

**Annual
Reports in
Inorganic
and General
Syntheses
1972**

Edited by

Kurt Niedenzu and Hans Zimmer

54.47088

A 615

:1972

Annual Reports in Inorganic and General Syntheses - 1972

Edited by

Kurt Niedenzu

*Department of Chemistry
University of Kentucky
Lexington, Kentucky*

Hans Zimmer

*Department of Chemistry
University of Cincinnati
Cincinnati, Ohio*

Academic Press



New York and London 1973

A Subsidiary of Harcourt Brace Jovanovich, Publishers

COPYRIGHT © 1973, BY ACADEMIC PRESS, INC.
ALL RIGHTS RESERVED.
NO PART OF THIS PUBLICATION MAY BE REPRODUCED OR
TRANSMITTED IN ANY FORM OR BY ANY MEANS, ELECTRONIC
OR MECHANICAL, INCLUDING PHOTOCOPY, RECORDING, OR ANY
INFORMATION STORAGE AND RETRIEVAL SYSTEM, WITHOUT
PERMISSION IN WRITING FROM THE PUBLISHER.

ACADEMIC PRESS, INC.
111 Fifth Avenue, New York, New York 10003

United Kingdom Edition published by
ACADEMIC PRESS, INC. (LONDON) LTD.
24/28 Oval Road, London NW1

LIBRARY OF CONGRESS CATALOG CARD NUMBER: 72-9991

PRINTED IN THE UNITED STATES OF AMERICA

PREFACE

The constant increase in the volume of chemical literature poses a problem for even the most ardent reader and frequently results in a lack of current information concerning methods of preparation. This is partly due to the fact that potentially useful data are widely scattered throughout the literature with few journals emphasizing synthetic aspects.

With this in mind an organized annual summary of new synthetic developments in inorganic chemistry and its related areas should be beneficial to the specialist as well as the chemist who has only a casual interest in synthesis.

To be of most value to the reader "Annual Reports in Inorganic and General Syntheses" is organized according to the Periodic Table. In addition to regular contributions based on the individual elements or groups of elements, a few chapters summarizing reaction principles, methods, specific classes of materials, etc. will be selected each year to be included in the "Reports." It is hoped that these topics will be of interest to the preparative chemist by illustrating recent trends of research and outlining possible future avenues of approach.

It is our goal to provide a useful summary of current information at a reasonable price. Hence, details are generally not presented; rather, the reader is expected to use the "Reports" as a source of information and as a guide to the original literature.

If the "Reports" are accepted by their intended audience, they will be published annually. The editors welcome any suggestions which may tend to improve the usefulness of future volumes.

Kurt Niedenzu
Hans Zimmer

CONTENTS

| | |
|---|-----|
| PREFACE | xix |
| <u>ALKALI AND ALKALINE EARTH ELEMENTS</u> | 1 |
| M. J. Steffel, Marion, Ohio | |
| The Elements | 1 |
| Complexes with Halogens | 1 |
| Compounds with Group VI Elements | 2 |
| Ozonide | 2 |
| Alkoxides | 2 |
| Oxygen-bonded chelates | 3 |
| Other salts and complexes of oxy compounds | 5 |
| Sulfur-containing compounds | 6 |
| Nitrogen-containing Compounds | 7 |
| Organometallic Compounds | 8 |
| Compounds with Transition Metals | 9 |
| References | 10 |
| <u>COPPER</u> | 12 |
| I. A. Boenig, Lexington, Kentucky | |
| Alloys and Intermetallic Compounds | 12 |
| Inorganic Copper Compounds | 12 |
| Binary and tertiary copper compounds | 12 |
| Copper(II) metallates | 13 |
| Complexes of Copper(I) | 13 |
| Phosphine ligands | 13 |
| Nitrogen containing ligands | 13 |
| Complexes of Copper(II) | 14 |
| Multidentate and polymeric ligands | 14 |
| Complexes of copper(II) with nitrogen linkage | 15 |
| Complexes of copper(II) with Schiff bases | 15 |
| Complexes of copper(II) with pyridine | 15 |
| Complexes with other heterocyclic ligands | 16 |
| Complexes with amino acid ligands | 16 |
| Complexes with phosphorus and arsenic ligands | 16 |
| Complexes with oxygen linkage | 16 |
| Derivatives with thio- and seleno-ligands | 17 |
| Complexes with fluorinated ligands | 17 |
| Organocupper compounds | 18 |

CONTENTS

| | |
|---|----|
| Copper(III) Compounds | 18 |
| References | 18 |
| <u>SILVER AND GOLD.</u> | 25 |
| B. J. McCormick, Morgantown, West Virginia | |
| General | 25 |
| Phosphine Complexes and Related Derivatives | 25 |
| Simple Salts and Other Complexes | 29 |
| Nitrogen donors | 30 |
| Chalcogen donors | 30 |
| Miscellaneous Organometallic Compounds | 31 |
| References | 31 |
| <u>ZINC, CADMIUM AND MERCURY.</u> | 34 |
| J. B. Smart, Cincinnati, Ohio | |
| General and Coordination Compounds | 34 |
| Compounds with Metal-Metal Bonds | 36 |
| Group IV metals | 36 |
| Boron derivatives | 37 |
| Transition metals | 37 |
| Organometallic Compounds | 38 |
| Organomercury | 38 |
| Organozinc. | 40 |
| References | 41 |
| <u>BORON.</u> | 44 |
| L. A. Melcher, New Orleans, Louisiana | |
| General | 44 |
| New Procedures | 44 |
| Organoboranes | 45 |
| Hydroboration | 46 |
| Carboranes | 46 |
| Boron hydrides | 46 |
| Metal-Boron Compounds | 47 |
| Three Coordinate Boron | 48 |
| Boron-nitrogen compounds | 48 |
| Ring systems | 48 |
| Four Coordinate Boron | 49 |
| BX_3 complexes | 49 |
| BX_4 complexes | 49 |
| References | 49 |

CONTENTS

| | |
|--|----|
| <u>ALUMINUM, GALLIUM, INDIUM, THALLIUM.</u> | 55 |
| J. P. Oliver, Detroit, Michigan | |
| Introduction | 55 |
| Procedures of Synthesis. | 55 |
| Aluminum. | 55 |
| Ga and In derivatives by oxidative addition | 56 |
| Thallium. | 56 |
| Deuterium and tritium labeling. | 57 |
| Reactions of Al Derivatives with Epoxides and Carbonyls. | 57 |
| Epoxides. | 57 |
| Carbonyl compounds. | 57 |
| Reactions of R ₂ AlX. | 58 |
| Reactions with Olefins | 59 |
| Addition reactions. | 59 |
| Cyclization | 59 |
| Reactions of Thallium Compounds. | 60 |
| Cyanation | 60 |
| Halogenation. | 60 |
| Oxidation | 60 |
| Compounds with Metal-Metal Bonds | 61 |
| Aluminum. | 61 |
| Gallium and indium. | 62 |
| Thallium. | 62 |
| Miscellaneous Reactions. | 62 |
| Ate complexes | 62 |
| Reactions of optically active compounds | 63 |
| Oxygen-bridged compounds. | 63 |
| Hydrogen-bridged compounds. | 64 |
| References | 64 |
| <u>YTTRIUM, SCANDIUM, LANTHANIDES AND ACTINIDES</u> | 67 |
| K. S. Mazdiyasni, Wright-Patterson AFB, Ohio | |
| Hydrides | 67 |
| Oxides | 67 |
| Fluorides. | 67 |
| Borides. | 68 |
| Chalcogenides. | 68 |
| Organo Lanthanides and Actinides | 68 |
| Beta-Diketonato Compounds. | 69 |
| References | 72 |
| <u>TITANIUM, ZIRCONIUM AND HAFNIUM.</u> | 73 |
| K. S. Mazdiyasni, Wright-Patterson AFB, Ohio | |
| Borides. | 73 |

CONTENTS

| | |
|---|-----------|
| Alkoxides | 73 |
| Phosphonato Complexes | 75 |
| Organo Titanium, Zirconium and Hafnium | 76 |
| Aniline and O-allylaniline | 76 |
| Methyltitanium trichloride | 76 |
| Cyclopentadienyl derivatives | 76 |
| Reaction with alkylaluminum | 77 |
| Cyclopentadienyl halo complexes | 77 |
| Heteronuclear complexes | 77 |
| Pentamethylcyclopentadienyl titanium | 78 |
| Metalloccycles | 79 |
| Binuclear compounds | 79 |
| References | 81 |
| GROUP V TRANSITION ELEMENTS | 82 |
| F. W. Moore and G. A. Tsigdinos, Ann Arbor, Michigan | |
| Vanadium | 82 |
| Halides, oxohalides and adducts | 82 |
| Other simple compounds | 82 |
| Coordination compounds | 82 |
| Vanadates and other oxide phases | 83 |
| Niobium and Tantalum | 83 |
| Halides, oxohalides and adducts | 83 |
| Other simple compounds | 84 |
| Coordination compounds | 84 |
| Niobates and tantalates | 84 |
| References | 85 |
| GROUP VI TRANSITION ELEMENTS | 89 |
| G. A. Tsigdinos and F. W. Moore, Ann Arbor, Michigan | |
| Chromium | 89 |
| Oxides | 89 |
| Chromates and chromites | 89 |
| Halogen-containing compounds of chromium | 89 |
| Refractory compounds | 90 |
| Miscellaneous | 90 |
| Molybdenum | 90 |
| Oxides | 90 |
| Simple molybdates | 91 |
| Isopoly compounds | 92 |
| Heteropoly compounds | 92 |
| Thiomolybdates and chalcogenides | 93 |
| Halogen-containing molybdenum compounds | 93 |
| Miscellaneous compounds | 93 |

CONTENTS

| | |
|---|-----|
| Tungsten | 94 |
| Tungsten bronzes and simple tungstates | 94 |
| Heteropoly tungstates | 94 |
| Chalcogenides and chalcotungstates | 95 |
| Halogen-containing tungsten compounds | 95 |
| References | 96 |
| <u>MANGANESE, TECHNETIUM AND RHENIUM</u> | 100 |
| G. Davies, Boston, Massachusetts | |
| General | 100 |
| Manganese | 100 |
| Lower oxidation states | 100 |
| Manganese(II) | 101 |
| Manganese(III) | 105 |
| Higher oxidation states | 106 |
| Technetium | 107 |
| Rhenium | 108 |
| Rhenium(I) | 108 |
| Rhenium(II) | 109 |
| Rhenium(III) | 109 |
| Rhenium(IV) | 111 |
| Rhenium(V) | 111 |
| Rhenium(VI) | 113 |
| Rhenium(VII) | 114 |
| References | 114 |
| <u>IRON</u> | 119 |
| J. R. Wasson and H. J. Stoklosa, Lexington, Kentucky | |
| General | 119 |
| Hydrides and Phosphine Complexes | 119 |
| Compounds with Iron-Carbon Bonds | 120 |
| Compounds with Nitrogen Donors | 120 |
| Compounds with Oxygen Donors | 121 |
| Complexes with Sulfur Ligands | 122 |
| Halide Complexes | 122 |
| Miscellaneous | 123 |
| References | 123 |
| <u>COBALT AND NICKEL</u> | 127 |
| P. R. Mitchell, Canterbury, Kent, England | |
| Low Oxidation States - Co(-I), Co(0), Co(I) | 127 |
| Carbonyls | 127 |
| Phosphine complexes | 128 |
| Nitrosyls | 129 |

CONTENTS

| | |
|---|------------|
| Low-Valent Nickel Complexes | 130 |
| Carbonyls | 130 |
| Phosphine complexes | 130 |
| Other zerovalent nickel complexes | 131 |
| Nickel(I) complexes | 132 |
| Nitrosyls | 132 |
| Cobalt(II) and Nickel(II) Complexes | 132 |
| Complexes with heavy donor atoms | 133 |
| Nickel(II) complexes of macrocyclic ligands | 133 |
| Oxidative and reductive syntheses of cobalt(II) and nickel(II) complexes | 134 |
| Unusual cobalt(II) and nickel(II) complexes | 134 |
| Cobalt(III) Complexes | 134 |
| Some unusual cobalt(III) complexes | 135 |
| Syntheses in non-aqueous solvents | 136 |
| Cobalt(III) intermediates with weakly coordinated solvent molecules | 136 |
| Syntheses from nitro, sulfito and carbonate intermediates | 136 |
| Complexes of macrocyclic ligands | 137 |
| Binuclear and polynuclear complexes | 137 |
| Cobalt(III) complexes with less common combinations of donor atoms | 138 |
| Separation of cobalt(III) complexes | 138 |
| Nickel in Higher Oxidation States - Ni(III) and Ni(IV) | 138 |
| Cobalt(IV) | 139 |
| References | 139 |
| PLATINUM METALS, PART I: Ru, Os, Rh, Ir | 145 |
| B. T. Heaton, Canterbury, Kent, England | |
| Introduction | 145 |
| The Chemistry of Ruthenium and Osmium | 145 |
| Group VII donors | 145 |
| Group VI donors | 145 |
| Oxygen donors | 145 |
| Sulfur donors | 146 |
| Group V donors | 146 |
| Nitrogen donors | 146 |
| Nitrogen donor complexes containing tertiary phosphines or arsines | 147 |
| Phosphorus and arsenic donors | 147 |
| Group IV donors | 148 |
| Ru(II) and Os(II) carbonyls | 148 |
| Monomeric Ru(O) and Os(O) carbonyls | 149 |
| Trimeric Ru(O) and Os(O) carbonyls | 149 |
| Nitrosylcarbonyls | 150 |
| Olefin complexes. Monoolefins | 151 |
| Chelating diolefins | 151 |
| Sandwich compounds | 152 |

CONTENTS

| | |
|---|------------|
| Arene complexes | 152 |
| Isocyanide and carbenoid complexes | 152 |
| The Chemistry of Rhodium and Iridium | 153 |
| Group VII donors | 153 |
| Group VI donors | 153 |
| Oxygen donors | 153 |
| Sulfur donors | 153 |
| Group V donors | 154 |
| Nitrogen donors | 154 |
| Phosphorus donors | 155 |
| Nitrosylphosphine complexes | 157 |
| Group IV donors | 157 |
| Carbonyl clusters | 157 |
| Other clusters | 158 |
| Dimeric carbonylphosphine complexes | 158 |
| Oxidative-addition reactions of carbonylphosphine and related complexes | 159 |
| Olefin complexes. Monoolefins | 160 |
| Chelating diolefins | 160 |
| π -Allyl and π -cyclopentadienyl complexes | 161 |
| Isonitrile and carbenoid complexes | 161 |
| Metallation reactions and complexes containing metal-carbon sigma bonds | 162 |
| References | 163 |
| PLATINUM METALS, PART II: Pd and Pt | 168 |
| B. T. Heaton, Canterbury, Kent, England | |
| Introduction | 168 |
| Group VII Donors | 168 |
| Group VI Donors | 169 |
| Oxygen donors | 169 |
| Sulfur donors | 169 |
| Group V Donors | 170 |
| Nitrogen donors | 170 |
| Phosphorus or arsenic donors | 170 |
| Palladium(II) and platinum(II) complexes | 171 |
| Hydrido-phosphine or -arsine complexes | 172 |
| Group IV Donors | 172 |
| Heteronuclear carbonyl complexes | 172 |
| Monoolefin and acetylene complexes | 173 |
| Chelating diolefin complexes | 174 |
| π -Allyl complexes | 174 |
| Isonitrile and carbenoid complexes | 174 |
| Metallation reactions and complexes containing metal-carbon sigma bonds | 174 |
| Complexes containing Pt-Si or Pt-Ge bonds | 175 |
| References | 176 |

CONTENTS

| | |
|---|-----|
| <u>SILICON.</u> | 180 |
| J. S. Thayer, Cincinnati, Ohio | |
| General | 180 |
| Silicon-Halogen. | 180 |
| Silicon-Nonmetal | 181 |
| Silicon-oxygen. | 181 |
| Silicon-carbon. | 182 |
| Silicon-nitrogen. | 183 |
| Other silicon-nonmetals | 183 |
| Silicon-Metal. | 183 |
| Silicon-Silicon. | 184 |
| Inorganic | 184 |
| Organic | 184 |
| References | 185 |
| <u>GERMANIUM, TIN AND LEAD.</u> | 187 |
| R. D. Joyner, Muncie, Indiana | |
| General | 187 |
| MR ₄ Compounds. | 187 |
| Metal-carbon bonded compounds | 187 |
| Metal-nitrogen bonded compounds | 187 |
| Metal-oxygen bonded compounds | 188 |
| Metal-halogen bonded compounds. | 188 |
| Compounds containing more than one group IV metal in the structure. | 189 |
| Miscellaneous MR ₄ compounds | 189 |
| Reactions of MR ₄ compounds. | 189 |
| Metal-Metal Bonded Compounds | 189 |
| Organometallic compounds. | 189 |
| Coordination compounds. | 190 |
| Coordination Compounds of Ge, Sn, Pb | 193 |
| References | 194 |
| <u>NITROGEN</u> | 201 |
| P. A. S. Smith, Ann Arbor, Michigan | |
| General | 201 |
| Compounds with no N-N Bonds. | 201 |
| Compounds with One N-N Bond. | 203 |
| Compounds with Three Linked Nitrogens. | 204 |
| Compounds with Chains of Four Nitrogens. | 206 |
| References | 207 |

CONTENTS

| | |
|--|-----|
| PHOSPHORUS | 209 |
| E. Lindner and H. D. Ebert, Tübingen, Germany | |
| Introduction | 209 |
| New Syntheses. | 209 |
| Elemental phosphorus. | 209 |
| Phosphoranes. | 209 |
| Phosphines, phosphine oxides and sulfides | 210 |
| Phosphorus-Boron Compounds | 211 |
| Compounds containing phosphorus-halogen bonds | 211 |
| Derivatives with halogen and other groups | 211 |
| Compounds with hydrogen or carbon bonded to phosphorus. | 211 |
| Phosphorus-Halogen Compounds | 211 |
| Phosphorus-Metal Derivatives | 212 |
| Phosphorus-Phosphorus Bonds. | 212 |
| Phosphorus-Oxygen Compounds. | 213 |
| Hypophosphites and phosphites | 213 |
| Halophosphates. | 213 |
| Metaphosphates and phosphates | 213 |
| Hypophosphates and diphosphates | 213 |
| Peroxiphosphoric acids. | 214 |
| Phosphorus-sulfur compounds | 214 |
| Phosphorus-Nitrogen Compounds. | 214 |
| Cyclic phosphazines | 214 |
| Cyclic phosphazines containing heteroatoms. | 215 |
| Cyclic and linear phosphazenes. | 216 |
| Linear phosphazenes | 216 |
| Phosphorus amides | 217 |
| Phosphorus amines | 218 |
| Hydrazine derivatives of halodiphosphines | 218 |
| P(III) and P(V) nitroxide fluorides | 219 |
| Imides of phosphorus. | 219 |
| Phosphorus azides | 219 |
| Phosphorus-Hydrogen Compounds. | 219 |
| Radicals in Phosphorus Chemistry | 219 |
| Phosphorus Containing Cage Compounds | 219 |
| Complexes with Phosphorus Containing Ligands | 220 |
| References | 220 |
| ARSENIC, ANTIMONY AND BISMUTH. | 225 |
| L. C. Duncan, Ellensburg, Washington | |
| General. | 225 |
| Organometallic Compounds of Arsenic, Antimony and Bismuth. | 225 |
| Chelating agents. | 225 |
| Tertiary arsines. | 225 |
| Heteroatom-arsenic species. | 226 |

CONTENTS

| | |
|---|-----|
| Cyclic compounds | 228 |
| Tertiary antimony | 229 |
| Antimony(V) compounds | 229 |
| Bismuth | 230 |
| Inorganic Arsenic, Antimony and Bismuth Compounds | 230 |
| Arsenic | 230 |
| Antimony | 230 |
| Bismuth | 231 |
| Acceptor Compounds Involving the Group V Elements | 231 |
| References | 232 |
| <u>THE CHALCOGENS</u> | 236 |
| K. Seppelt, Heidelberg, Germany | |
| Oxygen | 236 |
| Singlett oxygen | 236 |
| Oxygen compounds | 236 |
| Sulfur | 237 |
| Polysulfur compounds | 237 |
| Sulfur(II) compounds | 238 |
| Sulfur-nitrogen ring compounds | 239 |
| Sulfur(IV) compounds | 240 |
| Sulfur(VI) compounds | 241 |
| Selenium | 243 |
| Selenium(II) compounds | 243 |
| Selenium(IV) compounds | 243 |
| Selenium(VI) compounds | 243 |
| Tellurium | 244 |
| Polonium | 246 |
| References | 246 |
| <u>FLUORINE</u> | 250 |
| C. D. Miller, Richmond, Kentucky | |
| General | 250 |
| New Fluorinating Agents and Techniques | 250 |
| Xenon-Fluorine Compounds | 250 |
| Chlorine-Fluorine Compounds | 250 |
| Sulfur-Fluorine Compounds | 251 |
| Nitrogen-Fluorine Chemistry | 251 |
| Carbon-Fluorine Compounds | 252 |
| Fluoro Polymers | 253 |
| Silicon-Fluorine Chemistry | 254 |
| References | 255 |
| | 256 |

CONTENTS

| | |
|---|-----|
| <u>HALOGENS AND PSEUDOHALOGENS.</u> | 258 |
| J. J. Alexander, Cincinnati, Ohio and M. J. Steffel, Marion, Ohio | |
| General. | 258 |
| Halogens | 258 |
| Fluorine. | 258 |
| Chlorine. | 260 |
| Bromine | 261 |
| Iodine. | 262 |
| Miscellaneous | 264 |
| Pseudohalogen Compounds of Main Group Elements | 264 |
| Group II. | 264 |
| Group III | 264 |
| Group IV. | 265 |
| Group V | 265 |
| Group VI. | 265 |
| Compounds with Transition Metals | 266 |
| Compounds with Inner Transition Metals | 269 |
| References | 269 |
| <u>NOBLE GASES.</u> | 274 |
| K. Seppelt, Heidelberg, Germany | |
| General Remarks. | 274 |
| Argon, Krypton | 274 |
| Xenon. | 274 |
| References | 276 |
| <u>SIMPLE AND COMPLEX METAL HYDRIDES OF MAIN GROUPS I-III</u> | 277 |
| R. O. Bach, Bessemer City, North Carolina | |
| Introduction | 277 |
| Simple Hydrides of Groups I and II | 277 |
| Sodium (and other alkali metal) hydrides. | 277 |
| Beryllium hydride tertiary amine complexes. | 278 |
| Magnesium hydride | 278 |
| Complex Hydrides of Groups I and II. | 278 |
| Tetra hydrido-beryllates. | 278 |
| Complex magnesium hydrides. | 279 |
| Lithium strontium hydride | 279 |
| Aluminum Hydride | 279 |
| Amine Adducts of Aluminum Hydride. | 280 |
| Group I Metal Hydridoaluminates. | 280 |
| Lithium hydridoaluminates | 280 |
| Sodium hydridoaluminates | 281 |

CONTENTS

| | |
|--|-----|
| Group II Metal Hydridoaluminates | 281 |
| Hydridogallates | 282 |
| References | 282 |
| <u>NEW TECHNIQUES AND REAGENTS IN COORDINATION CHEMISTRY</u> | 284 |
| P. R. Mitchell, Canterbury, Kent, England | |
| Synthesis of Low-Valent Metal Complexes | 284 |
| Zerovalent metal complexes at intermediates | 284 |
| Carbonyls | 285 |
| Phosphine complexes | 286 |
| Nitrosyl complexes | 286 |
| Electrochemical syntheses | 287 |
| Metal Complexes in Normal Oxidation States | 287 |
| Intermediates with weakly coordinated solvents | 287 |
| Redox Catalysis | 288 |
| Carboxylate complexes | 288 |
| Complexes of neutral acetylacetone | 288 |
| Dinitrogen complexes | 289 |
| Metal Complexes in Higher Oxidation States | 290 |
| References | 290 |
| <u>STABILIZING EFFECTS OF LARGE COUNTER-IONS</u> | 293 |
| D. H. McDaniel, Cincinnati, Ohio | |
| Introduction | 293 |
| Lattice dominating | 293 |
| Lattice energy limiting | 294 |
| Insulating effects | 294 |
| Polarization effects | 294 |
| Shape and charge effects | 294 |
| Large Cations | 295 |
| Hydrogen Bonded Complex Ions | 297 |
| Anionic Boron Complexes | 299 |
| Nitrato Complexes | 300 |
| The Polyhalide Ions | 301 |
| Tellurocyanate Salts | 302 |
| Counter-Ion Effects in Linkage Isomerism | 302 |
| Silver Complexes | 303 |
| Indium Complexes | 303 |
| Tricoordinated Group IV Metals and Their Complexes | 304 |
| Pentacoordinated Group IV Metals | 305 |
| Group V | 305 |

CONTENTS

| | |
|---|------------|
| Group VI | 306 |
| Lanthanate Complexes | 306 |
| Actinides. | 306 |
| Carbonyl and Cyano Complexes | 307 |
| Transition Metal Complexes | 307 |
| Cationic Complexes | 309 |
| Stability. | 309 |
| References | 310 |