</td>
<td>292</td>
</tr>
<tr>
<td>14.5.2.4.3.</td>
<td>By Other Transition Metal Catalysts</td>
<td>293</td>
</tr>
</tbody>
</table>
14.5.2.5. Cyclodimerization and Cyclooligomerization of 1,3-Diolefins 294
14.5.2.5.1. By Nickel Catalysts. 294
14.5.2.5.2. By Other Transition Metal Catalysts. 297
14.5.3. Olefin Polymerization 298
14.5.3.1. Introduction 298
14.5.3.2. Ethylene Polymerization 299
14.5.3.2.1. By Titanium Catalysts. 299
14.5.3.2.2. By Vanadium Catalysts. 303
14.5.3.2.3. By Homogeneous Zirconium Catalysts. 304
14.5.3.2.4. By Chromium Catalysts. 305
14.5.3.2.5. By Nickel-Ylid Catalyst. 306
14.5.3.3. Propylene Polymerization 307
14.5.3.3.1. Heterogeneous Catalysts. 308
14.5.3.3.2. Homogeneous Catalysts. 309
14.5.3.4. Butadiene Polymerization 312
14.5.3.4.1. By Titanium Catalysts. 312
14.5.3.4.2. By Cobalt and Nickel Catalysts. 312
14.5.3.4.3. By Lithium. 313
14.5.4. Olefin Metathesis 314

14.6. Carbon Monoxide Reactions 315
14.6.1. Introduction 315
14.6.1.1. Oxidation and Disproportionation of Carbon Monoxide 316
14.6.1.2. Reductions of Carbon Monoxide 317
14.6.1.3. Base-Catalyzed Reactions of Carbon Monoxide 318
14.6.1.4. Acid-Catalyzed Reactions of Carbon Monoxide 319
14.6.1.5. Reactions of Carbon Monoxide with Transition Metals 320
14.6.1.6. Coordinative Addition of Carbon Monoxide 321
14.6.1.7. Insertions of Carbon Monoxide 323
14.6.1.8. Chemisorption of Carbon Monoxide 324
14.6.1.9. Metal-Catalyzed Reactions of Carbon Monoxide 326
14.6.2. Metal Carbonyls Important in Catalysis 329
14.6.2.1. Chromium, Molybdenum, and Tungsten Carbonyls 334
14.6.2.1.1. Preparation of the Hexacarbonyls M(CO)₆ \( (M = \text{Cr,Mo,W}) \). 334
14.6.2.1.2. Reactions of Hexacarbonyls of Cr, Mo, and W. 336
14.6.2.2. Manganese and Rhenium Carbonyls 338
14.6.2.2.1. Preparation of the Metal Carbonyls. 338
14.6.2.2.2. Reactions of the Carbonyls of Mn and Re. 340
14.6.2.3. Iron and Ruthenium Carbonyls 343
14.6.2.3.1. Preparation of the Metal Carbonyls. 343
14.6.2.3.2. Reactions of the Carbonyls of Iron and Ruthenium. 344
14.6.2.4. Cobalt Carbonyls 348
14.6.2.4.1. Preparation of Cobalt Carbonyls. 348
14.6.2.4.2. Reactions of Cobalt Carbonyls. 349
14.6.2.5. Nickel Carbonyls 351
14.6.2.5.1. Preparation of Tetracarbonylnickel(0). 351
14.6.2.5.2. Reactions of Tetracarbonylnickel. 352
14.6.3. Hydroformylation of Olefins 353
14.6.3.1. by Cobalt Catalysts 354
14.6.3.2. by Rhodium Catalysts 358
14.6.3.3. by Ruthenium Catalysts 362
14.6.3.4. by Platinum Catalysts 363
14.6.4. Hydrocarboxylation of Olefins 364
14.6.4.1. by Cobalt Catalysts 365
14.6.4.2. by Rhodium and Iridium Catalysts 367
14.6.4.3. by Palladium and Platinum Catalysts 369
14.6.5. Carbonylation and Reductive Carbonylation of C-OH and C-OR Bonds 372
14.6.5.1. Carbonylation of Alcohols 373
14.6.5.1.1. by Cobalt Catalysts. 373
14.6.5.1.2. by Rhodium Catalysts. 373
14.6.5.1.3. by Other Metal Catalysts. 375
14.6.5.2. Isomerization of Formates 376
14.6.5.3. Carbonylation of Esters 377
14.6.5.4. Reductive Carbonylation of Alcohols 377
14.6.5.4.1. by Cobalt Catalysts. 378
14.6.5.4.2. by Other Metals. 379
14.6.5.5. Reductive Carbonylation of Esters 380
14.6.6. Oxidation and Reduction of CO 381
14.6.6.1. Oxidation 382
14.6.6.2. In the Water Gas Shift Reaction 384
14.6.6.2.1. General Aspects. 384
14.6.6.2.2. Applications of the Reaction. 387
14.6.6.3. In Reduction 388
14.6.6.3.1. To Formyl. 388
14.6.6.3.2. To Alkyl, Hydroxyalkyl, and Alkoxy Ligands and Reductive Coupling. 389
14.6.6.3.3. To Alcohols and Alkanes. 392
14.6.6.4. Reduction by H₂ 394
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.7.</td>
<td>Oxidation</td>
<td>398</td>
</tr>
<tr>
<td>14.7.1.</td>
<td>Introduction</td>
<td>398</td>
</tr>
<tr>
<td>14.7.2.</td>
<td>Oxidation of Saturated Unactivated and Activated C-H Bonds</td>
<td>398</td>
</tr>
<tr>
<td>14.7.2.1.</td>
<td>In Methane Oxidation</td>
<td>398</td>
</tr>
<tr>
<td>14.7.2.2.</td>
<td>In Butane Oxidation</td>
<td>399</td>
</tr>
<tr>
<td>14.7.2.3.</td>
<td>In Cyclohexane Oxidation</td>
<td>402</td>
</tr>
<tr>
<td>14.7.2.4.</td>
<td>In Toluene Oxidation</td>
<td>404</td>
</tr>
<tr>
<td>14.7.2.5.</td>
<td>In Xylene Oxidation</td>
<td>406</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>14.8.</th>
<th>Bioinorganic Catalysis</th>
<th>408</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.8.1.</td>
<td>Introduction</td>
<td>408</td>
</tr>
<tr>
<td>14.8.2.</td>
<td>Cobalamin Reactions</td>
<td>408</td>
</tr>
<tr>
<td>14.8.2.1.</td>
<td>Cobalamin Models</td>
<td>408</td>
</tr>
<tr>
<td>14.8.2.1.1.</td>
<td>Formation of the Cobalt-Carbon Bond.</td>
<td>408</td>
</tr>
<tr>
<td>14.8.2.1.2.</td>
<td>Cleavage of the Cobalt-Carbon Bond.</td>
<td>414</td>
</tr>
<tr>
<td>14.8.2.2.</td>
<td>Cobalamin-Catalyzed Enzymatic Reactions</td>
<td>419</td>
</tr>
<tr>
<td>14.8.2.3.</td>
<td>Bioalkylation</td>
<td>426</td>
</tr>
<tr>
<td>14.8.2.3.1.</td>
<td>Mercury.</td>
<td>427</td>
</tr>
<tr>
<td>14.8.2.3.2.</td>
<td>Arsenic.</td>
<td>428</td>
</tr>
<tr>
<td>14.8.2.3.3.</td>
<td>Lead.</td>
<td>429</td>
</tr>
<tr>
<td>14.8.2.3.4.</td>
<td>Selenium and Tellurium.</td>
<td>429</td>
</tr>
<tr>
<td>14.8.2.3.5.</td>
<td>Tin.</td>
<td>430</td>
</tr>
<tr>
<td>14.8.2.3.6.</td>
<td>Other Metals, Metalloids, and Nonmetals.</td>
<td>430</td>
</tr>
<tr>
<td>14.8.2.4.</td>
<td>Biomethylation Mechanisms</td>
<td>431</td>
</tr>
<tr>
<td>14.8.3.</td>
<td>In Oxygen Transport</td>
<td>433</td>
</tr>
<tr>
<td>14.8.3.1.</td>
<td>Nature of the Bound Dioxygen</td>
<td>434</td>
</tr>
<tr>
<td>14.8.3.2.</td>
<td>Natural Oxygen Carriers</td>
<td>435</td>
</tr>
<tr>
<td>14.8.3.3.</td>
<td>Cobalt(II) Complexes</td>
<td>436</td>
</tr>
<tr>
<td>14.8.3.4.</td>
<td>Iron(II) Complexes</td>
<td>438</td>
</tr>
<tr>
<td>14.8.3.5.</td>
<td>Manganese(II) and Copper(I) Complexes</td>
<td>441</td>
</tr>
<tr>
<td>14.8.4.</td>
<td>In Oxidases</td>
<td>442</td>
</tr>
<tr>
<td>14.8.4.1.</td>
<td>In Cytochrome Oxidases</td>
<td>442</td>
</tr>
<tr>
<td>14.8.4.1.1.</td>
<td>Reactions.</td>
<td>445</td>
</tr>
<tr>
<td>14.8.4.1.2.</td>
<td>Models.</td>
<td>446</td>
</tr>
<tr>
<td>14.8.4.2.</td>
<td>In Copper-Containing Oxidases</td>
<td>448</td>
</tr>
<tr>
<td>14.8.4.2.1.</td>
<td>Reactions.</td>
<td>450</td>
</tr>
<tr>
<td>14.8.4.2.2.</td>
<td>Models.</td>
<td>452</td>
</tr>
<tr>
<td>14.8.4.3.</td>
<td>In Peroxidases and Catalases</td>
<td>454</td>
</tr>
<tr>
<td>14.8.4.3.1.</td>
<td>Reactions.</td>
<td>454</td>
</tr>
<tr>
<td>14.8.4.3.2.</td>
<td>Structures.</td>
<td>456</td>
</tr>
<tr>
<td>14.8.4.3.3.</td>
<td>Models.</td>
<td>457</td>
</tr>
</tbody>
</table>
14.8.5. The Catechol Dioxygenases 458
14.8.6. In Magnesium and Manganese Enzymes 463
  14.8.6.1. Introduction 463
  14.8.6.2. Reactions 464
  14.8.6.2.2. Models 465
  14.8.6.2.3. Physical Methods 466
  14.8.6.3. Sources 467
  14.8.6.4. Specific Examples 468
14.8.7. In Calcium Binding Proteins 473
  14.8.7.1. Introduction 473
  14.8.7.2. Characteristics of the Ca2+ Ion 474
  14.8.7.3. Intracellular Catalysis 475
  14.8.7.4. Extracellular Enzymes 484
14.8.8. In Selenium Enzymes 488
  14.8.8.1. Introduction 488
  14.8.8.2. Forms of Selenium Present in Biological Molecules 488
    14.8.8.2.1. Glutathione Peroxidase 490
    14.8.8.2.2. Formate Dehydrogenase 492
    14.8.8.2.3. Glycine Reductase 493

List of Abbreviations 495

Author Index 501

Compound Index 565

Subject Index 649
How to Use this Book

1. Organization of Subject Matter

1.1. Logic of Subdivision and Add-On Chapters

This volume is part of a series that describes all of inorganic reaction chemistry. The contents are subdivided systematically and so are the contents of the entire series. Using the periodic system as a correlative device, it is shown how bonds between pairs of elements can be made. Treatment begins with hydrogen making a bond to itself in $\text{H}_2$ and proceeds according to the periodic table with the bonds formed by hydrogen to the halogens, the groups headed by oxygen, nitrogen, carbon, boron, beryllium and lithium, to the transition and inner-transition metals and to the members of group zero. Next it is considered how the halogens form bonds among themselves and then to the elements of the main groups VI to I, the transition and inner-transition metals and the zero-group gases. The process repeats itself with descriptions of the members of each successive periodic group making bonds to all the remaining elements not yet treated until group zero is reached. At this point all actual as well as possible combinations have been covered.

The focus is on the primary formation of bonds, not on subsequent reactions of the products to form other bonds. These latter reactions are covered at the places where the formation of those bonds is described. Reactions in which atoms merely change their oxidation states are not included, nor are reactions in which the same pairs of elements come together again in the product (for example, in metatheses or redistributions). Physical and spectroscopic properties or structural details of the products are not covered by the reaction volumes; the latter are concerned with synthetic utility based on yield, economy of ingredients, purity of product, specificity, etc. The preparation of short-lived transient species is not described.

While in principle the systematization described above could suffice to deal with all the relevant material, there are other topics that inorganic chemists customarily identify as being useful in organizing reaction information and that do not fit into the scheme. These topics are the subject of eight additional chapters constituting the last four volumes of the series. These chapters are systematic only within their own confines. Their inclusion is based on the best judgment of the Editorial Advisory Board as to what would be most useful currently as well as effective in guiding the future of inorganic reaction chemistry.

1.2. Use of Decimal Section Numbers

The organization of the material is readily apparent through the use of numbers and headings. Chapters are broken down into divisions, sections, and subsections,
which have short descriptive headings and are numbered according to the following scheme:

1. Major Heading
1.1. Chapter Heading
1.1.1. Division Heading
1.1.1.1. Section Heading
1.1.1.1.1. Subsection Heading

Further subdivision of a five-digit "slice" utilizes lower-case Roman numerals in parentheses: (i), (ii), (iii), etc. It is often found that as a consequence of the organization, cognate material is located in different chapters but in similarly numbered pieces, i.e., in parallel sections. Section numbers, rather than page numbers, are the key by which the material is accessed through the various indexes.

1.3. Building of Headings

1.3.1. Headings Forming Part of a Sentence

Most headings are sentence-fragment phrases which constitute sentences when combined. Usually a period signifies the end of a combined sentence. In order to reconstitute the context in which a heading is to be read, superior-rank titles are printed as running heads on each age. When the sentences are put together from their constituent parts, they describe the contents of the piece at hand. For an example, see 2.3 below.

1.3.2. Headings Forming Part of an Enumeration

For some material it is not useful to construct title sentences as described above. In these cases hierarchical lists, in which the topics are enumerated, are more appropriate. To inform the reader fully about the nature of the material being described, the headings of connected sections that are superior in hierarchy always occur as running heads at the top of each page.

2. Access and Reference Tools

2.1. Plan of the Entire Series (Front Endpaper)

Printed on the inside of the front cover is a list, compiled from all 18 reaction volumes, of the major and chapter headings, that is, all headings that are preceded by a one- or two-digit decimal section number. This list shows in which volumes the headings occur and highlights the contents of the volume that is at hand by means of a gray tint.
2.2. Contents of the Volume at Hand

All the headings, down to the title of the smallest decimal-numbered subsection, are listed in the detailed table of contents of each volume. For each heading the table of contents shows the decimal section number by which it is preceded and the number of the page on which it is found. Beside the decimal section numbers, successive indentations reveal the hierarchy of the sections and thereby facilitate the comprehension of the phrase (or of the enumerative sequence) to which the headings of hierarchically successive sections combine. To reconstitute the context in which the heading of a section must be read to become meaningful, relevant headings of sections superior in hierarchy are repeated at the top of every page of the table of contents. The repetitive occurrences of these headings is indicated by the fact that position and page numbers are omitted.

2.3. Running Heads

In order to indicate the hierarchical position of a section, the top of every page of text shows the headings of up to three connected sections that are superior in hierarchy. These running heads provide the context within which the title of the section under discussion becomes meaningful. As an example, the page of Volume 1 on which section 1.4.9.1.3 “in the Production of Methanol” starts, carries the running heads:

1.4. The Formation of Bonds between Hydrogen and O, S, Se, Te, Po
1.4.9. by Industrial Processes
1.4.9.1. Involving Oxygen Compounds

whereby the phrase “in the Production of Methanol” is put into its proper perspective.

2.4. List of Abbreviations

Preceding the indexes there is a list of those abbreviations that are frequently used in the text of the volume at hand or in companion volumes. This list varies somewhat in length from volume to volume; that is, it becomes more comprehensive as new volumes are published. Abbreviations that are used incidentally or have no general applicability are not included in the list but are explained at the place of occurrence in the text.

2.5. Author Index

The author index is compiled by computer from the lists of references. Thus it tells whose publications are cited and in that respect is comprehensive. It is not a list of authors, beyond those cited in the references, whose results are reported in the text. However, as the references cited are leading ones, consulting them, along
How to Use this Book

with the use of appropriate works of the secondary literature, will rapidly lead to the complete literature related to any particular subject covered.

Each entry in the author index refers the user to the appropriate section number.

2.6. Compound Index

The compound index lists individual, fully specified compositions of matter that are mentioned in the text. It is an index of empirical formulas, ordered according to the following system: the elements within a given formula occur in alphabetical sequence except for C, or C and H if present, which always come first. Thus, the empirical formula

\[
\text{for } \text{Ti(SO}_4\text{)}_2 \text{ is } O_8\text{S}_2\text{Ti}
\]

\[
\text{BH}_3\text{NH}_3 \quad \text{BH}_6\text{N}
\]

\[
\text{Be}_2\text{CO}_3 \quad \text{CBe}_2\text{O}_3
\]

\[
\text{CsHBr}_2 \quad \text{Br}_2\text{CsH}
\]

\[
\text{Al(HCO}_3\text{)}_3 \quad \text{C}_3\text{H}_3\text{AlO}_9
\]

The formulas themselves are ordered alphanumerically without exception; that is, the formulas listed above follow each other in the sequence BH,N, Br,CsH, CBe,O,, C,H,AlO,, O,S,Ti.
classes such as organotin compounds or rare-earth hydrides which cannot be expressed by the empirical formulas of the compound index.

For multiple entries, additional keywords indicate contexts and thereby avoid the retrieval of information that is irrelevant to the user's need.

Again, section numbers are used to direct the reader to those positions in the book where substantial information is to be found.

**2.8. Periodic Table (Back Endpaper)**

Reference to periodic groups avoids cumbersome enumerations. Section headings in the series employ the nomenclature.

Unfortunately, however, there is at the present time no general agreement on group designations. In fact, the scheme that is most widely used (combining a group number with the letters A and B) is accompanied by two mutually contradictory interpretations. Thus, titanium may be a group IVA or group IVB element depending on the school to which one adheres or the part of the world in which one resides.

In order to clarify the situation for the purposes of the series, a suitable labeled periodic table is printed on the inside back cover of each volume. All references to periodic group designations in the series refer to this scheme.
Preface to the Series

Inorganic Reactions and Methods constitutes a closed-end series of books designed to present the state of the art of synthetic inorganic chemistry in an unprecedented manner. So far, access to knowledge in inorganic chemistry has been provided almost exclusively using the elements or classes of compounds as starting points. In the first 18 volumes of Inorganic Reactions and Methods, it is bond formation and type of reaction that form the basis of classification.

This new route of access has required new approaches. Rather than sewing together a collection of review articles, a framework has had to be designed that reflects the creative potential of the science and is hoped to stimulate its further development by identifying areas of research that are most likely to be fruitful.

The reaction volumes describe methods by which bonds between the elements can be formed. The work opens with hydrogen making a bond to itself in $\text{H}_2$ and proceeds through the formation of bonds between hydrogen and the halogens, the groups headed by oxygen, nitrogen, carbon, boron, beryllium and lithium to the formation of bonds between hydrogen and the transition and inner-transition metals and elements of group zero. This pattern is repeated across the periodic system until all possible combinations of the elements have been treated. This plan allows most reaction topics to be included in the sequence where appropriate. Reaction types that do not arise from the systematics of the plan are brought together in the concluding chapters on oxidative addition and reductive elimination, insertions and their reverse, electron transfer and electrochemistry, photochemical and other energized reactions, oligomerization and polymerization, inorganic and bioinorganic catalysis and the formation of intercalation compounds and ceramics.

The project has engaged a large number of the most able inorganic chemists as Editorial Advisors creating overall policy, as Editorial Consultants designing detailed plans for the subsections of the work, and as authors whose expertise has been crucial for the quality of the treatment. The conception of the series and the details of its technical realization were the subject of careful planning for several years. The distinguished chemists who form the Editorial Advisory Board have devoted themselves to this exercise, reflecting the great importance of the project.

It was a consequence of the systematics of the overall plan that publication of a volume had to await delivery of its very last contribution. Thus was the defect side of the genius of the system revealed as the excruciating process of extracting the rate-limiting manuscripts began. Intense editorial effort was required in order to bring forth the work in a timely way. The production process had to be designed so that the insertion of new material was possible up to the very last stage, enabling authors to update their pieces with the latest developments. The publisher supported the cost of a computerized bibliographic search of the literature and a second one for updating.
Each contribution has been subjected to an intensive process of scientific and linguistic editing in order to homogenize the numerous individual pieces, as well as to provide the highest practicable density of information. This had several important consequences. First, virtually all semblances of the authors' individual styles have been excised. Second, it was learned during the editorial process that greater economy of language could be achieved by dropping conventionally employed modifiers (such as very) and eliminating italics used for emphasis, quotation marks around nonquoted words, or parentheses around phrases, the result being a gain in clarity and readability. Because the series focuses on the chemistry rather than the chemical literature, the need to tell who has reported what, how and when can be considered of secondary importance. This has made it possible to bring all sentences describing experiments into the present tense. Information on who published what is still to be found in the reference lists. A further consequence is that authors have been burdened neither with identifying leading practitioners, nor with attributing priority for discovery, a job that taxes even the talents of professional historians of science. The authors' task then devolved to one of describing inorganic chemical reactions, with emphasis on synthetic utility, yield, economy, availability of starting materials, purity of product, specificity, side reactions, etc.

The elimination of the names of people from the text is by far the most controversial feature. Chemistry is plagued by the use of nondescriptive names in place of more expository terms. We have everything from Abegg's rule, Adkin's catalyst, Admiralty brass, Alfven number, the Amadori rearrangement and Adurssov oxidation to the Zdanovskii law, Zeeman effect, Zincke cleavage and Zinin reduction. Even well-practiced chemists cannot define these terms precisely except for their own areas of specialty, and no single source exists to serve as a guide. Despite these arguments, the attempt to replace names of people by more descriptive phrases was met in many cases by a warmly negative reaction by our colleague authors, notwithstanding the obvious improvements wrought in terms of lucidity, freedom from obscurity and obfuscation and, especially, ease of access to information by the outsider or student.

Further steps toward universality are taken by the replacement of element and compound names wherever possible by symbols and formulas, and by adding to data in older units their recalculated SI equivalents. The usefulness of the reference sections has been increased by giving journal-title abbreviations according to the Chemical Abstracts Service Source Index, by listing in each reference all of its authors and by accompanying references to patents and journals that may be difficult to access by their Chemical Abstracts citations. Mathematical signs and common abbreviations are employed to help condense prose and a glossary of the latter is provided in each volume. Dangerous or potentially dangerous procedures are highlighted in safety notes printed in boldface type.

The organization of the material should become readily apparent from an examination of the headings listed in the table of contents. Combining the words constituting the headings, starting with the major heading (one digit) and continuing through the major chapter heading (two digits), division heading (three digits), section heading (four digits) to the subsection heading (five digits), reveals at once the subject of a "slice" of the plan. Each slice is a self-contained unit. It includes its
own list of references and provides definitions of unusual terms that may be used in it. The reader, therefore, through the table of contents alone, can in most instances quickly reach the desired material and derive the information wanted.

In addition there is for each volume an author index (derived from the lists of references) and a subject index that lists compound classes, methods, techniques, apparatus, effects and other phenomena. An index of empirical formulas is also provided. Here in each formula the element symbols are arranged in alphabetical order except that C, or C and H if present, always come first. Moreover, each empirical formula is permuted successively. Each permuted formula is placed in its alphabetical position and cross referenced to the original formula. Therefore, the number of appearances that an empirical formula makes in the index equals the number of its elements. By this procedure all compounds containing a given element come together in one place in the index. Each original empirical formula is followed by a linearized structural formula and keywords describing the context in which the compound is discussed. All indexes refer the user to subsection rather than page number.

Because the choice of designations of groups in the periodic table is currently in a state of flux, it was decided to conform to the practice of several leading inorganic texts. To avoid confusion an appropriately labeled periodic table is printed on the back endpaper.

From the nature of the work it is obvious that probably not more than two persons will ever read it entire: myself and the publisher's copy editor, Arline Keithe. She, as well as Steven Bedney, Production Manager of VCH Publishers, are to be thanked for their unflagging devotion to the highest editorial standards. The original conception for this series was the brainchild of Dr. Hans F. Ebel, Director of the Editorial Department of VCH Verlagsgesellschaft in Weinheim, Federal Republic of Germany, who also played midwife at the birth of the plan of these reaction volumes with my former mentor, Professor Alan G. MacDiarmid of the University of Pennsylvania, and me in attendance, during the Anaheim, California, American Chemical Society Meeting in the Spring of 1978. Much of what has finally emerged is the product of the inventiveness and imagination of Professor Helmut Grünwald, President of VCH Verlagsgesellschaft. It is a pleasure to acknowledge that I have learned much from him during the course of our association. Ms. Nancy L. Burnett is to be thanked for typing everything that had to do with the series from its inception to this time. Directing an operation of this magnitude without her help would have been unimaginable. My wife Rose stood by with good cheer while two rooms of our home filled up with 10,000 manuscript pages, their copies and attendant correspondence.

Finally, and most important, an enormous debt of gratitude toward all our authors is to be recorded. These experts were asked to prepare brief summaries of their knowledge, ordered in logical sequence by our plan. In addition, they often involved themselves in improving the original conception by recommending further refinements and elaborations. The plan of the work as it is being published can truly be said to be the product of the labors of the advisors and consultants on the editorial side as well as the many, many authors who were able to augment more general knowledge with their own detailed information and ideas. Because of the unusually
strict requirements of the series, authors had not only to compose their pieces to fit within narrowly constrained limits of space, format and scope, but after delivery to a short deadline were expected to stand by while an intrusive editorial process homogenized their own prose styles out of existence and shrunk the length of their expositions. These long-suffering colleagues had then to endure the wait for the very last manuscript scheduled for their volume to be delivered so that their work could be published, often after a further diligent search of the literature to insure that the latest discoveries were being cited and that claims for facts now proved false were eliminated. To these co-workers (270 for the reaction volumes alone), from whom so much was demanded but who continued to place their knowledge and talents unstintingly at the disposal of the project, we dedicate this series.

J.J. ZUCKERMAN
Norman, Oklahoma
July 4, 1985

The JJZ vision of the *Inorganic Reactions and Methods* series, and the unique systemization of inorganic chemistry it embodies, continue as the series moves to completion. During the period of A.P. Hagen’s editorship and since, under my direction, every effort has been made to keep the style consistent with what was originally conceived. The continued development of this exciting series has depended upon the untiring efforts and patience of the many series authors and Dr. Barbara A. Chernow of Chernow Editorial Services.

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<tbody>
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