GMELIN
Handbook of Inorganic
and
Organometallic Chemistry
Complete Catalog 1997/98
### Periodic Table of Elements

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*NH₄*
GMELIN Complete Catalog 1997/98

Page   Contents
1 Recent Issues 1995/1997
1 Next volumes to appear 1997/98
2 Reference Table
3 Introduction and Explanatory Material
4 TYPIX
5 Alphabetical Index covering all volumes published up to January 1997
60 Index Volumes
   Facsimile reprint of the First Edition, 1817-1819
   GABCOM & GABMET

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Recent Issues 1995/1997

Au Gold Supplement Volume B3
   Gold Supplement Volume B4
B Boron Compounds, Fourth Supplement Volume lb
Be Beryllium Supplement Volume B4
F Perfluorohalogenoorgano Compounds of Main Group Elements Second Supple. V. 2
Fe Organooriron Compounds Part A11
Ga Gallium Supplement Volume C2
   Gallium Supplement Volume D2
   Gallium Supplement Volume D3
Ge Organogermain Compounds Part 6
Mn Manganese Volume A3a
   Manganese Volume A5a
   Manganese Volume A5bl
Mo Molybdenum Supplement Volume B8
   Organomolybdenum Compounds Part 10
   Organomolybdenum Compounds Part 11
   Organomolybdenum Compounds Part 13
N Nitrogen Supplement Volume B6
Ni Organonickel Compounds,
   First Supplement Part 3
Os Organooosmium Compounds Part B4a
   Organooosmium Compounds Part B8
   Organooosmium Compounds Part B9
P Phosphorus Supplement Volume C2
   Phosphorus Supplement Volume C5a
Pb Organolead Compounds Part 4
   Organolead Compounds Part 5
Re Organorehenium Compounds Part 4
   Organorehenium Compounds Part 7
S Sulfur-Nitrogen Compounds Part 11
Sc,Y, La-Lu Rare Earth Elements Volume C12a
   Rare Earth Elements Volume E2a
Si Silicon Supplement Volume B5bl
   Silicon Supplement Volume B5dl
   Silicon Supplement Volume B5d2
   Silicon Supplement Volume B8
Sn Organotin Compounds Part 22
   Organotin Compounds Part 23
   Organotin Compounds Part 24
U Uranium Supplement Volume B4
   Uranium Supplement Volume C6
   Uranium Supplement Volume D5
   Uranium Supplement Volume D6
In this catalog the Gmelin volumes are arranged alphabetically according to the chemical symbols for the elements. The New Supplement Series is included in the Main Series. Thus, for example the volumes dealing with boron compounds are to be found under the element symbol B, the organoiron compounds under Fe, the Organotin compounds under Sn and the perfluorohalogenoorganogano compounds under F.
The GMELIN Handbook

What is Gmelin?

For 180 years now "Gmelin" is the authoritative work of reference in the fields of inorganic, organometallic, and physical chemistry, and is without doubt one of the most valuable bibliographical research tools, not only for the chemist but also for the physicist, metallurgist, technologist, geochemist, mineralogist, and crystallographer.

The current 8th edition of the Handbook, including main series and supplements, is published by the Gmelin-Institut für Anorganische Chemie (Gmelin Institute for Inorganic Chemistry) in Frankfurt (Main), an institute of the Max-Planck-Society for the Advancement of Science. Starting in 1990, the Handbook has adopted the name GMELIN Handbook of Inorganic and Organometallic Chemistry. This describes more precisely what the reader finds in "Gmelin", its contents, program, and aims. In the past 30 years or so organometallic compounds have become a major subject of chemical research and, consequently, of a growing number of publications.

The objectives and scientific value of Gmelin

The primary objective of the Handbook is to assemble and systematically classify the research findings scattered throughout the innumerable publications of the world's primary scientific literature.

The reduction of this mass of data into readily usable form combines exhaustively coverage of all published material, thorough and objective assessment of all results, strictly logical grouping of related facts, modern monographic presentation. With its detailed and comprehensive treatment of all the available information, the Handbook is designed to provide the scientist in research, production, or planning with an essential tool for both the decision-making process and practical realization of scientific projects, and to contribute generally to the rationalization of scientific effort.

How up-to-date is Gmelin?

The Gmelin Handbook is published in modern "open-ended" form, allowing for dynamic coverage of the most recent findings, right up to the date of publication, including reviews of not yet completed developments. The literature closing date for each individual volume gives the year up to which the literature has been completely covered. In many cases, more recent material is also included. The newly published Gmelin volumes are thus up-to-date.

English in Gmelin

The excellent international reputation of the Gmelin Handbook has led to its widespread use in the English-speaking world. All Gmelin volumes published since 1980 are exclusively in English. And for a long time, English has been used in the tables of contents and for the section headings, so the English-speaking user will experience little difficulty in locating the required subject matter in the older volumes.

The significance of Gmelin

Abstracting journals normally review published material shortly after its appearance in the primary literature. This rapid coverage of new results is not, however, compatible either with a logical grouping of new material along with related or earlier findings on a specific subject, or with careful screening of the information contained in fee original publications.

Gmelin suffers from neither of these drawbacks. In other words, where a coherent and balanced review of the literature on a particular topic is required, with emphasis on critical appraisal of the results reproduced, consultation of the Gmelin Handbook is the natural choice.

The New Supplement Series of the 8th edition was started years ago in order to facilitate the rapid reporting of new developments in inorganic and organometallic chemistry. From 1978 on, the New Supplement Series has been fully incorporated in the 8th edition and is no longer designated as such.

GMELIN Complete Catalog 1997/98

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All compounds of a given element with elements having lower System Numbers are grouped for treatment under that element. For example, all compounds of zinc (System Number 32) with elements of System Numbers 1 to 31 are found under zinc.

The arrangement of the material

Here the material is classified on the basis of the chemical elements. The subject matter is arranged according to the "System of Elements". In general, compounds of each metal are arranged in order of increasing number of metal atoms in the formula unit (mono-, di-, trinuclear, etc.) and increasing number, n, of carbon atoms of the ligand, L, bonded to the metal. If there are different ligands present, the compound is classified according to the ligand which has the highest value of n. The L ligands comprise not only η-bonded ligands (R) such as alkyl or aryl, but also CO, isocyanates, carbenes, carbynes, or η-bonded ligands coordinated by one C atom and one heteroatom. The higher η ligands are exemplified by alkenes and alkylnes (η¹), η²-alkyl groups (η²), dienes (η²), C₆H₅ (η²), and arenes (η²).

Conventions for the volumes on Organometallic Chemistry

The organometallic volumes cover all compounds with metal-carbon bonds except carbides, cyanides, cyanates, and thio-cyanates. Additional conventions were developed for these volumes. In general, compounds of each metal are arranged in order of increasing number of metal atoms in the formula unit (mono-, di-, trinuclear, etc.) and increasing number, n, of carbon atoms of the ligand, L, bonded to the metal. If there are different ligands present, the compound is classified according to the ligand which has the highest value of n. The L ligands comprise not only η-bonded ligands (R) such as alkyl or aryl, but also CO, isocyanates, carbenes, carbynes, or η-bonded ligands coordinated by one C atom and one heteroatom. The higher η ligands are exemplified by alkenes and alkylnes (η¹), η²-alkyl groups (η²), dienes (η²), C₆H₅ (η²), and arenes (η²).
If necessary, ligands that are coordinated to the metal through heteroatoms (\(^{\text{D}}\), where \(m\) is the number of electrons that the ligand, \(D\), contributes to the coordination bond) or anions (\(X\)) are given a separate classification. Examples of such ligands are \(\text{P(CH}_3\text{)}_3\) (\(^{\text{D}}\)) and acetylacetonate (\(^{\text{D-X}}\)).

Comments on the Complete Catalog:
All volumes are alphabetically arranged according to Element Symbol (main Work and Supplements together with the volumes of the New Supplement Series). Thus, all of the volumes dealing with a given element and its compounds are listed under the symbol of that element.

The General Formula Index consists of 12 sections. Those volumes of the Main Work which appeared before the end of 1974, as well as Volumes 1 to 12 of the New Supplement Series, are covered. The index is published in English, and a user's guide is provided. The First Supplement 1974-1979 to the General Formula Index consists of 8 volumes; the Second Supplement 1980-1987 consists of 10 volumes. The Third Supplement 1988-1992 consists of 6 volumes. See page 60.

Information also available via Internet at http://sdience.springer.de/newmedia/gmelin/gmhome.htm

The GMELIN ONLINE DATABASE
The GMELIN ONLINE DATABASE represents the largest collection of critically evaluated data in the field of inorganic and organometallic chemistry including the related spheres of physics, metallurgy, technology, geochemistry, mineralogy, and crystallography.

A total sum of 120 subjects areas such as formation and preparation, chemical behavior and reactions, electrical properties, condensed phases, magnetic properties, molecular properties, multi-component systems, optical properties, phase transitions, spectroscopical properties, thermal properties, thermo-dynamical properties, transport phenomena are described using more than 800 different textual and numerical fields. The database which is available online from STN International comprises the factual data of the GMELIN HANDBOOK from 1924 to 1976 as well as the relevant information taken from the 111 most important periodicals from 1976 onwards together with facts, structures, and reactions of more than 1,200,000 compounds.

Extensive search possibilities such as substructural search for and reactions of more than 1,200,000 compounds. Extensive search possibilities such as substructural search for and reactions of more than 1,200,000 compounds. Extensive search possibilities such as substructural search for and reactions of more than 1,200,000 compounds. Extensive search possibilities such as substructural search for and reactions of more than 1,200,000 compounds.

If necessary, ligands that are coordinated to the metal through heteroatoms (\(^{\text{D}}\), where \(m\) is the number of electrons that the ligand, \(D\), contributes to the coordination bond) or anions (\(X\)) are given a separate classification. Examples of such ligands are \(\text{P(CH}_3\text{)}_3\) (\(^{\text{D}}\)) and acetylacetonate (\(^{\text{D-X}}\)).

Comments on the Complete Catalog:
All volumes are alphabetically arranged according to Element Symbol (main Work and Supplements together with the volumes of the New Supplement Series). Thus, all of the volumes dealing with a given element and its compounds are listed under the symbol of that element.

The General Formula Index consists of 12 sections. Those volumes of the Main Work which appeared before the end of 1974, as well as Volumes 1 to 12 of the New Supplement Series, are covered. The index is published in English, and a user's guide is provided. The First Supplement 1974-1979 to the General Formula Index consists of 8 volumes; the Second Supplement 1980-1987 consists of 10 volumes. The Third Supplement 1988-1992 consists of 6 volumes. See page 60.

Information also available via Internet at http://sdience.springer.de/newmedia/gmelin/gmhome.htm

The GMELIN ONLINE DATABASE
The GMELIN ONLINE DATABASE represents the largest collection of critically evaluated data in the field of inorganic and organometallic chemistry including the related spheres of physics, metallurgy, technology, geochemistry, mineralogy, and crystallography.

A total sum of 120 subjects areas such as formation and preparation, chemical behavior and reactions, electrical properties, condensed phases, magnetic properties, molecular properties, multi-component systems, optical properties, phase transitions, spectroscopical properties, thermal properties, thermo-dynamical properties, transport phenomena are described using more than 800 different textual and numerical fields. The database which is available online from STN International comprises the factual data of the GMELIN HANDBOOK from 1924 to 1976 as well as the relevant information taken from the 111 most important periodicals from 1976 onwards together with facts, structures, and reactions of more than 1,200,000 compounds.

Extensive search possibilities such as substructural search for and reactions of more than 1,200,000 compounds. Extensive search possibilities such as substructural search for and reactions of more than 1,200,000 compounds. Extensive search possibilities such as substructural search for and reactions of more than 1,200,000 compounds. Extensive search possibilities such as substructural search for and reactions of more than 1,200,000 compounds.

TYPIX
Standardized Data and Crystal Chemical Characterization of Inorganic Structure Types
TYPIX is a critical compilation of crystallographic data for 3206 compounds representing structure types found among inorganic compounds (structure types found exclusively among halides or oxides are only included in specific cases). TYPIX also contains condensed crystal chemical information about individual structures types and an extensive chapter on the crystal chemistry of particular structure families. The purpose of this compilation is to clarify and classify published data for intermetallic and other inorganic structures.

Volume 1: Standardization of Crystal Structure Data. Crystal Chemical Characterization of Inorganic Structure Types
Explains the criteria applied by the standardization method and their usefulness for classifying inorganic structure types. Groups structure families in 57 tables, most of them with drawings. The structure families are analysed according to various crystal chemical concepts: structures with close-packed layers, structures of compounds where valence electron considerations can be applied, structures with intergrown slabs, columns, or blocks, structures with particular coordinations or linkages, deformation, substitution, filled-up, or vacancy derivatives. - Literature closing date: 1993. 1993. XV, 260 pages. Cloth ISBN 3-540-93682-3

Volume 2: Cross-Reference Tables
Six cross-reference tables order the structure types according to their colloquial name, Pearson code, Strukturbericht notation, space group, stoichiometry and chemical formula of the type-defining compounds. Each of the tables can be used as an index for the main data table. Data for superseded structure proposals are included in the Pearson code and space group tables with a reference to the corrected structure type. - Literature closing date: 1993. 1993. XI, 408 pages. Cloth ISBN 3-540-93683-1

Volume 3: Main Data Table
(triclinic, monoclinic, and orthorhombic structure types) Gives the explanatory notes for the use of the main data table and starts the main data table with complete crystallographic data sets from triclinic, monoclinic, and orthorhombic structure types. Each data set is ordered according to the space group, the Pearson code, and the Wyckoff sequence. The standardized crystallographic data for the most recent refinement of the type-defining compounds have remarks about corrections of the original data, related literature, additional symmetry elements, a short description, reference to related structure types, etc. - Literature closing date: 1993. 1994. XI, 512 pages. Cloth ISBN 3-540-93684-X

Volume 4: Main Data Table
(tetragonal, trigonal, hexagonal, and cubic structure types) Continues the main data table with complete crystallographic data sets for tetragonal, trigonal, hexagonal, and cubic structure types. Includes on diskette the STRUCTURE TIDY program which allows one to standardize own data. - Literature closing date: 1993. 1994. XIII, 416. Cloth ISBN 3-540-93685-8

GMELIN Handbook of Inorganic and Organometallic Chemistry
Publisher: GMELIN Institute for Inorganic Chemistry of the Max-Planck-Society for the Advancement of Science Varrentrappstrafie 40/42 (Carl-Bosch-Haus) D-60486 Frankfurt (Main) Federal Republic of Germany
Part B: The Compounds

Section 1: Compounds with Noble Gases, H, O, N, F, and Cl

Chapters on adsorption, solution, and diffusion of noble gases onto, into, and through silver; oxides and double oxides with alkali and alkaline earth metals; nitride, azide, amide, nitrite, and nitrate; binary compounds and complexes, and systems and compounds of the silver halide with alkali and alkaline earth salts; silver salts of chlorine oxoacids such as chlorate or perchlorate. - Literature closing date: end of 1969. 1971. 154 figs. XXXI, 542 pages (in German). ISBN 3-540-93206-2

Section 2: Compounds with Bromine, Iodine, and Astatine

Includes the following topics: AgBr; complexes; systems of AgBr with other silver salts and with alkali and alkaline earth salts; and silver salts of bromooxocarboxylic acids. A similar chapter on silver and iodine completes the coverage of the silver halides. Photochemical decomposition, especially in connection with the photographic process, is also discussed. - Literature closing date: mid-1970. 1972. 118 figs. XXVI, 481 pages (in German). ISBN 3-540-93207-0

Section 3: Compounds with S, Se, Te, Po, B, C, and Si

The virtually insoluble black chalcogenides Ag_{2}S, Ag_{2}Se, and Ag_{2}Te - which occur in many modifications - are emphasized. The sulfide, thiosulfate, carbonate, cyanide, and thiocyanate are also covered. - Literature closing date: end of 1971. 1973. 149 figs. XXVIII, 389 pages (in German). ISBN 3-540-93208-9

Section 4: Compounds with P, As, Sb, Bi, and the Metals

Salts of the various phosphorus acids. Also many ternary sulfides, selenides, and tellurides, such as AgGaS_{2} and AgGaSe_{2}, whose electrical and optical properties have been studied in detail. - Literature closing date: end of 1972. 1974. 155 figs. XL, 493 pages (in German). ISBN 3-540-93209-7

Section 5: Organosilver Compounds. Organosilver Salts

Covers the organosilver compounds. Subsections deal with σ-compounds (especially the alkyl and alkenyl compounds), carbonyl and isonitrile complexes, as well as π-complexes with unsaturated organic ligands (e.g., ethylene). The second main chapter covers the silver salts of organic acids (especially of formic, acetic, and oxalic acids). - Literature closing date: end of 1973. 1975. 44 figs. XIV, 187 pages (in German). ISBN 3-540-93282-8

Section 6: Complex Compounds with Neutral and Inner-complex-forming Ligands: Silver(I) Complexes with N- and O-containing Ligands

The inorganic ligands (H_{2}O, NH_{3}, N_{2}H_{4}, and NH_{2}OH) are covered first, followed by organic ligands (amines, N-heterocycles, alcohols, aldehydes, ketones, ethers, O-heterocycles, aminoaalkohols, aminooacids, amino-N-polycarboxylic acids, Schiff's bases, azo compounds, oximes, acid amides, and nitriles). - Literature closing date: mid-1974. 1975. 49 figs. XVI, 356 pages (in German). ISBN 3-540-93306-9

Section 7: Complex Compounds with Neutral and Inner-complex-forming Ligands: Silver(II) Complexes with Ligands which Contain S, Se, Te, P, As, Sb, Bi, S, or Ge; Silver(II) and Silver(III) Complexes. Subject and Ligand Index for Silver Part B Sections 1 to 7

Completes the Ag^{I} complexes. Also describes the Ag^{II} and Ag^{III} complexes, among which ligands containing N, as for instance N-heterocycles, are most important. The subject and ligand indexes at the end of the volume improve access to the material contained in volumes Ag B 1 to Ag B 7. - Literature closing date: mid-1974. 1976. 49 figs. XVI, 430 pages (in German). ISBN 3-540-93310-7
Part C: Alloys

Aluminium - Al
Main Volume
Division I
The chapter on aluminium silicates occupies a considerable portion of the section dealing with occurrence. Preparation on an industrial scale is emphasized. - Literature closing date: end of 1933. 1934, reprint 1966. 27 figs. XII, 284 pages (in German). Cloth ISBN 3-540-93002-7

Section 2: Corrosion. Electrochemical Behavior of Aluminium
Covers electrochemical behavior and chemical reactions, as well as detection and determination. - Literature closing date: June 1934. 1934, reprint 1966. 3 figs. VIII, 166 pages (in German). Cloth ISBN 3-540-93003-5

Section 3: Surface Treatment of Aluminium and Aluminium Alloys

Division II
Section 4: Aluminium Alloys with Silicon up to Radium

Section 5: Aluminium Alloys with Zinc up to Uranium
Aluminium alloys with zinc, cadmium, gallium, indium, thallium, the rare earth elements, titanium, zirconium, hafnium, thorium, germanium, tin, lead, vanadium, niobium, tantalum, chromium, molybdenum, tungsten, and uranium. - Literature closing date: April 1937. 1937, reprint 1968. 108 figs. XX, 204 pages (in German). Cloth ISBN 3-540-93006-X

Section 6: Aluminium Alloys with Manganese up to Rhodium
Aluminium alloys with manganese, nickel, cobalt, silver, gold, the platinum metals, and thallium. Many polynary alloys are included. - Literature closing date: September 1938. 1939, reprint 1966. 97 figs. XVII, 224 pages (in German). Cloth ISBN 3-540-93007-8

Section 7: Aluminium Alloys with Iron
This volume covers the aluminium-iron alloys, as well as the appropriate multi-component alloys. - Literature closing date: September 1940. 1941, reprint 1966. 53 figs. XII, 124 pages (in German). Cloth ISBN 3-540-93008-6

Section 8: Ternary Alloy Systems: Al-Fe-C, Al-Fe-Si

Part B: The Compounds
Section 1: Compounds up to Aluminium and Carbon
Covers the compounds of aluminium from "Aluminium and Hydrogen" to "Aluminium and Carbon" in the usual Gmelin sequence. - Literature closing date: October 1933. 1933, reprint 1963. 10 figs. XXIV, 308 pages (in German). Cloth ISBN 3-540-93009-4

Section 2: Compounds (Continued)
Compounds from "Aluminium and Silicon" to "Aluminium and Mercury". "Aluminium and Iron" is included in an Appendix. The volume includes the aluminium silicates, alums, and feldspars. - Literature closing date: March 1934. 1934, reprint 1963. 33 figs. XXII, 305 pages (in German). Cloth ISBN 3-540-93010-8

Arsenic - As
Main Volume

Astatine - At
Main Volume
The naturally occurring radioactive element astatine has only short-lived isotopes. Nevertheless, a wealth of information on this element is available, and numerous inorganic and organic astatine compounds have been prepared: AtH, metal astatides, compounds with oxygen, astatates and perastatates, compounds with halogens, inorganic complexes, complexes with bipyridine, and with thiourea and its derivatives. Organic compounds of At are also covered. - Literature closing date: 1984. 1985. 135 figs. XIII, 291 pages. Cloth ISBN 3-540-93516-9
Gold - Au

Main Volume

Section 1: History
Covers history from classical antiquity, through the Middle Ages, to modern times. Also covers the practical uses of gold in historical times and delves into early conceptions about gold and its properties. - Literature closing date: end of 1949. 1950, reprint 1978. VIII, 100 pages (in German). Cloth ISBN 3-540-93077-9

Section 2: Occurrence, Manufacture, Formation and Preparation in Pure State. Special Forms. Colloidal Gold. Surface Treatment

Has a general section on the reactions of gold salts. Compounds and alloys include all elements except the platinum-group elements, Te, Re, and the transuranium elements, and alloys with rare earth elements and Ac. Alloys are indexed alphabetically. - Literature closing date: end of 1949. 1954, reprint 1979. 201 figs. XXXVIII, 558 pages (in German). Cloth ISBN 3-540-93079-5

Supplement Volume

Part B: Compounds
Section 1: Compounds with Noble Gases, H, O, N, F, and Cl.
Covers the interactions and compounds of gold with noble gases, hydrogen, oxygen, nitrogen, fluorine, and chlorine. The major portion deals with the halogen compounds and specifically with the chlorine containing compounds and ions: AuCl, AuCl2-, AuCl3-, and above all AuCl4-. Literature closing date: mid-1991. 1992. 35 figs. XVIII, 348 pages. Cloth ISBN 3-540-93655-6

Section 2: Compounds with Br, I, the Chalcogens (S, Se, Te, Po), B, and C
Covers the binary systems of gold and Br, I, S, Se, Te, Po, C, and treats the numerous gold compounds containing these and additional elements (H, O, N, F, Cl). - Literature closing date: end of 1992. 1994. 72 figs. XX, 367 pages. Cloth ISBN 3-540-93694-7

Section 3: Compounds with Si, P, As, Sb, Bi, the Alkali metals and Onium Cations
Covers the systems and compounds composed of gold, Si, P, As, Sb, or Bi and additional elements of Gmelin system nos. 1 to 19. Included are the compounds which in addition contain Li, Na, K, NH4, Rb, or Cs. Concludes with the description of compounds composed of an inorganic aurate anion and an onium (ammonium, iminium, iodonium, sulfonium, carbonium, phosphonium, arsonium) cation. - Literature closing date: end of 1993. 1995. 95 figs. XXII, 400 pages. Cloth ISBN 3-540-93719-6

Boron - B

Main Volume

Section 4: Compounds with Metals (Gmelin System Numbers 26 to 61)
Covers the systems and compounds which contain gold, at least one metal element of the groups 1 to 6, 11 to 14 of the periodic system, or Mn, Fe, Co, Ni, as well as a nonmetal element. Concludes the series on the purely inorganic gold compounds. - Literature closing date: mid of 1995. 1996. 73 figs. XVI, 245 pages. Cloth ISBN 3-540-93739-0

Organogold Compounds
Organogold compounds have been applied to a variety of practical uses in integrated circuits, protective coatings, catalysts, and medicine. All gold compounds with at least one gold-carbon bond are described, except for the gold cyanides. Contains an empirical formula index and a ligand formula index. - Literature closing date: end of 1979. 1980. 55 figs. XIV, 351 pages. Cloth

Supplement Volume 1

Elemental Boron. Boron Carbides

Boron Compounds

Includes BN, (Bi3)4B12N13, and B(N)3. The chapters on B-N-C heterocycles and on polymeric B-N compounds each have a section on nomenclature. - Literature closing date: 1972. 1974. 48 figs. XVIII, 331 pages (in German). Cloth ISBN 3-540-93274-7

Part 4: Compounds Containing Isolated Trigonal Boron Atoms and Covalent Boron-Nitrogen Bonding
(New Suppl. Ser. Vol. 22)

Part 5: Boron-Pyrazole Derivatives and Spectroscopy of Trigonal B-N Compounds
(New Suppl. Ser. Vol. 23)
Coverage of boron-nitrogen compounds is continued in this volume with the pyrazolylboranes. Subsequent chapters discuss the vibrational spectra, mass spectroscopy, nuclear resonance spectroscopy, and photoelectron spectroscopy of the compounds described in Part 4. Literature closing date: end of 1973. 1975. 28 fgs. XVI, 277 pages (195 pages in German). Cloth ISBN 3-540-93292-5

Part 6: Carboranes 2
(New Suppl. Ser. Vol. 27)
Includes the electronic structure of closo-carboranes, descriptions of specific carboranes with heteroatoms in the skeleton, and descriptions of those complexes which various carborane anions form with metals. Carborane polymers and their applications are covered in the final chapter. - Literature closing date: end of 1974; partly end of 1971. 1975. 48 fgs. XVI, 150 pages (68 pages in German). Cloth ISBN 3-540-93301-8

Part 7: Boron Oxides, Boric Acids, Borates
(New Suppl. Ser. Vol. 28)
Continues the description of boron oxides and boric acids. The treatment includes a review of metal borates and peroxoborates. The borates are covered in the following sequence: anhydrous borates, hydrated borates, and heteropolyborates. - Literature closing date: end of 1973. 1975. 84 fgs. XX, 237 pages (in German). Cloth ISBN 3-540-93302-6

Part 8: Tetrahydroborate Ion and Derivatives
(New Suppl. Ser. Vol. 33)
Anionic compounds with a single boron atom. Discusses the tetrahydroborate ion, tetrahydroborates, and compounds which are derived from BH4 by the partial or complete replacement of hydrogen by halogen, organylxlo, or amino groups. The corresponding compounds with a B-C bond are covered, as are the borates with inorganic oxoacid ligands attached to boron, and borano-carboxylic ions. Compounds derived from [B(OH)4]− by the replacement of H by organic substituents are also reviewed. - Literature closing date: end of 1974. 1976. 15 fgs. XXII, 220 pages (85 pages in German). Cloth ISBN 3-540-93311-5

Part 9: Boron-Halogen Compounds 1
(New Suppl. Ser. Vol. 34)
Boron-halogen compounds with trigonal boron. Specifically, the partially halogenated compounds which contain H, OH, or organic groups and one or two halogen atoms. - Literature closing date: end of 1974. 1976. 7 fgs. XVIII, 332 pages (295 pages in German). Cloth ISBN 3-540-93315-8

Part 10: Boron Compounds with Coordination Number 4
(New Suppl. Ser. Vol. 37)
Neutral μ-diboranes(6) and their adducts, boronium salts (with formally cationic boron), tetrahalaborates [BX4] where X = halogen or pseudohalogen, carbonyl boranes, and noble gas adducts of boron compounds. - Literature closing date: end of 1975. 1976. 11 fgs. XX, 272 pages (89 pages in German). Cloth ISBN 3-540-93326-3

Part 11: Carboranes 3
(New Suppl. Ser. Vol. 42)
Covers the three isomeric dicarba-closo-dodecaboranes, their mono- and di-derivatives, and most of their carbon-substituted derivatives. - Literature closing date: end of 1975. 1977. 6 fgs. XIV, 207 pages (in German). Cloth ISBN 3-540-93336-0

Part 12: Carboranes 4
(New Suppl. Ser. Vol. 43)

Part 13: Boron-Oxygen Compounds 1
(New Suppl. Ser. Vol. 44)

Part 14: Boron-Hydrogen Compounds 1
(New Suppl. Ser. Vol. 45)
Binary boron-hydrogen compounds such as mono-, di-, tetra-, and pentahydroborane and their ions. (BH3 and BH4) are treated with B2H6 in "Boron Compounds" Part 18.) Also covered are amine adducts of dihydroboranes, of borazine, oligo- and polyboranes. - Literature closing date: end of 1975. 1977. 32 fgs. XXII, 310 pages (257 pages in German). Cloth ISBN 3-540-93341-7

Part 15: Amine-Boranes and Related Compounds
(New Suppl. Ser. Vol. 46)

Part 16: Boron-Oxygen Compounds 2
(New Suppl. Ser. Vol. 48)
Topics are peroxoboranes, species containing HBO and CBO moieties, etc. - Literature closing date: end of 1975. 1977. 8 fgs. XVIII, 221 pages (37 pages in German). Cloth ISBN 3-540-93355-0

Part 17: Borazine and Its Derivatives
(New Suppl. Ser. Vol. 51)
Part 18: Boron-Hydrogen Compounds 2
(New Suppl. Ser. Vol. 52)

The boron-hydrogen compounds, including BH$_3$, B$_2$H$_6$, other diborane species, and the B$_3$ and B$_4$ species. Also, the vibrational spectra of BH$_3$ adducts with Lewis bases and a chapter on BH$_3$ and CO. - Literature closing date: end of 1976.

1978. 40 figs. XVIII, 238 pages (152 pages in German).
Cloth ISBN 3-540-93372-7


Covers both neutral and charged boron monohalides and dihalides, boron trihalides, perhalogenated di- and polyboranes, and tripseudohalides. A special chapter presents the vibrational spectra of the trihaloborane adducts of Lewis bases of the fifth main group. - Literature closing date: end of 1976.

1978. 5 figs. XXII, 343 pages (119 pages in German).
Cloth ISBN 3-540-93373-5

Boron Compounds, Formula Index

An empirical formula index for the 20 volumes on boron compounds. Compound types are easily found in the separate list of major topics.


Boron Compounds, First Supplement

Volume 1: Boron and Noble Gases, Hydrogen, and Oxygen

Boranes, boron oxides, and borates, B-O-H compounds, borate minerals, and selected carbon-containing derivatives of B-O compounds such as B(OR)$_3$. - Literature closing date: end of 1977.

1980. 68 figs. XVI, 319 pages (208 pages in German).

Volume 2: Boron and Nitrogen, Halogens

Boron nitride, aminoboranes, borazine, its derivatives, other B-N heterocycles, and ammine-boranes. The boron-halogen compounds include the boron halides and organylhaloboranes. - Literature closing date: end of 1977.

1980. 20 figs. XVI, 349 pages (287 pages in German).
Cloth ISBN 3-540-93421-9

Volume 3: Boron and Chalcogens, Carbonanes.

Formula Index for 1st Suppl. Vol. 1 to 3

Contains the boron-chalcogen compounds and the carbonanes, and a formula index for the entire First Supplement. - Literature closing date: end of 1977.

1981. 79 figs. XIV, 397 pages (104 pages in German).
Cloth ISBN 3-540-93427-8

Boron Compounds, Second Supplement

Volume 1: Boron and Noble Gases, Hydrogen, Oxygen, Nitrogen. Formula Index for 2nd Suppl. Vol. 1


ISBN 3-540-93466-9

Volume 2: Boron and Halogens, Chalcogens, Carbonanes

Formula Index for 2nd Suppl. Vol. 2

The compounds of boron with halogens, sulfur, selenium, and tellurium are described. A large chapter deals with carboranes. A separate alphanumeric index is included. Literature closing date 1980. 1982. 44 figs. XIX, 376 pages. Cloth

ISBN 3-540-93465-0

Boron Compounds, Third Supplement

Volume 1: Boron and Hydrogen

Describes the interaction of boron and noble gases. The treatment of boranes begins with a nomenclature of the boron polyhedra, which gives a new approach for naming the compounds of this class. Chemistry of higher boranes and their derivatives. - Literature closing date: end of 1984.

1984. 142 figs. XV, 242 pages. Cloth

ISBN 3-540-93549-5

Volume 2: Boron and Oxygen

Continues the description of the compounds of boron with oxygen, i.e., boron oxides, borate ions, and boronic acids. The table on borate minerals is updated. - Literature closing date: 1984.

1987. 39 figs. XVI, 186 pages. Cloth

ISBN 3-540-93543-6

Volume 3: Boron and Nitrogen, Boron and Fluorine

Covers the BN modifications of graphite-like or diamond-like structures and B-N compounds containing hydrogen and oxygen. There is a large chapter on BF$_3$ and its adducts. B-F compounds containing H, O, and N are also covered. - Literature closing date: end of 1984.

1988. 62 figs. XVI, 382 pages. Cloth

ISBN 3-540-93557-6

Volume 4: Boron and Cl, Br, I, S, Se, Te, Carboranes

Binary species BCl, BCl$_2$, and BCl$_3$, compounds with additional elements beginning with hydrogen (e.g., HBCl$_2$, H$_2$BCl) and followed by the related organoboranes (RBCl$_2$, R$_2$BCl), and those with O or N (e.g., Cl$_2$BN(CH$_3$)$_2$). Adducts are included. - Literature closing date: end of 1984.

1988. 19 figs. XVIII, 256 pages. Cloth

ISBN 3-540-93567-3

Index: Formula Index for Third Supplement, Volumes 1 to 4

"Linearized" structural formulas and "ring information" are given along with the empirical formulas (summation formulas) of the compounds. The "ring information" includes the ring atoms of boron-containing rings and their sequence.


ISBN 3-540-93576-2

Boron Compounds, Fourth Supplement

Volume 1a: Boron and Noble Gases, Hydrogen, Updates the information on mostly hypothetical compounds containing boron and noble gases and gives above all new information on the monoboron species BH, BH$_2$, BH$_3$, [BH$_4$]$^-$ as well as on diboranes and their derivatives. - Literature closing date: Chapter 1 end of 1993; Chapter 2 end of 1988.

1994. 73 figs. XIV, 157 pages. Cloth

ISBN 3-540-93704-8

Volume IIb: Boron and Hydrogen. Triboron to Nonaboron Compounds

Continues the update of the information on boron-hydrogen systems with the data on molecules containing three to nine boron atoms. Metal-containing boranes and their derivatives with three to eight boron atoms are also covered. - Literature closing date: end of 1988.

1996. 117 figs. XV, 156 pages. Cloth

ISBN 3-540-93747-1
Volume 2: Boron and Oxygen
Updates the information on compounds of boron with oxygen. Emphasis is on boron oxides including borates and borate glasses as well as on boron-derived acids and their linear and cyclic esters. Hydrated anionic B-O species and peroxoborates are treated separately. - Literature closing date: 1988. 1993. 23 fgs. XVI, 297 pages. Cloth
ISBN 3-540-93673-4

Volume 3a: Boron and Nitrogen
Updates the information on boron nitride with major chapters on the preparation, physical properties of the different modifications, and its technical applications. Other B-N compounds dealt with include amino- and iminoboranes, borazines, etc. - Literature closing date: end of 1988. 1991. 52 fgs. XV, 263 pages. Cloth
ISBN 3-540-93635-1

Volume 3b: Boron and Nitrogen, Fluorine
Continues with updating of boron-nitrogen compounds with amine-boranes, pyrazaboroles, nitrogen-substituted boron cations, as well as of boron-nitrogen compounds containing B-O bonds. The description of boron-fluorine compounds is dominated by BF3 and by tetrafluoroborates. - Literature closing date: end of 1988. 1992. 26 fgs. XV, 254 pages. Cloth
ISBN 3-540-93648-3

Volume 4: Boron and Cl, Br, I, S, Se, Te
Emphasis is on BC13, which has become an important chemical agent and is a preferred B-supplying compound in vapor phase deposition synthesis. New information on carboranes is augmented by chapters on metallacarboranes and carborane-containing polymers. - Literature closing date: end of 1988. 1991. 65 fgs. XX, 323 pages. Cloth
ISBN 3-540-93629-7

Supplement Volume
Not included in the complete set of the Gmelin Handbook:

W. Kliegel: Bor in Biologie, Medizin und Pharmazie
Physiologische Wirkung und Anwendung von Borverbindungen
Boron in Biology, Medicine, and Pharmacy
(Physiological Application and Effects of Boron Compounds)
Surveys the physiological effects of boron and its compounds and applications to experimental biology and medicine. Covers the uses of boron and its compounds as drugs, biocides, and reagents in analytical and preparative biochemistry, and discusses the general biological significance of boron. Particularly emphasizes data relating to the toxicity of boron compounds and known cases of poisoning to date. A special chapter is devoted to "B neutron-capture radiation in cancer therapy. Provides an interdisciplinary review of all biological, medical, pharmacological, and pharmaceutical aspects of boron, its compounds, and its isotopes. Comprehensive subject index 1980. 29 fgs. XVI, 900 pages (in German). Cloth
ISBN 3-540-93411-1
Part B: Compounds

Section 4: Compounds with Carbon to Francium
Covers systematically the numerous compounds and systems composed of beryllium, at least one of the following elements C, Si, P, As, Sb, Bi, Li, Na, K, Rb, Cs, Fr as well as NH₄, and optional elements H, O, N, halogens, chalcogens, and B. - Literature closing date: 1994. 1996. 74 figs. XXIV, 487 pages. Cloth ISBN 3-540-93741-2

Organoberyllium Compounds

Part 1: Organoberyllium Compounds
All beryllium compounds with at least one beryllium-carbon bond are described, except for the pure beryllium cyanides and isocyanides. There are two indexes: an empirical formula index of compounds and a ligand formula index. - Literature closing date: 1986.
1987. 21 figs. XII, 247 pages. Cloth ISBN 3-540-93556-8

Bismuth - Bi

Main Volume

Supplement Volume
Covers cosmic occurrence and geochemistry, minerals, and toxicity. Includes sections on formation and preparation of bismuth, and its isotopes, physical properties, electrochemical behavior, chemical reactions of the metal and of the Bi ion, as well as detection and determination, followed by chapters covering the alloys and compounds of bismuth. - Literature closing date: end of 1960.
1964. 212 figs. LXIII, 866 pages (in German). Cloth ISBN 3-540-93238-0

Organobismuth Compounds (New Suppl. Ser. Vol. 47)
This volume contains the compounds with bismuth bonded through carbon to one or more organic groups. The material is arranged under mononuclear, binuclear, and complex compounds. - Literature closing date: end of 1975. 1977. 6 figs. XVIII, 173 pages (in German). Cloth ISBN 3-540-93349-2

Carbon - C

Main Volume
Part B: The Element
History and occurrence of carbon. Preparation and properties of the element, as well as detection and determination. Compounds extend up to bromine and chlorine. The volume also reviews salts of the acids described. - Literature closing date: July 1931.

Bromine - Br

Main Volume
History and occurrence of bromine. Preparation and properties of the element, as well as detection and determination. Compounds extend up to bromine and chlorine. The volume also reviews salts of the acids described. - Literature closing date: July 1931.

Supplement Volume
Part A: The Element
The technology of bromine production plays a special role. Likewise large chapters occur concerning the bromine molecule, the dissociation and recombination of Br₂ in the gas phase, the system bromine-water, and the electrochemistry. The various ions of bromine are important, e.g., Br₂⁺, Br⁻, and especially Br₃⁻. - Literature closing date: 1983. 1985. 39 figs. XXII, 523 pages. Cloth ISBN 3-540-93511-8

Part B: Compounds
Section 1: Compounds with Rare Gases and Hydrogen
Compounds with rare gases are mainly van der Waals complexes or so-called exiplexes. Most of the volume is devoted to compounds with hydrogen, above all HBr and its aqueous solution. There is supplementary material on the Br⁺ ion. - Literature closing date: 1989. 1990. 50 figs. XVIII, 514 pages. Cloth ISBN 3-540-93600-9

Section 2: Compounds with Oxygen and Nitrogen
Covers all the chemical and physical properties of the approx. 80 known bromine compounds and ions which contain oxygen and/or nitrogen, and which may include hydrogen as well. Major chapters are on BrO, BrO₂, the oxoacids of bromine and their anions, as well as on BrN₃ and NOBr. - Literature closing date: end of 1989.

Section 3: Compounds with Fluorine and Chlorine
Describes all compounds with F and/or Cl and additional elements N, O, H, and noble gases. Major chapters are on technically important species BrF₃ and BrF₅ as well as on BrF, BrCl, and BrCl₂. - Literature closing date: end of 1990. 1991. 9 figs. XVI, 245 pages. Cloth ISBN 3-540-93642-4
Section 3: Chemical Reactions of Graphite. Graphite Compounds. Colloidal Carbon

The graphite compounds are subdivided into compounds having homopolar bonds (graphite oxides, fluorographite compounds) and those with ionic bonds (C\textsubscript{1}, Br\textsubscript{1}, ICl, and Br\textsubscript{2} graphite, nitrate, sulfate, and alkanol compounds, and compounds with metal halides). The concluding chapters deal with colloidal carbon (diamond powder, graphite powder, and soot).

- Literature closing date: end of 1965.
- 1968. 53 figs. XX, 262 pages (in German). Cloth ISBN 3-540-93103-1

Part C: The Compounds

Section 1: Compounds with Noble Gases, Hydrogen, and Oxygen

Starts with a short chapter on carbon-noble gas compounds detected by mass spectroscopy. Contains a description of CH\textsubscript{3} and C\textsubscript{2}H\textsubscript{5} molecules, radicals, and ions, and also of benzene and toluene. Has short sections on C\textsubscript{2}O and C\textsubscript{2}O\textsubscript{2}; larger sections are devoted to CO and CO\textsubscript{2} and include, in each case, systems of the compounds with inorganic and organic components.

- Literature closing date: 1968.

Section 2: Chemical Reactions of CO and CO\textsubscript{2}

Covers the several equilibria among C, O\textsubscript{2}, CO, and CO\textsubscript{2}, as well as the chemical reactions of CO and CO\textsubscript{2}.

- Literature closing date: 1971.
- 1972. 20 figs. XX, 208 pages (in German). Cloth ISBN 3-540-93105-8

Section 3: The CO\textsubscript{2} + C \rightleftharpoons 2 CO Equilibrium. Aqueous Solutions of Carbonic Acid. Carbonate Ions. Peroxocarbonic Acids

Begins with coverage of the CO\textsubscript{2} + C \rightleftharpoons 2 CO equilibrium. The major portion of this volume is then devoted to the dissolution of CO\textsubscript{2} in water and in aqueous solutions, and to the properties of such systems.

- Literature closing date: 1972.

Section 4: Selected C-H-O Radicals. Formic Acid. Acetic Acid. Oxalic Acid

This concluding volume of "Carbon" Part C (compounds with hydrogen and oxygen) covers selected C-H-O radicals containing one C atom: CH\textsubscript{2}O and CH\textsubscript{2}O\textsubscript{2}, HCO and HCO\textsubscript{2}, CH\textsubscript{2}O and CO\textsubscript{2}; HOCO\textsubscript{2} and CO\textsubscript{3}. Also covers formic, acetic, and oxalic acids, which are so important to inorganic chemists.

- Literature closing date: 1972.
- 1975. 36 figs. XIV, 236 pages (in German). Cloth ISBN 3-540-93283-6

Part D: The Compounds

Section 1: Carbon-Nitrogen Compounds

This volume covers the simple compounds, ions, and radicals of carbon and nitrogen. For example, the CN radical and ion, cyanogen, cyanide ion, hydrogen cyanide, and cyanic acid and its isomer. It also describes urea, semicarbazide, and guanidine.

- Literature closing date: 1970.

Section 2: Carbon-Halogen Compounds

Begins the halogen compounds of carbon. Compounds are arranged by the number of atoms bonded to carbon: X, Y, and Z denote halogens: CX, CX\textsubscript{2}, CX\textsubscript{3}, CX\textsubscript{4}, CHX, CX\textsubscript{2}Y, CX\textsubscript{2}Z, CX\textsubscript{3}Y, CX\textsubscript{3}Z, CX\textsubscript{4}Y, CX\textsubscript{4}Z, etc. are emphasized, as are the CX\textsubscript{4} molecules.

- Literature closing date: end of 1972.

Section 3: Carbon-Halogen Compounds (Continued)

Continues the treatment of simple carbon-halogen compounds. Included are the following: XCO radicals and ions, phosphene COCl\textsubscript{2}, and the other carbonyl halides COX\textsubscript{2}, halogen derivatives of urea, carbamic acid halides, halogen isocyanates, halogen cyanoxydes XCN, halogen isocyanic acids XNC, cyanuric acid halides, the F\textsubscript{3}CN radical, and halogenated cyanamides.


Section 4: Carbon-Sulfur Compounds

This is the first of three volumes devoted to the compounds of carbon and sulfur. It emphasizes carbon disulfide and the thiocarbonic acids. Other compounds covered are CS\textsubscript{2}, CS and its ions, and ions of CS\textsubscript{2}.

- Literature closing date: beginning of 1975.

Section 5: Carbon-Sulfur Compounds (Continued)

Continues the discussion of compounds of carbon and sulfur. The emphasis is on COS, CS\textsubscript{2}, and its ions, and the several NCS and CNS ions, including (SCN)\textsubscript{2}, and (SCN)\textsubscript{3}. Further compounds covered are ArOCS, S\textsubscript{2}CN\textsubscript{x} with x = 1 to 8, and (NC) (NCS).


Section 6: Carbon-Sulfur Compounds (Continued). Carbon-Selenium and Carbon-Tellurium Compounds

Completes the discussion of carbon-sulfur compounds begun in Section 4. Compounds covered include thiocyanic acid HNCS, thiourea (NH\textsubscript{2})\textsubscript{2}CS, and thiocarbonyl halides XCS and XYCS, where X or Y is halogen. It also covers the noncyclic carbon compounds of selenium and tellurium.


Perfluorohalogenoorganocompounds of Main Group Elements

See "F" Fluorine

Calcium - Ca

Main Volume


Section 1: History

Discusses historical aspects associated with the use of chalk and gypsum in building construction. Special chapters cover the history of particular compounds. A short section discusses the discovery of the element.

- Literature closing date: end of 1949.

Section 2: Occurrence. The Element. The Alloys

Covers cosmic and terrestrial occurrence as well as the minerals. Formation, preparation, physical properties, electrochemical behavior, and chemical reactions of the element. General reactions, physiological hazards due to calcium and its compounds, as well as detection and determination, conclude the review of the element.

- Literature closing date: end of 1949.
Supplement Volume
Discussion of history, occurrence (including minerals), technology of cobalt and its compounds, and uses. Description of the element. General reactions of Co and the chemical reactions of the cobalt ion. Compounds and alloys. Cobalt carbonyls are covered in the final chapter "Cobalt und Carbon". - Literature closing date: end of 1949.

Section 1: Cobalt(I) and Cobalt(II) Compounds
Covers cobalt(I) and cobalt(II) complexes with neutral and with inner-complex forming ligands. The cobalt(II) complexes are subdivided into those with inorganic ligands (H2O, NH3, and N2H4) and those with organic ligands. - Literature closing date: end of 1949.

Section 2: Cobalt(III) Compounds
Contains the complex compounds of trivalent cobalt with neutral, inorganic, and organic ligands arranged by type, e.g., [CoA6]X3, [CoXA5]X2, where A is a neutral ligand like NH3, amines, etc. Also covers the Co(III) compounds containing inner complexes. Contains a formula index for the organic ligands and an alphabetic index for the neutral and inner-complex-forming ligands. - Literature closing date: end of 1949. 1964. 71 fgs. XLIV, 507 pages (in German). Cloth ISBN 3-540-93100-7

Cobalt in Alloyed Steels, see "Fe" Iron, Part D, Supplement Vol. 2: "Magnetic Materials"

Organocobalt Compounds

Part I: Mononuclear Compounds (New Suppl. Ser. Vol. 5)

Part II: Polynuclear Compounds (New Suppl. Ser. Vol. 6)

Chromium - Cr

Main Volume

Part A: History, Occurrence. The Element and Its Alloys
Section 1: History. Occurrence. Technology. The Element (up to Physical Properties)
History; occurrence (geochemistry, economic deposits, minerals); technology of chromium and its inorganic compounds (ore treatment, attack of chrome-iron rocks, recovery of chromium metal, manufacture of inorganic chromium compounds and of inorganic chrome colors, toxicity); formation, preparation, and physical properties of the element. - Literature closing date: end of 1949. 1962. 38 fgs. XXIV, 418 pages (in German). Cloth ISBN 3-540-93047-7

Section 2: Electrochemistry. Chemical Reactions. Alloys

Chromium in Alloyed Steels, see "Fe" Iron, Part D, Supplement Vol. 2: "Magnetic Materials"

Part B: The Compounds
(Except for Coordination Compounds)
Chromium oxides and chromic acids occupy a major portion. Chromium carbides, carbonyls, and carbonates are treated as double salts, such as K2Cr(SO4)2, or salts with chromium in the anion, such as K2CrO4. The volume concludes with compounds containing Ta. - Literature closing date: end of 1949. 1962. 74 fgs. LXXXIII, 942 pages (in German). Cloth ISBN 3-540-93049-3

Part C: Coordination Compounds with Neutral Ligands and Ligands Forming Inner Complexes
Compounds are arranged by valencies of the central atom from Cr0 to CrVI. For each valency arrangement is by ligands, first inorganic, then organic. Covers complexes with inorganic ligands except for aquo-, acidoaquo-, and pure acido-complexes, which are described in Part B. Organic ligands are arranged in the order alkylamines, N-heterocyclic ligands, and ligands containing S, P, and As. There is a ligand formula index and an alphabetic index of neutral and inner-complex-forming ligands. - Literature closing date: end of 1960. 1965. 31 fgs. XLVIII, 431 pages (in German). Cloth ISBN 3-540-93050-7

Organochromium Compounds
(New Suppl. Ser. Vol. 3)

Part E: The Compounds
(Except for Coordination Compounds)
Covers compounds of chromium with mixed ligands, such as K2Cr(SO4)2 or salts with chromium in the anion. The volume concludes with compounds containing Ta. - Literature closing date: end of 1949. 1962. 74 fgs. LXXXIII, 942 pages (in German). Cloth ISBN 3-540-93049-3

Caesium - Cs

Main Volume

Section 1: Occurrence. Preparation and Properties of the Metal
Contains besides the title subjects also chapters on electrochemical and chemical behavior of the metal and the ion, and on analytical chemistry of caesium. Considerable space is devoted to the optical and electrical properties of the metal. - Literature closing date: end of 1937. 1938, reprint 1972. 3 fgs. XII, 104 pages (in German). Cloth ISBN 3-540-93037-X

Section 2: Caesium Compounds. Ekacaesium
Compounds described in this volume include elements up to Rb. A short appendix describes ekacaesium, known today as francium. - Literature closing date: end of 1937. 1938, reprint 1972. 5 fgs. XX, 164 pages (in German). Cloth ISBN 3-540-93038-8
Copper - Cu

Main Volume

Part A: History, Occurrence, The Element

Section 1: History, Occurrence, Metallurgy, Industrial Preparation of Copper Compounds
The major part deals with dressing of copper ores and various processes for the recovery of copper, including pyrometallurgical processes, wet processes, and electrochemical methods. Other chapters deal with the powder metallurgy of copper and with the industrial preparation of copper compounds. - Literature closing date: end of 1949.

A lengthy section dealing with electrolytic deposition of copper is provided in the chapter "Electrochemical Behavior". - Literature closing date: end of 1949.

Part B: The Compounds

Section 1: Copper Compounds up to Copper Tellurates
Hydrides, oxides, hydroxides (including ammoniacal solution of Cu hydroxide), compounds with elements up to Te. Chapters on copper oxides do not, however, include electrical properties; these are treated separately in Part D. Complexes with ammonia, ethylenediamine, etc., are covered under the copper salts - such as the nitrate, sulfate, or chloride - from which they are derived. - Literature closing date: end of 1949.

Section 2: Compounds from Copper and Boron to Copper and Bismuth
Compounds with B, C, P, As, Sb, and Bi. The Cu-Si, Cu-P, etc. alloys are covered under each of the corresponding systems. The Cu salts of organic acids are exhaustively described, in view of their particular importance. - Literature closing date: end of 1949.

Section 3: Compounds from Copper and Lithium to Copper and Iron. Reactions of Copper Ions
Compounds contain alkali metals including salts with NH₃, hydrazinium, and N-organic bases, and elements up to Fe. Also has chapters on complexes formed by copper double salts with neutral ligands, on the reactions of copper ions, and on acido-copper ions in solution and in solid compounds. - Literature closing date: end of 1959. 1965. 73 figs. XXXI, 476 pages (in German). Cloth ISBN 3-540-93112-0

Section 4: Coordination Compounds with Neutral Ligands and Ligands Forming Inner Complexes
Gives data on complexes with neutral ligands, on complex formation in solution, on solid compounds which were not covered in previous volumes. The second part is devoted to Cu compounds with ligands forming inner complexes. In view of the difficulties of precisely defining "inner complexes", organic compounds which might act as either neutral or inner-complex-forming ligands are included. Empirical formula index and alphabetical index of the ligands. - Literature closing date: end of 1960. 1966. 28 figs. XIII, 534 pages (in German). Cloth ISBN 3-540-93113-9

Part D: Electrical Properties of Copper Oxides
This volume is devoted exclusively to the electrical properties of Cu₂O and CuO. Data on electric conductivity occupy most of this volume, but there are also data on thermoelectric and photoelectric properties. - Literature closing date: end of 1959.

Organocopper Compounds
Organocopper reagents are widely used in organic syntheses. Though generally oligo- or polynuclear, most are poorly characterized structurally and are therefore described with their smallest formula unit unless higher aggregation has been

Part 1: Mononuclear Compounds with One Alkyl, Alkenyl, or Aryl Ligand
Describes compounds of the type RCu, where R is an alkyl, alkenyl, or aryl group. Also included are organocopper reagents consisting of RCu and inorganic salts or of RCu and donor ligands. - Literature closing date: 1983. 1985. 2 figs. X, 470 pages. Cloth ISBN 3-540-93517-7

Part 2: Mononuclear Compounds with Two or More Alkyl, Alkenyl, or Aryl Ligands
Deals mainly with organocopper reagents derived from RCu and organolithium or organomagnesium compounds. The bulk of the volume is devoted to the reactions of R₂CuLi, RR’CuLi, R₂CuMgX, or RR’CuMgX reagents with organic compounds. - Literature closing date: 1981. 1983. 2 figs. X, 247 pages. Cloth ISBN 3-540-93490-1

Part 3: Mononuclear Compounds with Alkynyl, Carbonyl, Isocyanide Ligands
Completes the coverage of "mononuclear" compounds with ligands bonded by one carbon atom and contains all compounds with alkynyl, carbonyl, isocyanide, and other carbon-bonded ligands. The largest part of the volume deals with compounds of the type R=C=CCu and their use in organic syntheses. - Literature closing date: 1985. 1986. 18 figs. XII, 249 pages. Cloth ISBN 3-540-93537-1

Part 4: Mononuclear Compounds with Ligands Bonded by More Than One C Atom and Polynuclear Compounds
The first part describes mainly mononuclear π-complexes. The remainder of the volume deals with di- to octanuclear and polymeric compounds whose structures are generally sufficiently characterized. - Literature closing date: 1986. 1987. 86 figs. XII, 272 pages. Cloth ISBN 3-540-93555-X

Index: Empirical Formula and Ligand Formula Index for Parts 1 to 4
Contains the empirical formula and ligand formula index for about 3000 organocopper compounds and reagents described in Parts 1 to 4. 1987. VIII, 244 pages. Cloth ISBN 3-540-93559-2
Fluorine - F

Main Volume
Complete coverage of fluorine, including history and occurrence, preparation and properties of the element, compounds with H, O, and N, and a chapter on detection and determination - Literature closing date: June 1926. 1926, reprint 1966. 4 figs. XI, 86 pages (in German). Cloth ISBN 3-540-93072-8

Supplement Volume
Volume 1
Includes cosmic and terrestrial occurrence, geochemistry, a description of the minerals, and coverage of the element and its compounds with H, O, and N. - Literature closing date: end of 1950. 1959. 31 figs. XXVIII, 258 pages (in German). Cloth ISBN 3-540-93073-6

Volume 2: The Element
There are chapters on industrial production, laboratory preparation, the atom, the molecule, the ions, the physical properties, and reactions. The reaction of fluorine with hydrogen has been thoroughly investigated in view of rocket propulsion and the hydrogen fluoride chemical laser. - Literature closing date: mid-1978. 1980. 17 figs. XII, 210 pages (30 pages in German). Cloth ISBN 3-540-93409-X

Volume 3: Compounds with Hydrogen
The major portion of this volume is devoted to hydrogen fluoride: methods of manufacture, preparation of ultra-pure HF, properties of HF from both experimental and theoretical studies, chemical reactions and energy-transfer processes in the HF laser, reactions of gaseous HF, anhydrous liquid HF as a solvent, and aqueous solutions of HF (hydrofluoric acid). Ions such as HF+, HF2-, and HF3- are also covered. - Literature closing date: mid-1980. 1982. 34 figs. XV, 345 pages. Cloth ISBN 3-540-93452-9

Volume 4: Compounds with Oxygen and Nitrogen
In the first part oxygen fluorides O_nF_m are described in the order of decreasing F : O ratio. It finishes with a description of hyperfluoristic acid HOF. The second part deals with the binary fluorine-nitrogen compounds such as NF4, NF3, NF2, NF, N2F4, N2F2 and N2F and related ions. - Literature closing date: 1984. 1986. 10 figs. XVIII, 409 pages. Cloth ISBN 3-540-93536-3

Volume 5: Compounds with Nitrogen
The first part deals with compounds containing fluorine, nitrogen, and hydrogen. The second part covers compounds which additionally contain one or more oxygen atoms. The volume concludes with a description of the FNO-HF and NOx-HF systems, which were intensively investigated due to their outstanding solubilizing properties. - Literature closing date: 1984. 1987. 13 figs. XV, 251 pages. Cloth ISBN 3-540-93546-0

Perfluoroallogenooorganic Compounds of Main Group Elements

Continues the treatment of SIV compounds begun in Part 1 and then describes compounds with Se IV and Te IV. Corresponding compounds of selenium and tellurium are also covered. A literature closing date: end of 1971. 1973. XII, 247 pages (in German). Cloth ISBN 3-540-93273-9

Cyclic compounds are covered first, and then the linear compounds. - Literature closing date: end of 1973. 1975. 4 figs. XVIII, 233 pages (in German). Cloth ISBN 3-540-93309-X

Covers perfluoroallogenooorganoo compounds of Na, K, Li, Be, Ca, Mg, B, Al, Ga, In, Ti, Si, Ge, Sn, and Pb. Contains the formula index for Parts 3 and 4. - Literature closing date: end of 1973. 1975. 2 figs. XVI, 213 pages (in German). Cloth ISBN 3-540-93300-X

Part 5: Compounds with Nitrogen: Heterocyclic Compounds
This volume and Part 6 cover nitrogen heterocycles in which all hydrogens attached to the carbon atoms of the ring and of the substituents are replaced with fluorine (or, in part, with another halogen). The compounds are arranged by ring size, number of nitrogen atoms, and number of other heteroatoms. This volume covers 3-, 4-, and 5-membered rings and starts the coverage of 6-membered rings. - Literature closing date: end of 1975. 1978. 2 figs. XVIII, 226 pages (in German). Cloth ISBN 3-540-93377-8

Part 6: Compounds with Nitrogen: Heterocyclic Compounds (Continued)
Continues the coverage of perfluorinated nitrogen heterocycles: the remaining 6-membered rings, fused ring systems, and rings with more than six atoms. The empirical formula index for Parts 5 and 6 concludes the volume. - Literature closing date: end of 1975. 1978. 1 fig. XVI, 196 pages (in German). Cloth ISBN 3-540-93378-6

Part 7: Aliphatic and Aromatic Nitrogen Compounds
Starts the treatment of the aliphatic and aromatic perfluoroallogenooorganoo compounds of nitrogen. Amines, amides, hydroxylamines, oximes, and nitroso compounds among others are described. - Literature closing date: end of 1975. 1979. 3 figs. XX, 217 pages (in German). Cloth ISBN 3-540-93397-2

Part 8: Aliphatic and Aromatic Nitrogen Compounds (Continued)
This volume continues the treatment of the aliphatic and aromatic perfluoroallogenooorganoo compounds of nitrogen, describing the nitro compounds, the compounds with N-N bonds, and compounds with nitrogen-halon bonds. - Literature closing date: end of 1975. 1980. 2 figs. XVIII, 230 pages (in German). Cloth ISBN 3-540-93426-X
Part 9: Aliphatic and Aromatic Nitrogen Compounds (Continued)
Described are compounds in which nitrogen is bonded to S, Se, P, As, B, Si, Ge, Sn, Li, K, Cs, or Hg; compounds with pseudo-halide groups (-CN, -NC, -NCO, -NCS, -NCN-, or > NCN); perfluorohalogenoorganooazaalkenes; and tertiary perfluorohalogenoorganooamino. Formula index for Parts 7 to 9. - Literature closing date: end of 1975. 1981. 1 fig. XIII, 223 pages. Cloth ISBN 3-540-93446-4

Perfluorohalogenoorgano Compounds of Main Group Elements, First Supplement

Volume 1: Compounds with Elements of Main Groups 1 to 5 (Excluding N) and with S (Partially)
Contains the compounds with elements of main groups 1 to 5, except for the nitrogen-containing compounds. The last section of this volume starts the description of compounds with the elements of main group 5 with the first part of the sulfur-containing compounds. - Literature closing date: 1981. 1984. 3 figs. XII, 212 pages. Cloth ISBN 3-540-93498-7

Volume 2: Sulfur(II) Compounds

Volume 3: Compounds with Elements of the Main Group 6 (SIV, SVI, Se, Te) and with I
Completes the treatment of the compounds of the Main Group 6 elements. Covers the sulfur(IV) compounds, sulfonic acids, anhydrides, and sulfates, sulfur(VI) oxides, sulfenyl nitrogen compounds, sulfenyl halides, sulfur(VI) halides, the compounds of selenium and tellurium, and those of iodine. Contains a formula index for the Supplement Volumes 1 to 3. - Literature closing date: end of 1981. 1987. 3 figs. XI, 310 pages. Cloth ISBN 3-540-93540-1

Volume 4: Compounds with Nitrogen: Heterocyclic Compounds
Covers the perfluorohalogenoorganoo nitrogen heterocycles. The compounds are arranged by ring size, number of nitrogen atoms, and number of other heteroatoms. An empirical formula index concludes the volume. - Literature closing date: end of 1985. 1988. 3 figs. XIII, 348 pages. Cloth ISBN 3-540-93569-X

Volume 5: Aliphatic and Aromatic Compounds of Nitrogen
Covers perfluorohalogenoorganoo nitrogen compounds with N-H, N-O, and N-N functional groups. The first chapter deals with compounds such as amines, amides, and imines, the second chapter with aminoxy derivatives, nitroso, and nitro compounds. Concludes with the description of compounds such as azides, hydrazines, hydrazides, and diazenes. - Literature closing date: 1985. 1991. XIV, 240 pages. Cloth ISBN 3-540-93623-8

Volume 6: Aliphatic and Aromatic Compounds of Nitrogen

Perfluorohalogenoorgano Compounds of Main Group Elements, Second Supplement

Volume 1: Compounds of Elements of Main Groups 1 to 5 (excluding N) and of S (partially)
Updates the information on perfluorohalogenoorgano compounds that contain Li, Cs; Mg; B, Al, In, TI; Si, Ge, Sn, Pb; P, As, Sb, Bi; or S. Many recent data are available for Si, Ge, P, As, Sb, and above all S(II) containing compounds. - Literature closing date: 1991. 1994. 22 figs. XIX, 343 pages. Cloth ISBN 3-540-93703-X

Volume 2: Compounds of S, Se, Te, Cl, Br, I and Xe
Continues the update of information on the perfluorohalogenoorgano compounds of sulfur. Treats in addition the perfluorohalogenoorgano compounds containing Se, Te, as well as Cl, Br, or I in oxidation states higher than one, and Xe. Empirical formula index for 2nd Supplement volumes 1 and 2. - Literature closing date: 1991. 1995. 13 figs. XVI, 406 pages. Cloth ISBN 3-540-93722-6

Iron - Fe
Division I

Section 1: History, Occurrence, Preparation and Forms of Pure Iron
The history is largely covered by a series of bibliographies. Geology of iron, economic deposits throughout the world, minerals, and production data. The description of pure iron covers preparation by electrolytic methods and by chemical methods and also describes special forms of pure iron. A subject index covers Division I of Part A (Sections 1 to 5). The iron minerals are included in this index. - Literature closing date: 1929. 1929, reprint 1974. 2 figs. LXXXI, 224 pages (in German). Cloth ISBN 3-540-93052-3

Includes physical properties of pure iron, namely: atomic properties, allotropic modifications, crystallographic properties, optical properties, magnetic and electrical properties, and electrochemical behavior. - Literature closing date: 1929. 1929, reprint 1967. 4 figs. VII, 88 pages (in German). Cloth ISBN 3-540-93053-1

Section 4: Metallurgy of Iron (Continued)

Manufacture of malleable iron by indirect methods, such as the charcoal hearth process, the puddling process, the crucible steel process, the converter processes, and the open hearth process. - Literature closing date: 1930.

Section 5: Metallurgy of Iron (Continued)

General physical and chemical fundamentals of processes for making malleable iron. Cast iron and cast steel. Ferroalloys. - Literature closing date: 1933.

Gmelin-Durrer: Metallurgy of Iron

4th edition (This is also a supplement to Fe Iron Part A, Sections 3 to 5.)

This 4th edition of Gmelin-Durrer "Metallurgy of Iron" involves in 12 volumes a total revision of the earlier edition. Each volume consists of two parts: the "a" part which is text, and the "b" part which contains the graphs, the diagrams, and the subject index.

Volumes la and lb: History, Definitions, General Physicochemical Principles. Thermal Pretreatment of Iron Ore

A short historical section covers the terminology associated with the words "iron" and "steel". The major part of this volume is devoted to the physical and chemical fundamentals of the iron smelting process and to thermal pretreatment and pelletizing of iron ores. - Literature closing date: 1963. Volume la: 1964.


Reviews raw material requirements and covers thermal processes other than the blast furnace. - Literature closing date: 1967.
Volume 2a: 1968. VI, 350 pages (in German).


Covers practical aspects of blast furnace equipment, operation, and products. - Literature closing date: 1968/69.
Volume 3a: 1971. XV, 320 pages (in German).


Contains discussions of blast furnace theory. - Literature closing date: 1969/70.
Volume 4a: 1972. XII, 353 pages (in German).


This volume is the first of two on the theory of steelmaking. It begins with a brief discussion of the concept steel and the possible ways to make steel. A chapter on the physical basis of steelmaking gives the properties of iron baths and slags. Then refining and special treatments are described. The volume concludes with reactions and equilibria important in steelmaking. - Literature closing date: 1976. Volume 5a: 1978. XXVI, 275 pages (in German). Volume 5b: 1978. 367 figs. German and English Subject Index. X, 224 pages. Cloth, together, ISBN 3-540-93361-1


This volume on steel production includes chapters on charge materials and additives, sampling and temperature measurements, hot metal mixers, air refining processes, and oxygen blowing processes. - Literature closing date: end of 1982. Volume 7a: 1984. XXII, 421 pages.


Contains chapters on the open hearth furnace process (Siemens-Martin-Prozess), electric arc furnace processes, new electrical steelmaking processes, such as plasma melting and induction furnace melting, and continuous steelmaking. - Literature closing date: 1983. Volume 8a: 1985. XV, 236 pages.
Volume 8b: 1985. 401 figs. German and English Subject Index. IX, 244 pages. Cloth, ISBN 3-540-93514-2
Volumes 9a and 9b: Practice of Steelmaking, Part 3: Treatment of Molten Steel Outside the Melting Unit. Remelting Processes. Automatic Control of Steelmaking Processes


Volumes 11a and 11b: Practice of Steelmaking, Part 5: Continuous Casting

Volumes 12a and 12b: Future of Iron and Steelmaking

Division II
Section 5: Continuous Casting

Section 6: Iron Systems from Fe-S to Fe-C. For the Fe-C System: Solidification, Cooling, and Subsequent Treatment of Carbon Steels, Hardening and Annealing of Steels, and Case Hardening

Section 7: Fe-C System (Continued): Magnetic and Electrical Properties of Pure and Carbon-Containing Iron

Following mechanical and thermal properties of pure and of carbon-containing iron, the ternary and higher systems of iron and carbon with H, O, N, S, Se, Te, and B are covered, followed in turn by the iron-silicon systems. Ternary and quaternary Fe-Si alloys are included, as are also the alloys of Fe with P, As, Sb, the alkali metals, and Be. - Literature closing date: June 1936. 1936, reprint 1979. 92 figs. XVI, 184 pages (in German). ISBN 3-540-93261-5

Section 9: The Systems from Fe-Mg to Fe-Pa
Continues the coverage of systems of iron from Mg up to Pa. - Literature closing date: mid-1939. 1939, reprint 1968. 58 figs. XV, 129 pages (in German). ISBN 3-540-93059-0

Part B: The Compounds
Section 1: Compounds up to Iron and Chlorine
Includes the hydrides, oxides, hydroxides, nitrates, azides, nitrosyls, nitrates, and halides. The ammonia addition compounds (formerly known as "am-mines") are covered under the salts from which they are derived; for example, FeCl₂.10 NH₃ is covered under Fe(II) chloride. - Literature closing date: 1929. 1929, reprint 1975. 22 figs. XXIII, 312 pages (in German). Cloth ISBN 3-540-93262-3

Section 2: Compounds up to Iron and Carbon
Sulfides, sulfites, sulfates, and other sulfur compounds are covered, as are compounds with Se, Te, and B. The carbonyls are included in the chapter "Iron and Carbon". The volume includes the carbonates. - Literature closing date: February 1930. 1930, reprint 1967. 15 figs. XXI, 200 pages (in German). Cloth ISBN 3-540-93060-4

Section 3: Compounds of Iron and Carbon (Continued)

Section 4: Compounds from Iron and Carbon to Iron and Bismuth
Continues coverage of iron-carbon compounds, starting with Fe cyanoferrate(II), Prussian blue, and related compounds. This is followed by cyanate, thio-cyanate, and compounds of iron with P, As, Sb, and Bi. The volume also contains a separate chapter covering general reactions of the iron salts. - Literature closing date: June 1931. 1931, reprint 1967. 9 figs. XVIII, 216 pages (in German). Cloth ISBN 3-540-93062-0
Section 5: Compounds (Continued)
Compounds described in this volume contain alkali elements including salts with NH₄, hydrazinium, and organic N-bases, and elements up to Co. Rare earth elements are, however, excluded. - Literature closing date: June 1932. 1932, reprint 1970. 16 figs. XLII, 294 pages (in German). Cloth ISBN 3-540-93063-9

Part C: Testing, Mechanical and Industrial Properties of the Carbon and Alloy Steels
Section 1: Hardness Testing
This volume covers hardness testing, and also discusses the relationships between hardness and other material properties. An alphabetic arrangement was used, in view of the large number of known hardness test methods, and a subject index has been provided. - Literature closing date: April 1937. 1937, reprint 1969. 105 figs. XVIII, 162 pages (in German). Cloth ISBN 3-540-93064-7

Section 2: Notch Impact Strength

Part D: Magnetic and Electrical Properties of the Alloyed Materials
Main Volume
Magnetic properties of alloyed composites of iron followed by electrical properties. Alloys and systems covered include all elements except Tc, Re, and transuranium elements. Includes data on applications. - Literature closing date: August 1936. 1936, reprint 1975. 342 figs. XLVI, 466 pages (in German). Cloth ISBN 3-540-93263-1

Supplements to magnetic and electrical properties of pure iron, of carbon-containing iron, and of the alloy steels. The chapters of this volume update the corresponding chapters of "Iron" Part A, Section 7, and of "Iron" Part D to a literature closing date of September 1937. 1937, reprint 1969. 166 figs. XXX, 148 pages (in German). Cloth ISBN 3-540-93067-1

Supplement Volume 2 for "Iron" Part D: Magnetic Materials
Covers magnetic and electrical properties of ferromagnetic elements and alloys: Fe, Fe alloys, Co, Co alloys, Ni, Ni alloys, Mn alloys, and chromium alloys. This volume thus also applies to System Numbers 58 (Co), 57 (Ni), 56 (Mn), and 52 (Cr). Also covers ferromagnetic semiconductors: iron spinels, other oxides of iron, mixed oxides, chromium oxides, chrome spinels, manganese and cobalt perovskites, and the ferromagnetic sulfides and selenides. Contains a patent literature index, an alloys index, an oxide systems index, and a trademark index. - Literature closing date: end of 1949 and end of 1955. 1959. 308 figs. XLIV, 580 pages (in German). Cloth ISBN 3-540-93068-X

Part E: Detection and Determination of Foreign Elements in Iron and Steel
Division I. Sections 1 and 2: Accompanying and Alloying Elements

Division II. Section 1: Major Alloying Elements. Other Elements
Detection and determination of foreign elements in iron and steel alloys: the alkali metals, the alkaline earth metals, B, Be, Zr, Hf, Se, Te, Ga, In, Tl, Ge, Re, Hg, Ag, Au, the Pt metals, Sn, Pb, Zn, Cd, U, Cu, Nb, Ta, W, Mo, Cr, and V. - Literature closing date: May 1938. 1938, reprint 1969. 7 figs. XXI, 164 pages (in German). Cloth ISBN 3-540-93070-1

Division II. Section 2: Other Elements (Continued). Special Methods. Standards

Iron, Supplement Volume
Part B: The Compounds
Section 1: Compounds with Noble Gases and Hydrogen
Describes the interactions between the bulk metal and noble gases and above all hydrogen. Hydrogen adsorption, dissolution, diffusion and their technical implications are treated in detail. A few compounds FeH, FeH₂, and the solid phase ε-FeH₂ are known. - Literature closing date: end of 1989. 1991. 70 figs. XX, 336 pages. Cloth ISBN 3-540-93621-1

Organoinorganic Compounds
These are covered in three multivolume series: Part A: Ferrocene and its derivatives; Part B: Mononuclear compounds other than ferrocene; Part C: Binuclear and polynuclear compounds.

Part A: Ferrocene and Its Derivatives
Section 1: Ferrocene 1 (Ferrocene and Mononuclear Monosubstituted Derivatives with Carbon, Hydrogen, and/or Halogen Substituents) (New Suppl. Ser. Vol. 14) Ferrocene 1 covers ferrocene itself as well as its monosubstituted derivatives with simple substituents such as alkyl, alkenyl, alkynyl, aryl, or halogen. The physics of ferrocene is covered in a special chapter. - Literature closing date: mid-1973. 1974. 5 figs. XIV, 395 pages (in German). ISBN 3-540-93275-5


Section 3: Ferrocene 3 (Mononuclear Monosubstituted Ferrocene Derivatives with Oxygen-Containing Substituents, Part 2: Other Ketones, the Carboxylic Acids and Their Derivatives, and Oxygen Heterocycles) (New Suppl. Ser. Vol. 50)

This volume contains additional derivatives of ferrocene: ketones (also see Ferrocene 2), the carboxylic acids, carboxylic acid derivatives, and oxygen heterocycles. - Literature closing date: end of 1976. 1978. X, 180 pages (in German). Cloth ISBN 3-540-93425-1

Section 4: Ferrocene 4 (Mononuclear Monosubstituted Ferrocene Derivatives with Nitrogen-Containing Substituents)

Treats the monosubstituted ferrocenes C₅H₅FeC₅H₄R in which R contains nitrogen. Thus included are amines, amidines, compounds with N-N or N-O bonds, and the nitrogen heterocycles. - Literature closing date: end of 1979. 1980. 4 figs. XII, 302 pages (in German). Cloth ISBN 3-540-93709-9

Section 5: Ferrocene 5 (Mononuclear Monosubstituted Ferrocene Derivatives with Substituents Containing Elements other than C, H, Halogens, O, and N)

Major sections deal with C₅H₅FeC₅H₄R ferrocene derivatives in which R contains sulfur, boron, silicon, or phosphorus. Contains an empirical formula index and a ligand formula index for volumes A1 through A5. - Literature closing date: mid-1981. 1981. 10 figs. XII, 381 pages (in German). Cloth ISBN 3-540-93450-2

Section 6: Ferrocene 6 (Binuclear and Polynuclear Ferrocenes) (New Suppl. Ser. Vol. 41)

Multinuclear compounds with 2 to 6 ferrocene nuclei. The largest chapter deals with compounds containing 2 ferrocene nuclei. The compounds biferrocene and biferoceylene, which have been studied particularly intensively, are covered here. Contains an empirical formula index. - Literature closing date: end of 1975, partially mid-1976. 1977. 24 figs. XIV, 316 pages (in German). Cloth ISBN 3-540-93332-8

Section 7: Ferrocene 7 (Mononuclear Disubstituted Ferrocene Derivatives with Substituents Containing Carbon, Hydrogen, Halogen, and Oxygen)

Disubstituted mononuclear ferrocenes FeC₅H₄R₁R₂. Complete coverage is given for compounds in which R₁ and R₂ contain only C, H, and halogens, and coverage is begun for compounds in which the R groups contain oxygen. - Literature closing date: end of 1979. 1980. 9 figs. XIV, 270 pages (in German). Cloth ISBN 3-540-93428-6

Section 8: Ferrocene 8 (Mononuclear Disubstituted Ferrocene Derivatives with C-, H-, and O-Containing Substituents)

Continuation of the mononuclear, unbridged, disubstituted ferrocene derivatives with at least one oxygen-containing substituent. The vast important of these compounds is Fe(C₅H₅COCH₃)₂. Contains an empirical formula index and ligand formula index for volumes A7 and A8. - Literature closing date: 1984. 1986. 14 figs. XIII, 419 pages. Cloth ISBN 3-540-93527-4

Section 9: Ferrocene 9 (Mononuclear Disubstituted Ferrocene Derivatives with N-, S-, Se-, B-, Si-Containing Substituents)

In this volume the description of the unbridged ferrocenes FeC₅H₄R₁R₂ is continued. At least the substituent R₂ contains in these compounds the elements N, S, Se, B, or Si. Contains an empirical formula index and a ligand formula index. - Literature closing date: 1986. 1989. 4 figs. XIV, 384 pages. Cloth ISBN 3-540-93590-8

Section 10: Ferrocene 10 (Mononuclear Disubstituted Ferrocene Derivatives, continued from "Ferrocene 9", and Trisubstituted Ferrocene Derivatives)


Section 11: Ferrocene 11 (Tetra-to Decasubstituted Ferrocene Derivatives)


Part B: Mononuclear Compounds (Excluding Ferrocenes)

Section 1: Mononuclear Compounds 1 (New Suppl. Ser. Vol. 36)

Compounds which contain one Fe atom, and in which the organic ligands are each attached to the Fe by a single C atom. The iron carbonyl complexes occupy by far the greatest portion of the volume. - Literature closing date: end of 1975. 1976. 18 figs. XV, 209 pages (54 pages in German). Cloth ISBN 3-540-93323-9

Section 2: Mononuclear Compounds 2

This volume continues the description of iron carbonyl compounds begun in Section 1 and is devoted to those compounds with one (CO),Fe group. Contains an empirical formula index and a ligand formula index for volumes Bl and B2. - Literature closing date: end of 1976. 1978. 29 figs. X, 250 pages. Cloth ISBN 3-540-93359-X

Section 3: Mononuclear Compounds 3

Compltes the description of the mononuclear iron carbonyls with coverage of compounds with five or more carbonyl groups. The greatest part of this volume is devoted to Fe(CO)₅ and its chemical properties. Contains an empirical formula index and a ligand formula index. - Literature closing date: end of 1977. 1979. 5 figs. XII, 262 pages (228 pages in German). Cloth ISBN 3-540-93400-6
Section 4: Mononuclear Compounds 4
Describes the mononuclear isonitrile and carbene compounds. Also described are compounds in which organic ligands are bonded by two carbon atoms to the iron atom. - Literature closing date: end of 1977. 1978. 45 figs. XIV, 380 pages (in German). Cloth ISBN 3-540-93375-1

Section 5: Mononuclear Compounds 5
Presents mononuclear compounds in which organic ligands are bonded by three carbon atoms to the iron (\(^{1}\)LFe compounds). Contains an empirical formula index and a ligand formula index for volumes B4 and B5. - Literature closing date: end of 1977. 1978. 17 figs. X, 234 pages (in German). Cloth ISBN 3-540-93376-X

Section 6: Mononuclear Compounds 6
Compounds of the type \(^{1}\)LFe(CO\(_\text{2}\))\(_\text{2}\) \((\text{D})\text{2}\)\(_\text{2}\) are described where \(n = 0\) to 2. Also, compounds of the type \(^{1}\)LFe(CO\(_\text{2}\))\(_\text{3}\), where \(^{1}\)L includes butadiene and its derivatives and other acyclic ligands bonded to the Fe atom by four C atoms. - Literature closing date: end of 1980. 1981. 36 figs. X, 425 pages. Cloth ISBN 3-540-93441-3

Section 7: Mononuclear Compounds 7
Covers compounds of the type \(^{1}\)LFe(CO\(_\text{3}\)) where \(^{1}\)L includes cyclobutadiene and cyclopentadiene and their derivatives, and five-membered heterocyclic ligands bound to the Fe atom by four C atoms. Contains an empirical formula index and a ligand formula index for volumes B6 and B7. - Literature closing date: end of 1980. 1981. 16 figs. IX, 258 pages. Cloth ISBN 3-540-93447-2

Section 8: Mononuclear Compounds 8
This volume continues the description of the compounds of the type \(^{1}\)LFe(CO\(_\text{3}\)). The \(^{1}\)L ligands covered include, among others, cyclic hexa-1,3-dienes and hexa-1,4-dienes. - Literature closing date: 1983. 1985. 28 figs. IX, 486 pages. Cloth ISBN 3-540-93510-X

Section 9: Mononuclear Compounds 9
Covers carbonyl compounds of the type \(^{1}\)LFe(CO\(_\text{3}\)) with seven-, eight-, and nine-membered ring systems. Examples of the \(^{1}\)L ligands are cycloheptadiene, cycloheptatriene, cyclooctatetraene, and cyclononatriene. A compound with a ten-membered ring system is also described. - Literature closing date: 1983. 1985. 27 figs. X, 286 pages. Cloth ISBN 3-540-93522-3

Section 10: Mononuclear Compounds 10
In the first part the description of the \(^{1}\)LFe(CO\(_\text{3}\)) compounds is continued; the second part contains compounds with a \(^{1}\)L ligand and one or two \(^{1}\)L ligands. The compounds in the third part have a \(^{1}\)L and a \(^{2}\)L ligand, while those in the fourth part have two \(^{1}\)L ligands. Contains an empirical formula index and a ligand formula index for volumes B8, B9, and B10. - Literature closing date: 1983. 1986. 33 figs. IX, 361 pages. Cloth ISBN 3-540-93523-1

Section 11: Mononuclear Compounds 11
Begins the description of compounds with \(^{1}\)L ligands, especially those in which \(^{1}\)L = cyclopentadienyl. This volume deals with \(^{1}\)LFe compounds that contain no additional CO group or one additional CO group. Also described are compounds with two additional CO groups which are of the type \([^{1}\text{LFe(CO)}_\text{2} (\text{D})\text{2}]X\) where \(X\) is H, a halogen or pseudohalogen, or a group bonded by O, S, Se, Te, N, P, As, Sb, or Bi. Contains an empirical formula index and a ligand formula index. - Literature closing date: end of 1979. 1983. 29 figs. XI, 447 pages. Cloth ISBN 3-540-93473-1

Section 12: Mononuclear Compounds 12
Continues the description of organoiron compounds containing a \(^{1}\)LFe(CO\(_\text{3}\)) unit, concluding with compounds of the type \([^{1}\text{LFe(CO)}_\text{2} (\text{D})\text{2}]X\). The last chapter covers compounds of the type \(\text{C}_\text{2} \text{H}_\text{2} \text{Fe(CO)}_\text{3} \text{R}\), where \(R\) represents an alkyl, haloalkyl, or substituted alkyl group containing a functional group derived from group 14 to 16 elements. Contains an empirical formula index and a ligand formula index. - Literature closing date: 1981. 1984. 34 figs. IX, 341 pages. Cloth ISBN 3-540-93500-2

Section 13: Mononuclear Compounds 13
Continues the description of \(\text{C}_\text{5} \text{H}_\text{5} \text{Fe(CO)}_\text{2} \text{R}\) compounds. In this case, \(R\) represents an alkyl group substituted by a heterocyclic ring or an acyl, iminoacetyl, thioacyl, alkynyl, allyl, or aryl group. - Literature closing date: end of 1986. 1988. 11 figs. XI, 274 pages. Cloth ISBN 3-540-93577-0

Section 14: Mononuclear Compounds 14
Concludes the description of \(\text{C}_\text{5} \text{H}_\text{5} \text{Fe(CO)}_\text{2} \text{R}\) compounds: compounds with heterocyclic \(R\), as well as compounds in which \(R\) contains carboranyl groups, or \(\text{CO} \text {(C)}\text{O})_\text{2}\). A further section treats \(^{1}\text{LFe(CO)}_\text{2} \text{R}\) compounds having \(^{1}\text{L}\) ligands other than \(\text{C}_\text{5} \text{H}_\text{5} \) \(\text{[^{1}\text{LFe(CO)}_\text{2}]^{-}}\) anions and their salts, as well as ions and radicals containing the \(^{1}\text{LFe(CO)}_\text{2}\) group. Contains an empirical formula index and a ligand formula index for volumes B13 and B14. - Literature closing date: end of 1986. 1989. 12 figs. XI, 239 pages. Cloth ISBN 3-540-93578-9

Section 15: Mononuclear Compounds 15
Cations of the type \([^{1}\text{LFe(CO)}_\text{2}]^+\) form the majority of the compounds described in this volume. They are easy to obtain from tricarbonyl(diene)iron complexes. Short sections review compounds with \(\text{CS}\) or isocyanide ligands; \(\text{C}_\text{5} \text{H}_\text{5}\) is the dominant \(^{1}\text{L}\) ligand. Contains an empirical formula index and a ligand formula index. - Literature closing date: end of 1987. 1989. 11 figs. XII, 409 pages. Cloth ISBN 3-540-93579-7

Section 16a: Mononuclear Compounds 16a
Deals with carbene complexes containing a \(^{1}\text{LFe} = \text{CRR'}\) unit. The most important are the rather unstable \([^{1}\text{LFe(CO)}_\text{2} (\text{D})\text{2}]\text{CRR'}\) cations with a chiral Fe atom. The electrophilic properties of the prochiral \(\text{CRR'}\) ligand enables the stereospecific addition of nucleophiles as well as the enantioselective transfer to alkenes giving substituted cyclopropanes. Contains an empirical formula index and a ligand formula index. - Literature closing date: mid-1990. 1990. 23 figs. XI, 263 pages. Cloth ISBN 3-540-93622-X
Section 16b: Mononuclear Compounds 16b

Begins the description of \(^{5}\)Fe compounds with additional \(^{1}\)L ligands such as alkenes, alkynes, amines, heterocycles, and dicarbaboranes. Covers compounds with no CO ligand as well as compounds with one CO ligand. Contains an empirical formula index and a ligand formula index. - Literature closing date: mid-1989. 1990. 32 figs. XI, 193 pages. Cloth

ISBN 3-540-93614-9

Section 17: Mononuclear Compounds 17

Closes the series dealing with \(^{1}\)L ligands and completes the description of \(^{1}\)Fe compounds with additional \(^{1}\)L ligands and two CO groups, especially cations of the type \([^{5}\text{Fe}^{2}\text{L}(\text{CO})_{2}]^{+}\). The following chapters deal with \(^{1}\)Fe compounds with additional \(^{1}\)L or \(^{4}\)L ligands. The last chapter is devoted to compounds with two \(^{2}\)L ligands, except for the ferrocene derivatives described in the A series. Contains an empirical formula index and a ligand formula index. - Literature closing date: end of 1987. 1990. 37 figs. XII, 416 pages. Cloth

ISBN 3-540-93601-7

Section 18: Mononuclear Compounds 18

Covers compounds with one \(^{3}\)L ligand and additional ligands bonded by heteroatoms or \(^{2}\)L to \(^{4}\)L ligands. \([^{1}\text{Fe}^{2}\text{L}]^{2-}\) compounds contain benzene or monosubstituted benzenes as \(^{1}\)L ligand. Contains an empirical formula index and a ligand formula index. - Literature closing date: mid-1990. 1991. 56 figs. XI, 335 pages. Cloth

ISBN 3-540-93628-9

Section 19: Mononuclear Compounds 19

Continues the description of compounds with one \(^{1}\)L ligand and one \(^{2}\)L ligand. The description of compounds with two \(^{3}\)L ligands, mainly bisarene iron(II) salts, is followed by a short chapter on the compounds containing ligands bonded by more than six C atoms. Contains an empirical formula index and a ligand formula index. - Literature closing date: end of 1977. 1979. 61 figs. XIV, 292 pages (in German). Cloth

ISBN 3-540-93649-1

Part C: Binuclear and Polynuclear Compounds

Section 1: Binuclear Compounds 1

Contains binuclear compounds in which all ligands are of type \(^{1}\)L. Most of these substances are carbonyl complexes in which two Fe(CO)\(_{n}\) entities are bonded to each other by bridging ligands. Although \(n\) ranges from 2 to 5, it is usually 3 or 4. Contains an empirical formula index and a ligand formula index. - Literature closing date: end of 1977. 1979. 61 figs. XIV, 292 pages (in German). Cloth

ISBN 3-540-93383-2

Section 2: Binuclear Compounds 2

Describes binuclear carbonylate anions and \(\text{Fe}_{2}(\text{CO})_{n}\) and concludes treatment of binuclear organoiron compounds with \(^{1}\)L ligands. Compounds with \(^{5}\)Fe(ligand) \(_{2}\) and \(^{5}\)Fe(ligand) \(_{3}\) ligands are then described. Contains an empirical formula index and a ligand formula index. - Literature closing date: end of 1977. 1979. 36 figs. XII, 198 pages (in German). Cloth

ISBN 3-540-93396-4

Section 3: Binuclear Compounds 3

Describes binuclear organoiron compounds with \(^{4}\)L ligands and starts the description of compounds with \(^{3}\)L ligands. Contains an empirical formula index and a ligand formula index. - Literature closing date: end of 1977. 1980. 42 figs. X, 196 pages. Cloth

ISBN 3-540-93414-6

Section 4: Binuclear Compounds 4

Concludes the treatment of binuclear complexes with \(^{1}\)L ligands: (a) carbonyl compounds with two \(^{1}\)L ligands and two or three bridging groups of various types, with major attention to \((\text{C}_{5}^{2}\text{H}_{5}\text{Fe}^{2}\text{L}(\text{CO})_{2})_{2}\), and (b) compounds containing additional \(^{1}\)L (other than carbonyl) and \(^{1}\)L, \(^{2}\)L, and \(^{4}\)L ligands. - Literature closing date: end of 1978. 1981. 46 figs. X, 285 pages. Cloth

ISBN 3-540-93436-7

Section 5: Binuclear Compounds 5

Binuclear compounds with ligands bonded to the iron atoms by six, seven, eight, ten, or twelve carbon atoms. The majority of these compounds belong to the \([^{1}\text{Fe}^{2}\text{L}(\text{CO})_{n}]^{n}\) types, where \(n\) is 4 to 7. The very few Lewis base \((\text{D})\) derivatives are treated in conjunction with the parent compounds. - Literature closing date: end of 1978. 1981. 52 figs. X, 172 pages. Cloth

ISBN 3-540-93443-X

Section 6a: Trinuclear Compounds 6a

Trinuclear compounds with \(^{1}\)L ligands, e.g. terminal and bridging carbonyls or isocyanides, and bridging noncarbon ligands. Includes a large number of \(\text{Fe}_{2}(\text{CO})_{n}\), \(n\) = 3 to 9, compounds and clusters with a \(\text{Fe}_{3}\text{M}_{n}\) skeleton where \(M\) is another transition metal. - Literature closing date: end of 1989. 1991. 96 figs. XIII, 320 pages. Cloth

ISBN 3-540-93631-9

Section 6b: Trinuclear Compounds 6b

Describes \(\text{Fe}_{2}(\text{CO})_{n}\) compounds with \(n = 10,11\). The great variety arises from \((1)\) additional noncarbon ligands with Group 13 to 16 elements acting as iron-bridging atoms, \((2)\) hydrogen-bridged clusters and their deprotonated anions, and \((3)\) additional \(^{1}\text{D}\) ligands. \(\text{Fe}_{2}\text{M}_{n}\)-type compounds, where \(M\) is an additional transition metal, are included. Contains an empirical formula index and a ligand formula index for volumes C6a and C6b. - Literature closing date: end of 1989. 1992. 36 figs. XI, 202 pages. Cloth

ISBN 3-540-93646-7

Section 7: Polynuclear Compounds 7

Treats the organoiron compounds with three or more iron atoms. This includes \(\text{Fe}_{2}(\text{CO})_{n}\) and \(\text{Fe}_{n}\), compounds with \(^{1}\)L (\(n \geq 2\)). Polynuclear compounds with \(\text{Fe}_{n}\) to \(\text{Fe}_{n}\), mostly cluster compounds, are included. Contains an empirical formula index and a ligand formula index. - Literature closing date: 1984. 1986. 134 figs. XII, 410 pages. Cloth

ISBN 3-540-93530-4

Francium - Fr

Main Volume

Described are the natural occurrence, appearance in the decay series of radioactive elements, nuclear properties, production and isolation, analytical chemistry, physical properties, and chemical properties. Very little is available on francium compounds. - Literature closing date: mid-1982. 1983. 68 figs. XI, 137 pages. Cloth

ISBN 3-540-93477-4
Gallium - Ga

Main Volume
Covers elemental gallium, its alloys, and compounds. Alloys covered are those with Li, Na, K, Cs, Mg, Al, In, Sn, Pb, Bi, Zn, Cd, Hg, Ni, Fe, Ca, Ag, Au, and Pt. - Literature closing date: September 1936. 1936, reprint 1972. 8 figs. XIV, 100 pages (in German). Cloth ISBN 3-540-93074-4

Supplement Volume
Part D: Coordination Compounds
Section 1: Coordination Compounds 1
Describes the few known Ga²⁺, Ga³⁺, and above all the Ga³⁺ complexes with 1) oxygen containing ligands (water, alcohols, aldehydes, ketones, quinones, ethers, carboxylic acids, etc.), 2) ammonia and amines, and 3) heterocycles with one ring nitrogen atom. Aside from the many isolated compounds also those occurring only in solution and in the gas phase are described. - Literature closing date: 1990. 1992. 23 figs. XVI, 320 pages. Cloth ISBN 3-540-93657-2

Part 2: Coordination Compounds 2

Part 3: Coordination Compounds 3
Continues the treatment of complexes with N- or N- and O-containing ligands. Ligands are azo compounds, triazenes, Schiff bases, hydrazones, formazanes, and nitriles. Concludes the description of gallium complexes with those having ligands which contain S, Se, B, Si, P, or As. Empirical formula index of ligands for volumes DI to D3. - Literature closing date: 1993. 1995. 27 figs. XV, 397 pages. Cloth ISBN 3-540-93717-X

Organogallium Compounds
Part 1:
Contains all compounds with gallium bonded through carbon to one to four organic groups. Special sections deal with organogallium anions and include transition metal compounds containing organogallium groups as multidentate anionic ligands. A few gallium(I) derivatives with Ti⁶-bonded aromatic systems conclude the volume. - Literature closing date: end of 1984. 1987. 105 figs. XIV, 514 pages. Cloth ISBN 3-540-93545-2

Germanium - Ge

Main Volume

Supplement Volume
Occurrence of germanium, recovery from ores and from by-products, preparation and properties of the element, analysis, alloys, and compounds. The voluminous research on the electrical and photoelectric properties of germanium is given extensive coverage. - Literature closing date: end of 1953, partially end of 1954. 1958. 290 figs. III., 576 pages (in German). Cloth ISBN 3-540-93076-0

Organogermanium Compounds
Part 1: Tetraorganogermanium Compounds
Contains tetraorganogermanium compounds of the type GeR₄ and begins the treatment of type GeR₃R' compounds. - Literature closing date: through 1985. 1988. 6 figs. XV, 232 pages. Cloth ISBN 3-540-93568-1

Part 2: Ge(CH₃)₃R and Ge(C₂H₅)₃R Compounds
Continues the treatment of the tetraorganogermanium compounds, and completes the description of compounds of the type Ge(CH₃)₃R. These are followed by the triethyl compounds, Ge(C₂H₅)₃R. - Literature closing date: 1985. 1989. 3 figs. XI, 398 pages. Cloth ISBN 3-540-93585-1

Part 3: Tetraorganogermanium Compounds from Ge(C₃H₇)R to GeRR’R”R’”’ and Other Organogermanium Compounds with Low-Coordinate Germanium Atoms
Completes the description of the GeR₃R’ compounds and includes compounds of types GeR₂R₂ to GeRR’R”R’”’. Concludes with compounds containing Ge in rings as well as with other four-coordinate compounds. The volume contains an empirical formula index and a ligand formula index. - Literature closing date: 1987. 1990. 20 figs. XV, 518 pages. Cloth ISBN 3-540-93595-9

Part 4: Compounds with Germanium-Hydrogen Bonds

Part 5: Compounds with Germanium-Oxygen Bonds
Describes all organogermanium compounds containing organic and inorganic groups bonded through oxygen to Ge, such as -OH, -OR, -OOCR, -OS, -ON, -OP, etc. Includes germanium oxides of the R₆GeO₄GeR₆ type as well as bi- and trimuclear derivatives of polybasic acids. Compounds may have additional Ge-H and Ge-halogen bonds. Contains an empirical formula index and a ligand formula index. - Literature closing date: end of 1990. 1993. 31 figs. XV, 546 pages. Cloth ISBN 3-540-93660-2
Part 6: Germanium-Fluorine Compounds and Triorganogermanium Chlorides
Describes all mononuclear organogermanium compounds with germanium-fluorine bonds. Compounds may have additional germanium-hydrogen bonds. The second and major part describes all triorganogermanium monochloride compounds, i.e., compounds of the types GeR$_3$Cl, GeR$_2$R'Cl, and GeRR'R''Cl.

Supplement Volume

Organohafnium Compounds (New Suppl. Ser. Vol. n)
Bound together with: Organozirconium Compounds (New Suppl. Ser. Vol. 10), see "Zr" Zirconium

Mercury - Hg
Main Volume
Section 1: History. Occurrence. Preparation. Physical Properties
History of elemental mercury and of selected compounds. Terrestrial and cosmic occurrence and minerals, uses, toxicity, preparation, and properties of the element. - Literature closing date: end of 1949.
Section 2: Electrochemistry. Chemical Reactions. Alloys
Electrochemistry of mercury and extended coverage of mercury electrodes with their special characteristics. Chemical reactions of mercury and of mercury ions. Binary, ternary, and polynary alloys with alkali metals including NH$_4$, alkaline earth metals except Mg, Sb, Bi, Zn, Cd, and Tl. Alloys with Mg may be found in "Magnesium" Main Volume A. - Literature closing date: end of 1949. 1962. 285 figs. XLIV, 709 pages (in German). Cloth ISBN 3-540-93174-0
Part B: The Compounds
Section 1: Compounds up to Mercury and Nitrogen (Including Other N-containing Mercury Compounds) Compounds of mercury with hydrogen, oxygen, and nitrogen. Among the latter compounds, the amido mercury salts and the salts of Millon's base receive particular consideration. A large chapter is also devoted to the addition and complex compounds of mercury which contain N compounds as neutral ligands. - Literature closing date: end of 1960. 1965. 28 figs. XLVI, 400 pages (in German). Cloth ISBN 3-540-93175-9
Section 2: Mercury-Halogen Compounds
Covers the halides and the salts of halogen oxoacids. - Literature closing date: end of 1963.
1967. 80 figs. XL, 552 pages (in German). Cloth ISBN 3-540-93176-7
Section 3: Compounds from Mercury and Sulfur to Mercury and Carbon
Compounds of mercury with sulfur, selenium, tellurium, polonium, and carbon. - Literature closing date: end of 1964.

Noble Gases – He, Ne, Ar …
Main Volume
History, occurrence, preparation, and physical properties of He, Ne, Ar, Kr, Xe, and Rn. Chemical reactions, detection, determination, and uses. - Literature closing date: July 1925. 1926, reprint 1963. 6 figs. XVIII, 251 pages (in German). Cloth ISBN 3-540-93051-5

Noble Gas Compounds (New Suppl. Ser. vol. 1)
Covers the noble gas compounds, as defined in a narrow sense, i.e., those in which there are chemical bonds between the noble gas atom and one or more elements. These compounds include, especially, the fluorides, oxides, and metal complexes of the noble gases. Also covered are the noble gas cage compounds. - Literature closing date: March 1970. 1970. 42 figs. XV, 160 pages (in German). Cloth ISBN 3-540-93243-7

Hafnium - Hf
Main Volume
History and occurrence of the element; recovery of hafnium compounds; Zr-Hf separation; reduction of the compounds to the metal; a listing of relevant patents covering industrial uses; physical properties; chemical reactions; detection and determination; compounds of hafnium with H, alkali metals including NH$_4$, Sr, B, C, N, P, As, Sb, O, S, and halogens. - Literature closing date: end of 1939. 1941, reprint 1964. 1 fig. X, 62 pages (in German). Cloth ISBN 3-540-93080-9
Section 4: Compounds (Continued). Formula and Heading Index for Parts A and B

Addition and complex compounds of mercury with carbon-containing ligands; compounds of mercury with silicon, phosphorus, arsenic, antimony, bismuth, the alkali and alkaline earth metals, zinc, and cadmium. The concluding chapter covers compounds with organic bases. A German and an English alphabetic subject index and a formula index increase accessibility to Part A and B. - Literature closing date: end of 1965. 1969. 54 figs. IX, 438 pages (in German). Cloth ISBN 3-540-93178-3

Iodine - I

Main Volume
Section 1: History. Occurrence. The Element
Covers the occurrence of the element, followed by descriptions of the element and its aqueous and nonaqueous solutions. Electrochemistry, chemical reactions, physiological activity, and detection and determination conclude the volume. - Literature closing date: March 1931. 1931, reprint 1964. 17 figs. XXIV, 244 pages (in German). Cloth ISBN 3-540-93084-1

Section 2: Iodine Compounds
Compounds of iodine with hydrogen, oxygen, fluorine, chlorine, and bromine. Includes aqueous and nonaqueous solutions of the various iodium-containing acids and ions. Reviews of the salts are inserted under the corresponding acids. Reactions of halides, hypohalogenites, halogenites, halogenates, and perhalogenates are covered. - Literature closing date: May 1933. 1933, reprint 1967. 20 figs. XXXVII, 416 pages (in German). Cloth ISBN 3-540-93085-X

Supplement Volume
Section 1: Metal. Alloys
Describes the metal - preparation, physical properties, and chemical reactions - and its alloys. Interest in the properties of the intermetallic phases has greatly increased in recent decades. - Literature closing date: end of 1975. 1978. 112 figs. XXIV, 149 pages (in German). Cloth ISBN 3-540-93086-8

Section 2: Compounds
Covers the binary compounds of iodium with H, B, C, Si, N, P, As, Sb, the chalcogens, and the halogens, their double salts, and the iodium complexes in which the listed elements are donor atoms. The bulk of the material is on the complexes. - Literature closing date: end of 1975. 1978. 52 figs. XXXII, 269 pages (36 pages in German). Cloth ISBN 3-540-93368-9

Indium - In

Main Volume
Covers the element, alloys, and compounds. The working up of zinc blende is given major treatment. Alloys covered are those with Li, Na, Cs, Al, Ga, Tl, Sn, Pb, Bi, Zn, Cd, Hg, Cu, Ag, Au, Pd, and Pt. Compounds include those with organic N-bases. - Literature closing date: October 1936. 1936, reprint 1969. 8 figs. XV, 116 pages (in German). Cloth ISBN 3-540-93082-5

Organoindium Compounds
Describes all indium compounds which contain at least one In-C bond. Several compounds became prominent precursors in vapor-phase epitaxy. - Literature closing date: spring 1991. 1991. 101 figs. XIV, 442 pages. Cloth ISBN 3-540-93641-6

Potassium - K

Main Volume
Section 1: The Element. Compounds up to Potassium and Oxygen

Section 2: Compounds up to Potassium and Chlorine

Section 3: Compounds up to Potassium and Tellurium

Section 4: Compounds up to Potassium Acetate

26 GMELIN Complete Catalog 1997/98
**Potassium. Appended Volumes**

**Oceanic Salt Deposits**

**Main Volume**

Monographic treatment of oceanic salt deposits and their solutions. Covers systems with two or more cations (Na, K, Mg, and Ca) and one or more anions (Cl, SO₄), with or without H₂O, and includes the associated double salts. - Literature closing date: end of 1939. 1942, reprint 1969. 1 tabular appendix (75 figs, in 38 charts). XVII, 220 pages (in German). Cloth ISBN 3-540-93094-9

**Supplement Volume**

Entirely devoted to systems of sulfates and chlorides of Na, K, Mg, and Ca, with and without H₂O. Covers the voluminous literature which appeared after 1939. - Literature closing date: 1967. 1970. 49 figs. XX, 166 pages (in German). Cloth ISBN 3-540-93093-0

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**Magnesium - Mg**

**Main Volume**

Part A: History, Occurrence. The Element and Its Alloys

Section 1: History, Occurrence. Preparation of the Metal


Section 2: Properties of the Metal


Section 3: Alloys from Magnesium and Silicon to Magnesium and Radium


Part B: The Compounds

Section 1: Compounds up to Magnesium and Iodine


Section 2: Compounds up to Magnesium Carbonates


Section 3: Compounds up to Magnesium and Bismuth

Covers compounds of magnesium with carbon (cyanides, cyanates including thiо-, seleno-, and tellurocyanates, and salts of formic, acetic, oxalic, and tartaric acid) and continues with the compounds of magnesium with silicon, phosphorus, arsenic, antimony, and bismuth. - Literature closing date: April 1938. 1938, reprint 1963. 4 figs. XI, 92 pages (in German). Cloth ISBN 3-540-93123-6

Section 4: Compounds (Continued). Industrial Preparation of Magnesium Compounds

Completes coverage of the magnesium compounds: compounds of magnesium with alkali metals (special emphasis on the double salts), with ammonium, with hydrazinium, with hydroxyammonium, and with beryllium. Concludes with a chapter on the production of commercially important magnesium compounds. - Literature closing date: October 1938. 1939, reprint 1963. 16 figs. XV, 127 pages (in German). Cloth ISBN 3-540-93124-4

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**Lithium - Li**

**Main Volume**

Contains chapters on history, occurrence, and the production of lithium compounds from minerals. The major portion of the volume deals with the preparation and properties of the element and its compounds. - Literature closing date: July 1926. 1927, reprint 1974. 13 figs. XXVII, 254 pages (in German). Cloth ISBN 3-540-93267-4

**Supplement Volume**

Describes elemental lithium, its alloys and compounds. Contains a chapter dealing with the general reactions of the lithium ion. - Literature closing date: end of 1949. 1960. 73 figs. XLII, 525 pages (in German). Cloth ISBN 3-540-93116-3

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Section 5: Compounds up to Potassium and Bismuth

Concludes the compounds of potassium and carbon (salts of oxalic and tartaric acid), and then describes the compounds of potassium with silicon, phosphorus, arsenic, antimony, and bismuth. - Literature closing date: end of 1937. 1938, reprint 1963. 11 figs. XIX, 142 pages (in German). Cloth ISBN 3-540-93090-6

Section 6: Compounds (Continued)

Potassium compounds with lithium and sodium, with broad coverage of double salts and systems. - Literature closing date: September 1938. 1938, reprint 1963. 47 figs. XV, 156 pages (in German). Cloth ISBN 3-540-93091-4

Section 7: Manufacture of Potassium Salts


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Section 1: History, Occurrence. Preparation of the Metal


Section 2: Properties of the Metal


Section 3: Alloys from Magnesium and Silicon to Magnesium and Radium


Part B: The Compounds

Section 1: Compounds up to Magnesium and Iodine


Section 2: Compounds up to Magnesium Carbonates


Section 3: Compounds up to Magnesium and Bismuth

Covers compounds of magnesium with carbon (cyanides, cyanates including thiо-, seleno-, and tellurocyanates, and salts of formic, acetic, oxalic, and tartaric acid) and continues with the compounds of magnesium with silicon, phosphorus, arsenic, antimony, and bismuth. - Literature closing date: April 1938. 1938, reprint 1963. 4 figs. XI, 92 pages (in German). Cloth ISBN 3-540-93123-6

Section 4: Compounds (Continued). Industrial Preparation of Magnesium Compounds

Completes coverage of the magnesium compounds: compounds of magnesium with alkali metals (special emphasis on the double salts), with ammonium, with hydrazinium, with hydroxyammonium, and with beryllium. Concludes with a chapter on the production of commercially important magnesium compounds. - Literature closing date: October 1938. 1939, reprint 1963. 16 figs. XV, 127 pages (in German). Cloth ISBN 3-540-93124-4

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**Oceanic Salt Deposits**

**Main Volume**

Monographic treatment of oceanic salt deposits and their solutions. Covers systems with two or more cations (Na, K, Mg, and Ca) and one or more anions (Cl, SO₄), with or without H₂O, and includes the associated double salts. - Literature closing date: end of 1939. 1942, reprint 1969. 1 tabular appendix (75 figs, in 38 charts). XVII, 220 pages (in German). Cloth ISBN 3-540-93094-9

**Supplement Volume**

Entirely devoted to systems of sulfates and chlorides of Na, K, Mg, and Ca, with and without H₂O. Covers the voluminous literature which appeared after 1939. - Literature closing date: 1967. 1970. 49 figs. XX, 166 pages (in German). Cloth ISBN 3-540-93093-0
Main Volume
Part A: History. Occurrence
Section 1: History
This history of manganese, its alloys, and its compounds uncovers numerous uncertainties and historical inaccuracies. The first preparation of elemental manganese is usually credited to Johann Gottfried Gahn (1774); actually the metal was prepared four years earlier by Ignaz Gottfried Kaim. Even the name of the element is of uncertain origin; it probably does not stem, as is commonly thought, from Magnesia. - Literature closing date: 1979. 1980. 7 figs. XVI, 218 pages (in German). Cloth ISBN 3-540-93401-4

Section 2: Natural Occurrence. Minerals
Outlines the geo- and cosmochemical characteristics of Mn, its abundance and distribution. The treatment of minerals covers the native metal, its solid solutions with Fe or Al, silicides, the carbide, sulfides and related compounds, halogenides and oxyhalogenides, and oxides of the type MO. - Literature closing date: 1991. 1993. 9 figs. XI, 180 pages. Cloth ISBN 3-540-93665-3

Section 3a: Minerals (Oxides of Type M₂O₃)

Section 3b: Minerals (Oxides of Type M₃O₄)
Continues the description of the Mn minerals of the M₂O₃ type and covers the minerals which belong to the spinel group or are related to the spinel and/or hausmannite group. - Literature closing date: 1992. 1994. 9 figs. XII, 271 pages. Cloth ISBN 3-540-93699-8

Section 4: Minerals (Oxides of Type M₃O₄)

Section 5b 1: Minerals (M₂O₇-Type Tunnel Oxides)
Covers the Mn minerals of the MO₇ type with a tunnel structure which belong to the hollandite group (hollandite, cryptomelane, manjirioite, coronadite, Sr-rich hollandite-group Mn oxide). Mineral index. - Literature closing date: 1995. 1996. 7 figs. XII, 250 pages. Cloth ISBN 3-540-93746-3

Part B: The Element
Preparation of elemental manganese, atomic properties, macrophysical properties, electrochemical behavior, and chemical reactions. Such topics as sorption and reactions on ion exchange resins and oxidation and reduction of Mn⁰, Mn⁺2, and Mn⁰ in solution are covered. - Literature closing date: mid-1971. 1973. 71 figs. XXII, 404 pages (in German). Cloth ISBN 3-540-93125-2

Manganese in Alloyed Materials, see "Fe" Iron Part D, Supplement 2 "Magnetic Materials"

Part C: The Compounds
Section 1: Hydrides, Oxides, Hydrated Oxides, and Hydroxides

Section 2: Oxomanganese Ions. Permanganic Acid. Compounds and Phases with Metals of the 1st and 2nd Main and Transition Groups of the Periodic System
Oxomanganese ions and acids with emphasis on MnO₄²⁻, MnO₄³⁻, MnO₄⁴⁻, and HMnO₄⁻. The major portion of the volume then covers compounds and phases of the various oxidation states of Mn with the alkali metals (including NH₄ and related species), with Be, Mg, and the alkaline earth metals, and with Zn, Cd, and Hg. - Literature closing date: mid-1974. 1975. 66 figs. XVIII, 302 pages (in German). Cloth ISBN 3-540-93287-9

Section 3: Compounds of Manganese with Oxygen and with Metals of the 3rd, 4th, 5th, and 6th Groups of the Periodic System. Manganese-Nitrogen Compounds
Compounds and phases of manganese and oxygen with group 3 through group 6 metals. Also covers compounds of manganese with nitrogen, e.g., binary manganese nitrides, double nitrides, azides, amides, nitrites, and nitrates. - Literature closing date: end of 1974. 1975. 140 figs. XX, 307 pages (in German). Cloth ISBN 3-540-93299-2

Section 4: Compounds of Manganese with Fluorine

Section 5: Compounds of Manganese with Chlorine, Bromine, and Iodine
The major portion of this volume is devoted to manganese compounds of chlorine: MnCl, MnCl₂, and its hydrates, MnCl₃, MnCl₄; the chloro complexes of Mn²⁺, Mn³⁺, and Mn⁴⁺; manganese chloride double compounds with other elements, especially alkali metals and ammonium; organically substituted ammonium chloromanganates. Manganese compounds with bromine and iodine are also covered. - Literature closing date: beginning of 1977. 1978. 111 figs. XXX, 343 pages (in German). Cloth ISBN 3-540-93363-8

Section 6: Compounds of Manganese with Sulfur, Selenium, and Tellurium
The coverage emphasizes the sulfide (MnS), the sulfate (MnSO₄), its most important hydrates, and double and multiple compounds of the sulfate with sulfates of other metals. Magnetic properties are quoted for almost all of the compounds. - Literature closing date: end of 1975. 1976. 127 figs. XL, 360 pages (in German). Cloth ISBN 3-540-93325-5
Section 7: Compounds of Manganese with Boron and Carbon
Describes the borides, borates, carbides, and carbonates of manganese. Compounds which contain other metals in addition to manganese are also covered. - Literature closing date: 1979. 1981. 120 figs. XV, 248 pages. Cloth

ISBN 3-540-93438-3

Section 8: Compounds of Manganese with Silicon
Covers the silicides and silicates of manganese. The former include the ternary and polynary manganese silicides which are important in steel deoxidation; the latter include complex manganese silicates which are important in mineralogy and metallurgical slags. - Literature closing date: 1979. 1982. 167 figs. XVI, 370 pages. Cloth

ISBN 3-540-93451-0

Section 9: Compounds of Manganese with Phosphorus, Arsenic, Antimony
Phosphides, phosphates, arsenides, arsenates, and antimonides of manganese are the main topics. Although the major part is concerned with the phosphates, more than 30 pages are dedicated to the description of MnAs, which may well be one of the most intriguing inorganic compounds by virtue of its many crystallographic and magnetic structures and their intricate interrelationships. - Literature closing date: 1980. 1983. 194 figs. XXII, 456 pages. Cloth

ISBN 3-540-93469;-

Section 10: Electronic Spectra of Manganese Halides.
Cumulative Index of C 1 to C 10
The optical spectra of the manganese halides and halogen complexes are treated in the same chapter on account of numerous parallels and the common theoretical foundation. The index contains all compounds described in Part B and Volumes C 1 to C 10 as well as the salts and complexes of carbon-containing inorganic and carboxylic acids treated in Part D. - Literature closing date: 1980. 1983. 5 figs. X, 396 pages. Cloth

ISBN 3-540-93478-2

Part D: Coordination Compounds

Section 1: Coordination Compounds 1
Complexes of manganese with water, alcohols, phenols, aldehydes, ketones, diketones, quinones, and oxygen heterocycles. There is an organic ligand formula index and a brief survey of earlier Gmelin coverage of inorganic manganese complexes. - Literature closing date: end of 1977. 1979. 16 figs. XVIII, 174 pages (in German). Cloth

ISBN 3-540-93387-5

Section 2: Coordination Compounds 2
Describes the salts and complexes of manganese with the carboxylic acids and their derivatives: Of particular interest are the manganese formates and acetates, which show complex magnetic behavior. Manganese (II) acetate is an oxidant in organic chemistry and the starting material for a series of manganese (III) compounds. The cyano- and cyanonitrileyl-manganeseates are also described. There is a formula index. - Literature closing date: end of 1978. 1980. 54 figs. XXIV, 307 pages (in German). Cloth

ISBN 3-540-93419-7

Section 3: Coordination Compounds 3
Continues the description of manganese complexes: complexes with ammonia, amines (including ethylenediamine and the polyamines), hydrazine and its derivatives, hydroxylamine, and N-heterocycles. There is a ligand formula index. - Literature closing date: 1980. 1982. 28 figs. XIII, 341 pages. Cloth

ISBN 3-540-93467-7

Section 4: Coordination Compounds 4
Manganese coordination compounds with ligands containing two or more nitrogen atoms comprise the first part of this volume. Special attention is given to compounds with porphyrins and related compounds, as well as to phthalocyanines and macrocyclic ligands containing nitrogen and oxygen. Complexes with amino alcohols, amino phenols, amino ethers, amino acids, amino oxo compounds, N-heterocyclic carboxylic acids, peptides, and proteins are covered in the second part of the volume. - Literature closing date: 1983. 1985. 27 figs. XV, 395 pages. Cloth

ISBN 3-540-93513-4

Section 5: Coordination Compounds 5
Describes manganese complexes with amine-N-polycarboxylic acids, hydrazincarboxylic acids, amides, hydrazides, derivatives of hydroxylamine, oximes and nitroso compounds, azo compounds, and triazenes. A formula index of the organic ligands is included. - Literature closing date: 1985. 1987. 25 figs. XIX, 349 pages. Cloth

ISBN 3-540-93550-9

Section 6: Coordination Compounds 6
Manganese complexes of Schiff bases, the condensation products of aldehydes or ketones with amines, occupy more than half of the present volume. Following these are the Mn complexes with related compounds (hydrazones, semicarbazones, and thiosemicarbazones), as well as with carbazones, thio carbazones, and formazanes. - Literature closing date: end of 1986. 1988. 29 figs. XVIII, 416 pages. Cloth

ISBN 3-540-93565-7

Section 7: Coordination Compounds 7
Contains the complexes with nitriles and related compounds as well as complexes with nitro hydrocarbons. Complexes with sulfur-containing ligands are followed by those with sulfoxide, thiourea, or dithiocarbamic acid (as outstanding examples). A chapter with ligands containing Se and Te concludes the volume. - Literature closing date: 1987. 1990. 19 figs. XVI, 289 pages. Cloth

ISBN 3-540-93602-5

Section 8: Coordination Compounds 8
Concludes the series on manganese complexes and covers ligands with B, Si, P, As, Sb, or Sn. Phosphorus ligands predominate. Oligomeric and polymeric dihalogen complexes of Mn(RP3 X)2 formula units and their THF solvates can reversibly bind small molecules. - Literature closing date: 1988. 1990. 41 figs. XV, 245 pages. Cloth

ISBN 3-540-93618-1

Molybdenum - Mo

Main Volume
History of molybdenum, occurrence (including economic geography and minerals), recovery from ores and by-products. The element, its alloys with Sb, Bi, Zn, Hg, Al, Ti, Zr, Th, Sn, Pb, Ta, Cr (in that order), and its compounds. Molybdenum heteropoly acids and their salts. - Literature closing date: end of 1934. 1935, reprint 1971. 13 figs. XXVIII, 393 pages (in German). Cloth

ISBN 3-540-93127-9
Section 3b: Oxomolybdenum Species in Aqueous Solutions (Continued). Oxomolybdenum Species in Nonaqueous Solvents. Oxomolybdenum Species in Melts. Peroxomolybdenum Species

In the first part, the treatment of oxomolybdenum(VI) species in aqueous solution is completed. Of great importance is the formation of heteropolymolybdate ions by the reaction of oxometallates of about 40 heteroelements with molybdate ions. Subsequent chapters treat oxomolybdate ions in nonaqueous (organic) solvents and in melts. - Literature closing date: mid-1985.


Section 4: Hydrous Molybdates of Groups VA to VI B Metals

Contains hydrated molybdenum-oxygen compounds which also contain other metals. Compounds with NH₄ or organically substituted N- or P-cations are treated in connection with the compounds with alkali metals. There is a comprehensive section on monomolybdates, isopolyoxomolybdates, and peroxo-molybdates of the alkali (including NH₄, etc.) and alkaline earth metals. In the majority of the compounds which contain transition metals, etc. as an additional metallic element, molybdates as well as molybdometallates are present. - Literature closing date: 1982. 1985. 85 figs. XXIV, 359 pages. Cloth ISBN 3-540-93518-5

Section 5: Compounds with N, F, Cl

In the Mo-N system the stable compounds are Mo₂N and MoN. Among the fluorides MoF₃, the compounds with n = 3 to 6 are stable but not those with n < 2. The pentafluoride MoF₅ is frequently contaminated with MoOF₄. An important and intensively examined oxide fluoride is, in addition to Mo₂OF₆, Mo₃OF₆F₂. In the Mo-CI series the structure of the well-investigated α-MoCl₂ is remarkable with the appearance of the Mo₂Cl₄ cluster as an important component. It is also found in (H₂O)[(Mo₂Cl₆)Cl₄] • 6H₂O. - Literature closing date: 1987. 1990. 75 figs. XVII, 391 pages. Cloth ISBN 3-540-93603-3

Section 6: Compounds with Cl, Br, I

The description of the chlorine-containing compounds is continued by the ternary compounds, especially the oxide chlorides, nitride chlorides, etc. The compounds with bromine and iodine resemble those of the corresponding chlorine-containing compounds. Heteropoly compounds were formed with iodine(VII) in contrast to the other halogens. - Literature closing date: 1988. 1990. 59 figs. XVII, 303 pages. Cloth ISBN 3-540-93619-X

Section 7: Compounds with S

Describes the Mo-S phase diagram and all binary molybdenum sulfides: Mo₅S₉, Mo₃S₆, Mo₆S₈, Mo₅S₇, and Mo₂S₇. Above all, properties of Mo₅S₇ were thoroughly investigated because of its numerous applications. Binary molybdenum sulfide ions comprise MoS₄²⁻, MoS₅²⁻, a few other mononuclear, several dinuclear Mo₅S₉⁺ (n = 6 to 12), and several polynuclear species up to Mo₅S₇⁺. - Literature closing date: end of 1989. 1992. 59 figs. XIV, 351 pages. Cloth ISBN 3-540-93650-5

Section 8: Compounds with S, Se

Covers the ternary and polynary compounds composed of Mo, S, and additional H, O, N, and/or halogens. Covers also the binary compounds of Mo and Se. - Literature closing date: mid of 1992. 1995. 74 figs. XV, 308 pages. Cloth ISBN 3-540-93705-6
Organomolybdenum Compounds

Part 5: Mononuclear Compounds

Describes \( ^1 \text{LMo} \) compounds with \( n = 1 \) to 4. Additional CO groups may be present. Additional D ligands (D = amines, phosphines, nitriles) and X ligands (X = halides, pyrazolyl derivatives) lead to a great number of different types of compounds. - Literature closing date: end of 1983. 1992. 72 figs. XIV, 430 pages. Cloth ISBN 3-540-93661-0

Part 6: Mononuclear Compounds

Describes Mo compounds with one \( ^1 \text{L} \) ligand. Compounds described in the present volume can also contain one CO group and additional \( ^1 \text{L} \), \( ^2 \text{L} \), \( ^3 \text{L} \), or \( ^4 \text{L} \) ligands. Contains an empirical formula index and a ligand formula index. - Literature closing date: 1987. 1990. 106 figs. XIII, 502 pages. Cloth ISBN 3-540-93615-7

Part 7: Mononuclear Compounds

Continues the description of \( ^1 \text{LMo} \) compounds and their derivatives containing two CO groups but no additional \( ^1 \text{L} \) ligands. Derivatives include ligands X (e.g. halogens) or \( ^{1+} \text{D} \) (e.g. PR3, ethers). Cations of this type with \( [\text{C}_5 \text{H}_5 \text{Mo(CO)}_3]^- \) as counter anion are included. - Literature closing date: end of 1988. 1991. 52 figs. XI, 368 pages. Cloth ISBN 3-540-93625-4

Part 8: Mononuclear Compounds

Completes the description of \( ^1 \text{LMo(CO)}_3 \) compounds with \( ^1 \text{L} = \text{C}_5 \text{H}_5 \), indenyl, or substituted derivatives of \( \text{C}_5 \text{H}_5 \). Additional ligands are \( ^1 \text{L} \) (allyl, aryl, carbene, isonitrile, carbonyl, etc.), \( ^1 \text{L} \) (olefine), \( ^1 \text{L} \), and \( ^1 \text{L} \) (butadiene derivatives) type. \( ^2 \text{D} \), \( ^2 \text{L} \) X ligands may be present. Contains an empirical formula index and a ligand formula index. - Literature closing date: end of 1989. 1992. 55 figs. XI, 396 pages. Cloth ISBN 3-540-93652-1

Part 9: Mononuclear Compounds

Completes the description of \( ^1 \text{LMo(CO)}_3 \) compounds with heteronuclear compounds containing one or more additional transition metal fragments. Starts the treatment of compounds containing three CO groups with \( [\text{C}_5 \text{H}_5 \text{Mo(CO)}_3]^+, [\text{C}_5 \text{H}_5 \text{Mo(CO)}_3]^-, [\text{C}_5 \text{H}_5 \text{Mo(CO)}_3]^0 \) (incl. the appropriate salts), \( [\text{C}_5 \text{H}_5 \text{Mo(CO)}_3]^+, \) and \( [\text{C}_5 \text{H}_5 \text{Mo(CO)}_3]^0 \). - Literature closing date: 1989 and 1992. 1993. 55 figs. XIII, 332 pages. Cloth ISBN 3-540-93670-X

Part 10: Mononuclear Compounds

Continues the description of compounds with a \( \text{C}_5 \text{H}_5 \text{Mo(CO)}_3 \) fragment. Includes compounds of the types \( \text{C}_5 \text{H}_5 \text{Mo(CO)}_3 \), \( \text{C}_5 \text{H}_5 \text{Mo(CO)}_3 \), \( \text{C}_5 \text{H}_5 \text{Mo(CO)}_3 \), \( \text{C}_5 \text{H}_5 \text{Mo(CO)}_3 \), \( \text{C}_5 \text{H}_5 \text{Mo(CO)}_3 \), \( \text{C}_5 \text{H}_5 \text{Mo(CO)}_3 \), \( \text{C}_5 \text{H}_5 \text{Mo(CO)}_3 \), \( \text{C}_5 \text{H}_5 \text{Mo(CO)}_3 \), \( \text{C}_5 \text{H}_5 \text{Mo(CO)}_3 \), as well as the heteronuclear compounds \( \text{C}_5 \text{H}_5 \text{Mo(CO)}_3 \). - Literature closing date: end of 1993. 1995. 30 figs. XII, 296 pages. Cloth ISBN 3-540-93724-2

Part 11: Mononuclear Compounds

Continues the description of mononuclear organomolybdenum compounds with a \( \text{C}_5 \text{H}_5 \text{Mo(CO)}_3 \) fragment by the treatment of \( \text{C}_5 \text{H}_5 \text{Mo(CO)}_3 \), \( ^1 \text{L} \) and \( [\text{C}_5 \text{H}_5 \text{Mo(CO)}_3] \) \( ^{1+} \text{D} \), \( ^2 \text{L} \), \( ^2 \text{L} \), \( ^3 \text{L} \), \( ^3 \text{L} \), \( ^3 \text{L} \), \( ^3 \text{L} \), \( ^3 \text{L} \), \( ^3 \text{L} \), and \( ^3 \text{L} \) ligands. Empirical formula index and transition metal cross reference - Literature closing date: end of 1995. 1996. 37 figs. XII, 395 pages. Cloth ISBN 3-540-93743-9

Part 12: Mononuclear Compounds

Describes mononuclear compounds of the types \( [\text{C}_5 \text{H}_5 \text{Mo(CO)}_3] \), \( ^2 \text{L} \), \( ^3 \text{L} \), \( ^3 \text{L} \), the great variety of mononuclear compounds with two \( ^2 \text{L} \) and additional \( ^1 \text{L} \), \( ^2 \text{L} \), \( ^2 \text{L} \), \( ^2 \text{L} \), \( ^3 \text{L} \), \( ^3 \text{L} \), \( ^3 \text{L} \), and \( ^3 \text{L} \) ligands. Contains an empirical formula index. - Literature closing date: March 1991. 1993. 92 figs. XII, 333 pages. Cloth ISBN 3-540-93692-0

Part 13: Mononuclear Compounds

Starts the description of mononuclear organomolybdenum compounds with one \( ^1 \text{L} \) ligand. Additional \( ^2 \text{D} \) and up to three \( ^1 \text{L} \) ligands may be present. \( ^1 \text{L} \) ligands are alkyl, carbonyl, thio carbonyl, isocy anide, or carbene groups. Empirical formula index. - Literature closing date: end of 1993. 1996. 45 figs. XI, 253 pages. Cloth ISBN 3-540-93744-7

Nitrogen - N

Main Volume

Section 1: History. Occurrence. The Element
History of nitrogen; cosmic occurrence; terrestrial occurrence of nitrogen and its compounds; transformation of nitrogen and its compounds in the soil; formation and preparation of the element, its physical properties, electrochemical behavior, and chemical reactions; detection and determination; active nitrogen. - Literature closing date: June 1934. 1934, reprint 1968. 10 figs. XVI, 382 pages (in German). Cloth ISBN 3-540-93213-5

Section 2: Compounds of Nitrogen with Hydrogen
\( \text{HN}_3 \), \( \text{H}_2 \text{NNH}_2 \), and \( \text{NH}_3 \). Most of this volume is devoted to \( \text{NH}_3 \) - its formation, decomposition, and properties. - Literature closing date: April 1935. 1935, reprint 1968. 32 figs. XV, 224 pages (in German). Cloth ISBN 3-540-93214-3

Section 3: Compounds of Nitrogen with Oxygen
The binary oxides of nitrogen, especially \( \text{N}_2 \text{O} \), \( \text{NO} \), \( \text{N}_2 \text{O}_3 \), \( \text{NO}_2 \), and \( \text{N}_2 \text{O}_5 \). - Literature closing date: August 1935. 1936, reprint 1968. 54 figs. XXIV, 348 pages (in German). Cloth ISBN 3-540-93215-1

Section 4: Compounds with Oxygen (Continued)
Covers compounds such as hydroxylamine, nitramide, nitrous acid, and nitric acid. - Literature closing date: February 1936. 1936, reprint 1968. 16 figs. XIV, 184 pages (in German). Cloth ISBN 3-540-93216-X
Supplement Volume Part B: Compounds

Section 1: Compounds with Noble Gases and Hydrogen
Describes binary nitrogen-noble gas compounds. The major part deals with the binary species NH, NH₂, NH₄, and NH₅, their ions, and some additives (NH₄ and NH₅⁺ are excluded). There is extensive information on NH and NH₂.- Literature closing date: mid-1992. 1993. 11 figs. XIV, 280 pages. Cloth

ISBN 3-540-93686-6

Section 2: Compounds with Noble Gases and Hydrogen
Continues the description of binary nitrogen-hydrogen compounds with species having two, three or more nitrogen atoms (with the exception of N₂H₆). The major part deals with N₂H, N₂H₂, N₂H₃, N₂H₄, and corresponding ions. Several compounds with more than three nitrogen atoms are well known, e.g. N₃H, NH₃N₃, N₂H₅N₃, and N₅H₄. - Literature closing date: mid-1992. 1993. 2 figs. XIII, 188 pages. Cloth

ISBN 3-540-93672-6

Section 6: Compounds with Oxygen (N₂O₃, NO₃, NO₃⁻)
Deals with all known binary species formed between nitrogen and oxygen with the O:N ratio ≥ 2.5, i.e., N₂O₃, NO₃⁻, NO₃⁺, NO₂, NO₂⁺, ONOO-, NO₂⁻, N₂O₃, N₂O₄, N₂O₅, N₂O₆, N₂O₇, N₂O₈, NO₃, and NO₃⁺, n = 1-2.3. A wealth of chemical and physico-chemical data is reported on dinitrogen pentoxide, the NO₃ radical, and the nitrate ion. There is recent interest in the chemistry of the peroxynitrite ion. - Literature closing date: end of 1994. 1996. 16 figs. XV, 377 pages. Cloth

ISBN 3-540-93729-3

Sodium - Na

Main Volume
Covers the element and its compounds. Includes most of the important sodium salts: halides, sulfate, sulfite, thiosulfate, carbonate, cyanide, and phosphates. Alloys of sodium with antimony, bismuth, and lithium are covered, together with the corresponding compounds. - Literature closing date: end of 1927. 1928, reprint 1969. 75 figs. LI, 992 pages (in German). Cloth

ISBN 3-540-93128-7

Supplement Volume
Section 1: Technology of Sodium and Its Compounds
Covers technology of metallic sodium, sodium hydroxide, sodium nitrate, sodium halides, sodium salts of the halogen oxoacids, sulfides, sulfoxide, sulfite, thiosulfate, dithionate, tetrahydroborate, borates, carbonates, cyanide, silicates (water glass), phosphates, peroxo compounds, and H₂O₂ addition compounds. Toxicity of sodium and its compounds. - Literature closing date: end of 1960. 1964. 35 figs. XXIX, 399 pages (in German). Cloth

ISBN 3-540-93129-5

Section 2: The Element. Compounds with Hydrogen and Oxygen
Covers elemental sodium including preparation, enrichment of radioactive isotopes, properties of the various states of the element, and chemical reactions of the element and of the sodium ion. Also covered are the compounds with hydrogen and with oxygen. - Literature closing date: end of 1960. 1965. 66 figs. XL, 496 pages (in German). Cloth

ISBN 3-540-93130-9

Niobium - Nb

Main Volume
Part A: History. The Element
(Occurrence is covered in "Ta" Tantalum Part A, Section 1) History; toxicity; dressing of raw materials; purification of products; separation from tantalum; manufacture of the various forms of the metal; preparation, separation, and enrichment of radioisotopes; properties of the atom, of atomic ions, and of the metal; electrochemical behavior; chemical reactions; analysis. - Literature closing date: end of 1965. 1969. 76 figs. XX, 356 pages (in German). Cloth

ISBN 3-540-93145-7
Main Volume

Section 1: The Element. Compounds up to Ammonium and Iodine

Section 2: Compounds up to Ammonium and Potassium. Hydrazinium. Hydroxylammonium
Compounds of ammonium with S, Se, Te, B, C, Si, P, As, Sb, Bi, and the alkali metals Li, Na, and K. The hydrazinium and hydroxylammonium ions - which are analogs of NH$_4^+$ - and their salts are covered at the end of the volume. - Literature closing date: June 1936. 1936, reprint 1969. 19 figs. XXIX, 360 pages (in German). Cloth ISBN 3-540-93012-4

Part A I: History, Occurrence, Preparation

Part A II: The Element
Section 1: Physical Properties of the Element
Covers the isotopes of nickel, the atom and atomic ions, optical and X-ray spectra, and the crystallographic, mechanical, thermal, electrical, magnetic, and optical properties of the element. - Literature closing date: end of 1963. 1967. 128 figs. XIX, 398 pages (in German). Cloth ISBN 3-540-93138-4

Section 2: Electrochemical Behavior and Chemical Reactions. Detection. Determination

Part B: Alloys and Compounds
Section 1: The Alloys of Nickel
Covers the alloys with all metals except Co, Fe, Cu, Ag, Au, platinum-group elements, Tc, Re, and transuranium elements. - Literature closing date: end of 1960. 1965. 141 figs. XXXI, 314 pages (in German). ISBN 3-540-93140-6

Nickel in Alloyed Materials, see "Fe" Iron Part D, Supplement 2 "Magnetic Materials"

Section 2: Compounds up to Nickel and Polonium

Section 3: Compounds (Continued)

Part C: Coordination Compounds with Neutral and Inner-complex-forming Ligands
Section 1: Briefly covers nickel(0) and nickel(I) complexes. The major portion is devoted to nickel(II) compounds with organic ligands. Ligands covered include amines, N- and O-heterocyclics, alcohols, aromatic hydroxy compounds, ethers, carboxylic acids, and esters. - Literature closing date: end of 1965. 1968. 35 figs. VIII, 496 pages (in German). Cloth ISBN 3-540-93143-0

Nickel - Ni

Part A I: History, Occurrence, Preparation

Part A II: The Element
Section 1: Physical Properties of the Element
Covers the isotopes of nickel, the atom and atomic ions, optical and X-ray spectra, and the crystallographic, mechanical, thermal, electrical, magnetic, and optical properties of the element. - Literature closing date: end of 1963. 1967. 128 figs. XIX, 398 pages (in German). Cloth ISBN 3-540-93138-4

Section 2: Electrochemical Behavior and Chemical Reactions. Detection. Determination

Part B: Alloys and Compounds
Section 1: The Alloys of Nickel
Covers the alloys with all metals except Co, Fe, Cu, Ag, Au, platinum-group elements, Tc, Re, and transuranium elements. - Literature closing date: end of 1960. 1965. 141 figs. XXXI, 314 pages (in German). ISBN 3-540-93140-6

Nickel in Alloyed Materials, see "Fe" Iron Part D, Supplement 2 "Magnetic Materials"

Section 2: Compounds up to Nickel and Polonium

Section 3: Compounds (Continued)

Part C: Coordination Compounds with Neutral and Inner-complex-forming Ligands
Section 1: Briefly covers nickel(0) and nickel(I) complexes. The major portion is devoted to nickel(II) compounds with organic ligands. Ligands covered include amines, N- and O-heterocyclics, alcohols, aromatic hydroxy compounds, ethers, carboxylic acids, and esters. - Literature closing date: end of 1965. 1968. 35 figs. VIII, 496 pages (in German). Cloth ISBN 3-540-93143-0

Ammonium – NH$_4^+$

Part B: Compounds and Alloys
Section 1: Compounds up to Niobium and Bismuth
Niobium compounds with noble gases, H, O, N, the halogens, S, Se, Te, B, C, Si, P, As, Sb, and Bi; includes systems such as Nb-C and Nb-C-O, and the phases encountered; salts of organic acids, niobium carbonyls, etc., are covered in Section B 4. - Literature closing date: 1968. 1970. 121 figs. XXXII, 424 pages (in German). Cloth ISBN 3-540-93146-5

Section 2: Alloys
Binary and multicomponent niobium alloys with Be, Mg, Al, Ga, In, Ti, Ge, Sn, Pb, Zn, Cd, Hg, rare earth elements, Ti, Zr, Hf, V, and Th. - Literature closing date: mid-1970. 1971. 167 figs. XXII, 307 pages (in German). Cloth ISBN 3-540-93147-3

Section 3: Oxoniobates (Excluding Alkali Oxoniobates)
Oxoniobates with Be, Mg, Al, Ga, In, Ti, Ge, Sn, Pb, Zn, Cd, Hg, rare earth elements, Ti, Zr, Hf, V, and Th. Presents numerous structures as well as data on electrical and optical properties of these compounds. - Literature closing date: mid-1970. 1972. 205 figs. XXVIII, 330 pages (in German). Cloth ISBN 3-540-93148-1

Section 4: Alkali Oxoniobates. Niobium Compounds with Other Cations. Carbon Compounds of Niobium
Completes the description of the oxoniobates with coverage of the alkali oxoniobates and then describes other niobium compounds containing H, B, C, Si, N, P, As, Sb, or halogens, and one or more additional metals (all metals of the main groups inclusive of NH$_4^+$ and organic bases which are presented with the alkali metals, Zn, Cd, Hg, rare earth elements, Ti, Zr, Hf, V, and Th). Also covers organic compounds of niobium and coordination compounds with inorganic and organic ligands. - Literature closing date: end of 1971. 1973. 153 figs. XXX, 473 pages (in German). Cloth ISBN 3-540-93149-X

Formulare and Heading Index, see under "Ta" Tantalum
In Gmelin, NH$_4^+$ has its own System Number and is handled as an alkali metal. The most important ammonium salts are found under NH$_4^+$.
Section 2:
Complete coverage of nickel(II) complexes. Organic ligands are: aldehydes, ketones, aminooalcohols, aminophenols, aminocids, amino-N-polycarboxylic acids, Schiff’s bases, azo compounds, oximes and nitroso compounds, acid amides and hydrazides, cyanides and isocyanides. Ligands containing S, Se, B, P, and As, Ni(III) and Ni(V) complexes. Empirical formula index of the organic ligands and alphabetic ligand index for Parts B and C. - Literature closing date: end of 1967. 1969. 61 figs. X, 749 pages (in German). Cloth

ISBN 3-540-93144-9

Organonickel Compounds

Much of the volume is devoted to a description of Ni(CO)4, continuing the presentations begun in "Nickel" Part B Section 3 and Part A 1. - Literature closing date: end of 1973. 1975. 44 figs. XIV, 419 pages (in German). Cloth

ISBN 3-540-93294-1

Includes mononuclear organonickel compounds in which a ligand is bound to nickel by more than two C atoms. Covers polynuclear organonickel compounds. - Literature closing date: end of 1973. 1974. 90 figs. XVI, 402 pages (in German). Cloth

ISBN 3-540-93279-8

Index for Parts 1 and 2 (New Suppl. Ser. Vol. 18)
Empirical formula index and a ligand formula index. 1975. IX, 129 pages (bilingual: English and German). Cloth

ISBN 3-540-93296-8

Organonickel Compounds, First Supplement

Part 1: Mononuclear Compounds
Covers all mononuclear organonickel compounds which contain one Ni-C bond. The major part deals with planar NiCo compounds of the type (L)Ni(CO)3X, X = L)Ni compounds containing \( \eta \)-bonded C, fragments such as CO and CS, and related metallacyclic compounds are included. The catalytic properties of the compounds are emphasized. - Literature closing date: 1990/mid-1993. 1993. 76 figs. XI, 381 pages. Cloth

ISBN 3-540-93681-5

Part 2: Mononuclear Compounds
Covers mononuclear organonickel compounds of the types (L)Ni, (L'Ni), (L,Ni), (L,Ni), (L,Ni), (L,Ni), Ni, n \( \eta \)-Carbene, Ni, \( n \) = 1 to 4, and (carbyne) Ni. - Literature closing date: 1993. 1994. 56 figs. XI, 215 pages. Cloth

ISBN 3-540-93706-4

Part 3: Mononuclear Compounds
Covers all mononuclear organonickel compounds with isonitrile, carbonyl, thio-carbonyl, or ylide as the only organic ligand. Additional X and D ligands may be present. Ni(CO)4 and more than 600 (OC)Ni(D)\( _\eta \) species are described in detail. Empirical formula index for supplement volumes 1 to 3 and transition metal cross reference - Literature closing date: 1994. 1996. 57 figs. XIII, 406 pages. Cloth

ISBN 3-540-93732-3

Transuranium Elements – Np, Pu ...

Main Volume
History, natural occurrence, prepared by G. T. Seaborg, and properties of the atomic nuclei, by E.K. Hyde. Isotope table and decay schemes are shown. - Literature closing date: end of 1970. 1973. 86 figs. XII, 178 pages. Cloth

ISBN 3-540-93248-8

Covers manufacture of transuranium nuclides, chemical recovery of the synthesized elements, and isotope enrichment. - Literature closing date: end of 1970. 1974. 89 figs. XX, 370 pages (70 pages in German, 75 pages in French). Cloth

ISBN 3-540-93276-3

Covers general properties of the atoms and ions, spectra, analytical chemistry, uses, processing, radiation behavior, storage, and biological activity of the transuranium elements. - Literature closing date: end of 1970. 1973. 124 figs. XXV, 424 pages (219 pages in German, 22 pages in French). Cloth

ISBN 3-540-93249-6

Covers the transuranium metals Np, Pu, Am, Cm, Bk, Cf, Es, and Fm, and presents information on preparation, crystal structure, mechanical and thermal properties, and on the industrially important properties such as tensile and compressive strength, and hardness. Also covered are electrical and magnetic properties and chemical reactions. - Literature closing date: end of 1971. 1976. 29 figs. XII, 84 pages (56 pages in German). Cloth

ISBN 3-540-93308-5

Describes the binary alloy systems of neptunium and begins coverage of the binary alloy systems of plutonium. Includes a semi-empirical interpretation of the alloying behavior of plutonium and a discussion of the electronic structure of plutonium and the lighter actinides in the metallic state. - Literature closing date: end of 1971 for Np alloys; end of 1973 for Pu alloys. 1976. 191 figs. XXIV, 241 pages (in German). Cloth

ISBN 3-540-93327-1

Continues the description of binary alloy systems of plutonium, including the important Pu-Fe, Pu-Al, and Pu-Ga systems. Three short chapters cover the binary alloy systems of americium, of curium, and of the transcurium elements. - Literature closing date: end of 1973 for Pu alloys; end of 1971 for americium, curium, and transcurium elements. 1977. 204 figs. XXVIII, 275 pages (in German). Cloth

ISBN 3-540-93329-8

Part C: The Compounds (New Suppl. Ser. Vol. 4)
Describes the compounds of the transuranium elements, including the compounds of elements 104 and 105. - Literature closing date: end of 1971. 1972. 128 figs. XXIV, 279 pages (194 pages in German). Cloth

ISBN 3-540-93245-3

Part D 1: Chemistry in Solution (New Suppl. Ser. Vol. 20)
Describes the solution chemistry of the transuranium elements. Covered in this volume are the aqueous solutions: physical properties, electrochemistry, redox reactions, precipitation, coprecipitation, and coordination chemistry. - Literature closing date: end of 1970. 1975. 24 figs. XIX, 176 pages (101 pages in French). Cloth

ISBN 3-540-93286-0

**Index**
The index includes the subjects and the substances appearing in Volumes AI I, AI II, A2, B1, B2, B3, C, DI, and D2. It completes the volumes on the transuranium elements published between 1973 and 1977. In addition to the usual terms such as occurrence, preparation, physical properties, and chemical properties, there are numerous terms from the field of nuclear chemistry: reprocessing, criticality, Purex process, health physics, etc. 1979. VI, 243 pages. Cloth ISBN 3-540-93389-1

### Oxygen - O

**Main Volume**

#### Section 1: History

#### Section 2: Occurrence. Technology

#### Section 3: Elemental Oxygen
Laboratory preparation of oxygen and its isotopes, physical properties, and electrochemical behavior. Reactions in O2-H2 mixtures are treated in detail and include topics such as detonations and flames. - Literature closing date: end of 1949. 1958, reprint 1971. 100 figs. XXX, 518 pages (in German). Cloth ISBN 3-540-93186-4

#### Section 4: Air. Active Oxygen. Ozone
Covers mechanical and thermal properties of air, its solubility in water, in aqueous solutions, and in organic solvents, its sorption by surface-active materials, and its physical properties. The major portion of this volume is devoted to ozone: formation and decomposition, preparation, physical properties, electrochemical behavior, and chemical reactions. - Literature closing date: end of 1949. 1960, reprint 1971. 76 figs. XXI, 366 pages (in German). Cloth ISBN 3-540-93187-2

### Osmium - Os

**Main Volume**
Covers the element (physical properties, electrochemical behavior, chemical reactions) and the osmium compounds. An appended chapter, "Ekaosmium", contains early data on element 94 (now called plutonium). - Literature closing date: August 1938. 1939, reprint 1976. XVI, 100 pages (in German). Cloth ISBN 3-540-93150-3

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### Section 5: Systems. Ordinary Water (up to Chemical Reactions, Excluding Electrochemical Behavior)

Continues the description of water: electrochemical behavior; the H2O-O2 system, systems of water with hydrocarbons, benzene, alcohols, ethers, and aliphatic acids; enrichment, properties, and reactions of the various isotopic forms of water (D2O, HDO, H217O, H218O, D216O, T2O, etc.); ions of water, especially H3O+ and OH-. - Literature closing date: 1949. 1964. 60 figs. XXVIII, 364 pages (in German). Cloth ISBN 3-540-93189-9

#### Section 7: Hydrogen Peroxide. Deuterium Peroxides

#### Section 8: The Radicals OH and HO2. Hydrogen Ozonide
HO2. Higher Hydrogen Peroxides. Formula Index and German-English Heading Index for Sections l to 8
Covers besides the title compounds the higher peroxides H2O3 and H2O4. Contains a German and an English subject index, with about 10,000 entries in each, and a formula index for Volumes 1 to 8. - Literature closing date: 1965. 1969. 12 figs. XIII, 421 pages (in German). Cloth ISBN 3-540-93191-0

### Oxygen, Appended Volumes

#### Water Desalting
Describes procedures for obtaining fresh water from sea water and from brackish waters. Over 14,000 publications which appeared from 1965 to mid-1974 were evaluated for this purpose, and 3000 of them are cited in this volume. - Literature closing date: end of 1973. 1974. 62 figs. XX, 339 pages. Cloth ISBN 3-540-93280-1

#### Supplement Volume I
Brings the 1974 treatment up-to-date. Conspicuous in the literature are the efforts to improve the energy efficiency of water desalting in view of the sharply increasing cost of oil. - Literature closing date: end of 1977. 1979. 11 figs. XIV, 360 pages. Cloth ISBN 3-540-93398-0
Osmium Alloys are also described under "Pt" Platinum Part A, Section 6

Supplement Volume

Section 1: The Metal. Alloys. Compounds

Presents the physical properties, the electrochemical behavior, and the chemical reactions of the metal. Alloys and the compounds of osmium with emphasis on the non-organometallic coordination chemistry. - Literature closing date: end of 1978. 1980. 140 figs. XXII, 347 pages. ISBN 3-540-93420-0

Part A: Mononuclear Compounds

Section 1: Mononuclear Compounds

Describes a) \(1L\) compounds with alkyl, aryl, acyl, or alkynyl ligands except CO, b) Os(CO)\(n\) compounds which contain additional heteroatom-bonded ligands, such as H, halogens, O, S, N, or P donors, or boranes, or c) Os(CO)\(n\) compounds with additional alkyl, alkenyl, alkynyl, aryl, or acyl ligands. Contains an empirical formula and a ligand formula index. - Literature closing date: end of 1990. 1992. 37 figs. XI, 283 pages. Cloth

ISBN 3-540-93647-5

Section 2: Mononuclear Compounds

Continues the description of mononuclear (\(1L\)) Os compounds with those where \(1L = CO\) and \(n=2,3,4,5,6\). Describes all known compounds which contain CS, CSe, CTe, and one to six CNR ligands for \(1L\). Compounds with carbene and carbyne \(1L\) ligands are included. Contains an empirical formula index and a ligand formula index. - Literature closing date: end of 1992. 1993. 49 figs. XI, 410 pages. Cloth

ISBN 3-540-93679-3

Part B: Binuclear and Polynuclear Compounds

Section 3: Trinuclear Compounds (continued) Covers Os\(3\) carbonyl compounds: binary carbonyls except Os\((CO)\)\(n\), hydridocarbonyls, carbonyls with additional halogen, CN, O-, S-, Se-, or Te-bonded ligands, and with terminally N-bonded ligands. Contains an empirical formula index, a ligand formula index, and a transition metal cross reference. - Literature closing date: mid 1993. 1994. 57 figs. XI, 282 pages. Cloth

ISBN 3-540-93697-1

Section 4a: Trinuclear Compounds (continued)

Continues the description of triosmium carbonyl compounds with N-bonded ligands by treatment of the species where ligands bridge two or three osmium atoms. Includes all known trinuclear carbonyl compounds with P-bonded ligands. Empirical formula index, ligand formula index, and transition metal cross reference. - Literature closing date: mid 1994. 1995. 59 figs. XI, 178 pages. Cloth

ISBN 3-540-93723-4

Section 5: Trinuclear Compounds (continued)

Covers Os\(3(1L)CO\)\(n\) compounds with terminal \(1L = alkyl, CS, isocyanide, carbene\). Other \(1L\) ligands are coordinated to Os\(3\) by one nonbridging Os-C bond and additional E \(\rightarrow\) O donor bonds (E = O, S, N, P). Contains an empirical formula index, a ligand formula index, and a transition metal cross reference for volumes B5 and B6. - Literature closing date: end of 1993. 1994. 121 figs. XI, 389 pages. Cloth

ISBN 3-450-93698-X

Section 6: Trinuclear Compounds

Treats triosmium carbonyl compounds which contain additional ligands bonded to Os by a \(\mu_2\) - or \(\mu_3\) -bridging carbon atom. Contains also heterometallic Os\(3\) carbonyl compounds which have additional, mostly bridging \(1L\) ligands. - Literature closing date: end of 1992. 1993. 95 figs. XI, 248 pages. Cloth

ISBN 3-540-93671-8

Section 8: Tetranuclear Compounds

Describes all known tetrasodium compounds which are classified according to the number of Os-Os bonds. Most of the compounds have a tetrahedral Os\(4\) core or a butterfly Os\(4\) arrangement with six or five Os-Os bonds, respectively. Empirical formula index, ligand formula index, and transition metal cross reference. - Literature closing date: mid 1994. 1995. 107 figs. XII, 197 pages. Cloth

ISBN 3-540-93725-0

Section 9: Polynuclear Compounds

Covers organoosmium compounds which contain 5 up to 40 Os atoms. The classes of penta-, hexa-, and decaosmium carbonyl compounds comprise the most numerous and prominent examples. Contains an empirical formula index, a ligand formula index and a transition metal cross reference. - Literature closing date: mid 1994. 1995. 219 figs. XI, 379 pages. Cloth

ISBN 3-540-93715-3

Phosphorus - P

Main Volume

Part A: History. Occurrence

Covers historical development and early application of phosphorus, its occurrence, geochemistry, and minerals. - Literature closing date: end of 1960. 1965. 6 figs. (1 color photograph), XVIII, 510 pages (in German). Cloth

ISBN 3-540-93153-8

Part B: Technology. Toxicity. The Element


ISBN 3-540-93154-6

Part C: The Compounds of Phosphorus Contains compounds of phosphorus with H, B, C, Si, N, chalcogens, halogens, and noble gases.

The Blaser-Worms nomenclature is employed for the phosphorus acids of lower oxidation state. Special chapters are devoted to linear and cyclic phosphorus halide nitrides and derivatives. - Literature closing date: end of 1960. 1965. 158 figs. LLII, 642 pages (in German). Cloth

ISBN 3-540-93155-4

Formula and Heading Index

Includes all of the defined compounds described in Parts A, B, or C. 1967. IV, 210 pages (bilingual: English, German). Cloth

ISBN 3-540-93156-2


**Supplement Volume**

**Part C: The Compounds**

**Section 2: Mononuclear Compounds with Hydrogen**
Covers the mononuclear, binary phosphorus-hydrogen compounds PH, PH₂, PH₃, PH₄, and PH₅ as well as the appropriate ions. There is extensive information on the chemical and physical properties of PH₅. - Literature closing date: May 1992. 1993. 13 figs. XVI, 326 pages. Cloth ISBN 3-540-93680-7

**Section 2: Dinuclear Compounds with Hydrogen, Polyphosphines including Organyl-Substituted Derivatives**
Covers the binary diphosphorus-hydrogen species and acyclic, monocyclic, and polycyclic polyphosphorus compounds with 3 or more phosphorus atoms. Because the information on the parent polyphosphorus-hydrogen compounds is scarce, selected data on the phosphorus skeletons of their organyl-substituted derivatives is included. Contains an empirical formula index. - Literature closing date: end of 1993 1995. XX, 349 pages. Cloth ISBN 3-540-93714-5

**Section 5a: Cyclic Phosphorus-Nitrogen Compounds. Three-, Four-, and Five-Membered Ring Systems**
Comprises monocyclic three-membered, i.e., P₃N, P₄N₂, four-membered, i.e., P₅N, P₆N₃, P₇N₄, and five-membered, i.e., P₈N₉, P₁₀N₁₀, compounds. Emphasis is on the chemistry and physical data characteristic for the different ring skeletons. Empirical formula index. - Literature closing date: end of 1993. 1995. XIV, 238 pages. Cloth ISBN 3-540-93736-6

**Protactinium - Pa**

**Main Volume**
Deals with the history and occurrence of protactinium, formation by radioactive decay, and the making of protactinium preparations. This is followed by a description of the element and its compounds, as well as by coverage of the protactinium isotopes, uranium X₂, and uranium Z, together with their compounds. - Literature closing date: end of 1939. 1942, reprint 1969. 4 figs. XII, 99 pages (in German). Cloth ISBN 3-540-93172-4

**Supplement Volume**

**Section 1: The Element**

**Section 2: The Metal. Alloys. Compounds. Solution Chemistry**
Pa metal and alloys, compounds, chemistry of protactinium in aqueous solution, liquid-liquid distribution, ion exchange, and coprecipitation, chromatography, electrochemical methods, etc. - Literature closing date: end of 1975. 1977. 222 figs. XXII, 337 pages (130 pages in German). Cloth ISBN 3-540-93355-7

**Lead - Pb**

**Main Volume**

**Part A: History. Occurrence**

**Section 1: History**
Starts with names and symbols, followed by the history of elemental lead in various cultures. Covers the recovery and treatment of lead ores, as well as recovery of lead, ore smelting, and refining. Later chapters are devoted to the compounds and alloys of lead. - Literature closing date: 1970. 1973. 31 figs. X, 218 pages (in German). ISBN 3-540-93023-X

**Section 2a: Cosmochemistry. Geochemical Cycle. Crystallochemical Fundamentals. Isotope Geochemistry, Geochemical Character and Abundance**
Lead abundance and isotope composition of meteorites. Coordination of lead in various minerals and lead content of 297 minerals. Isotope ratios are frequently used to clarify the origins of galena and the other minerals. - Literature closing date: end of 1975. 1976. 7 figs. XIV, 280 pages (in German). ISBN 3-540-93324-7

**Section 2b: Magmatic Cycle**
Includes the entire magmatic cycle with chapters on the orthomagmatic phase, pegmatites and pneumatolites, the hydrothermal phase, and recent volcanism. There are numerous tables for the lead contents and the lead isotope ratios. - Literature closing date: end of 1976. 1977. 6 figs. XVI, 276 pages (in German). Cloth ISBN 3-540-93024-8

**Section 2c: Sedimentary Cycle. Metamorphic Cycle. Hydrosphere. Atmosphere**
Covers the weathering of lead minerals, the ratios of the lead isotopes in sediments together with the significance of these ratios in understanding the origins. Extensive material on environmental pollution due to lead. - Literature closing date: 1974. 1975. 4 figs. XII, 185 pages (in German). Cloth ISBN 3-540-93298-4

**Section 3: Minerals. European Deposits**
Alphabetic listing of the lead minerals. Production statistics and a description of the European deposits (excluding the Soviet Union) are then given for most of these minerals. - Literature closing date: end of 1970. 1972. 1 color illustration, XIX, 189 pages (in German). Cloth ISBN 3-540-93025-6

**Section 4: Non-European Deposits**
Completes the description of the lead deposits. Separate chapters deal with Africa, with the Soviet Union, with Asia, with Australia and Oceania, with Greenland and North America, with Mexico and Central America, and with South America. - Literature closing date: end of 1970. 1972. XII, 180 pages (in German). Cloth ISBN 3-540-93026-4

**Part B: The Element**

**Section 1: The Element (Excluding Electrochemical Behavior)**
Deals with elemental lead, except for preparation (which is covered in "Lead" Part C, Section 1) and electrochemistry (which is covered in the following volume). - Literature closing date: end of 1969. 1972. 87 figs. XXVI, 497 pages (in German). Cloth ISBN 3-540-93027-2
Section 2: The Element (Electrochemical Behavior)
Topics of electrochemical corrosion and the lead storage battery are restricted to listings of the general and specialized literature, whereas the subject matter in the remaining chapters is covered in the usual depth. Single electrode reactions at the Pb electrode, especially with H₂SO₄ as an electrolyte, are described in detail. - Literature closing date: end of 1968. 1972. 173 figs. XXI, 416 pages (in German). Cloth ISBN 3-540-93028-0

Part C: The Compounds
Section 1: Metallurgy of Lead. Compounds up to Lead and Chlorine
Deals with industrial preparation of lead: roasting reduction reactions and processes; wet metallurgical and electrolysitic processes; recovery from wastes, fly ash, and scrap; and purification of lead. Covers also the compounds with the noble gases, hydrogen, oxygen, nitrogen, fluorine, and chlorine. - Literature closing date: end of 1964. 1969. 69 figs. XXVI, 346 pages (in German). Cloth ISBN 3-540-93029-9

Section 2: Compounds from Lead and Bromine to Lead and Carbon
Major sections are devoted to lead sulfides and lead sulfates. Includes also lead salts of selected organic acids. - Literature closing date: end of 1964. 1969. 115 figs. XXXI, 460 pages (in German). Cloth ISBN 3-540-93030-2

Section 3: Compounds from Lead and Silicon to Lead and Radium

Section 4: Compounds and Alloys with Zn, Cd, Hg, Al, Ga, In, Ti, the Rare Earth Elements, Ti, Zr, Hf, Th, Ge, and Sn. Coordination Compounds with Neutral and Inner-complex-forming Ligands. Ligand Index. German-English Subject Index for Part C
Concludes the coverage of lead compounds, with major emphasis on systems and so-called double compounds. The final chapter contains a particularly large number of compounds with sulfur-containing ligands. Contains a formula index of organic ligands and an alphabetic subject index for Part C, Sections 1 through 4. - Literature closing date: 1969. 1971. 235 figs. XXXVII, 639 pages (in German). Cloth ISBN 3-540-93032-9

Organolead Compounds
Part 1: Tetramethylene
This volume is devoted exclusively to tetramethylene. Owing to the recent large-scale use as an antiknock agent, its application, toxicological, biological, and environmental aspects are given much attention, in addition to its chemical and physical properties. - Literature coverage up to 1986. 1987. 4figs. XII, 194 pages. Cloth ISBN 3-540-93560-6

Part 2: Tetraethyllead
Description of tetraethyllead, that as well as the methyl compound was used for many years as an antiknock additive in vehicle fuel. Gradually these were replaced by other additives. About 700 literature references cover the various processes used to prepare the compound. Analysis and toxicology are also well documented. - Literature closing date: 1988. 1990. 5figs. XI, 273 pages. Cloth ISBN 3-540-93606-8

Part 3: Tetraalkyldiene, Tetraaryldiene Compounds
Describes Pb₄R₄ compounds with four identical ligands except R = CH₃, C₂H₅. Symmetrical spiro compounds are included. Properties of tetratetramethyl-, tetrabutyl-, and tetraphenylethle are known in more detail. Contains an empirical formula index. - Literature closing date: 1991. 1992. 5 figs. XIII, 246 pages. Cloth ISBN 3-540-93588-0

Part 4: R₃PbR' Compounds
Describes the numerous compounds of the type R₃PbR' which make up the larger portion of known unsymmetrical tetraorganolead compounds. Compounds were prepared and several of them studied in great detail in view of their antiknock properties as well as for their use in organic synthesis. - Literature closing date: 1994. 1995. 9 figs. XIV, 409 pages. Cloth ISBN 3-540-93727-7

Part 5: R₃PbR', R₃PbR'R'', R₃PbR'R''R''', and R₄-nPbHₙ (n = 1 to 3) Compounds
Covers in the first part unsymmetrical tetraorganolead compounds with two, three, and four different organo groups. The second part deals with the organolead hydrides of the types R₄-nPbHₙ with n = 1, 2, 3. Empirical formula index. - Literature closing date: 1995. 1996. 5 figs. XIII, 191 pages. Cloth ISBN 3-540-93748-X

Main Volume
Section 1: The Element
Covers the element, and includes physical properties, electrochemical behavior, and chemical reactions. - Literature closing date: end of 1939. 1941, reprint 1968. 19 figs. XII, 114 pages (in German). Cloth ISBN 3-540-93151-1

Palladium Alloys, see under "Pt" Platinum Part A, Section 5

Section 2: Compounds of Palladium
In the Pd-H₂ system, special attention is given to diffusion and sorption. The final chapter describes the palladium complexes with amines and with amine-like compounds. - Literature closing date: end of 1939. 1942, reprint 1968. 51 figs. XXXV, 321 pages (in German). Cloth ISBN 3-540-93152-X

Supplement Volume
Part B: Compounds
Section 2: Palladium Compounds
This volume deals with the compounds of palladium with oxygen, nitrogen, halogens, S, Se, Te, B, C, Si, P, As, and Sb. Binary compounds are described first, and afterwards the derived compounds of higher order (e.g., o xo- or chloropolalades) as well as some complex compounds with neutral or other ligands. - Literature closing date: 1986. 1989. 87 figs. XVI, 354 pages. Cloth ISBN 3-540-93586-X
Platinum - Pt

Main Volume


Section 1: History. Occurrence

Starts with history of platinum and contains a section dealing with discovery of the other platinum metals. In this and the following volume, all of the platinum metals are handled together in the chapters dealing with occurrence. - Literature closing date: end of 1937. 1938, reprint 1963. 2 figs. VII, 144 pages (in German). Cloth ISBN 3-540-93157-0

Section 2: Occurrence (Continued)

Occurrence in North and South America, in Africa, and in Australia. The minerals are also covered. - Literature closing date: beginning of 1939. 1939, reprint 1963. 1 fig. IX, 166 pages (in German). Cloth ISBN 3-540-93158-9

Section 3: Preparation of the Platinum Metals

Covers preparation of the six platinum metals: recovery of Pt metals from minerals, recovery of Pt metals from wastes and residues, manufacture of pure Pt metals. Other chapters deal with uses of the Pt metals and special forms such as Pt black, Pd black, Pt sponge, and the colloidal Pt metals. - Literature closing date: June 1939. 1939, reprint 1963. IX, 120 pages (in German). Cloth ISBN 3-540-93159-7

Section 4: Detection and Determination of the Platinum Metals

Chapters on detection and determination both have separate sections on each of the six Pt metals. The latter chapter also covers the separation of the Pt metals from one another and from other elements. - Literature closing date: end of 1939. 1940, reprint 1971. XIII, 102 pages (in German). Cloth ISBN 3-540-93160-0

Supplement Volume

Part C: The Compounds of Platinum

Section 1: Compounds up to Platinum and Bismuth

Includes compounds with the noble gases, H, O, N, halogens, S, Se, Te, B, C, Si, P, As, Sb, and Bi. - Literature closing date: mid-1939. 1939, reprint 1962. 13 figs. XII, 140 pages (in German). Cloth ISBN 3-540-93167-8

Section 2: Compounds up to Platinum and Caesium

Continues the compounds, and covers platinum and the alkali metals, including ammonium and organic ammonium compounds. This volume is mostly devoted to a description of the alkali-metal Pt double salts. - Literature closing date: July 1939. 1940, reprint 1962. 3 figs. XVII, 120 pages (in German). Cloth ISBN 3-540-93168-6

Polonium - Po

Main Volume

Describes the physical properties of the element, the isotopes, and radioactive behavior. Covers the compounds with H, N, chalcogens, halogens, the most important carbon compounds (carbonyl, polonium alkyls, and polonium complex compounds), and compounds with sodium, potassium, and ammonium. - Literature closing date: end of 1939. 1941, reprint 1969. 8 figs. XVI, 187 pages (in German). Cloth ISBN 3-540-93171-6

Supplement Volume

Section 1: Element. Metal. Compounds. Chemistry in Solution

Contains chapters on the history and natural occurrence of polonium, on the nuclear and decay properties of the isotopes (from 209Po to 219Po), on production, isolation, and purification of the most important isotope 210Po and of 218Po, 219Po, and the short-lived isotopes. Additional chapters deal with analytical chemistry and applications of Po, radiological problems in handling Po, metabolism and toxicology, as well as the metal Po, the compounds, and the solution chemistry. - Literature closing date: 1989. 1990. 125 figs. XXV, 425 pages. Cloth ISBN 3-540-93161-9

Section 2: Chemical Reactions (Continued) and Electrical Reactions

Continues the electrochemical behavior, with sections dealing with standard potential, position in the electromotive series, cells, electrolytic deposition of Pt, behavior as a cathode and as an anode, and reactions at the Pt electrode during polarization. The chapter on chemical reactions concludes Part B. - Literature closing date: end of 1939. 1942, reprint 1971. 11 figs. XII, 76 pages (in German). Cloth ISBN 3-540-93166-X

Section 3: Electrochemical Behavior of the Metal (Overvoltage Phenomena)


Section 4: Electrochemical Behavior (Continued) and Chemical Reactions

Continues the electrochemical behavior, with sections dealing with standard potential, position in the electromotive series, cells, electrolytic deposition of Pt, behavior as a cathode and as an anode, and reactions at the Pt electrode during polarization. The chapter on chemical reactions concludes Part B. - Literature closing date: end of 1939. 1942, reprint 1971. 11 figs. XII, 76 pages (in German). Cloth ISBN 3-540-93166-X

Section 5: Alloys of the Platinum Metals: Ruthenium, Rhodium, Palladium


Section 6: Alloys of the Platinum Metals: Osmium, Iridium, and Platinum

Alloys of osmium from Os and B to Os and Pd. Alloys of iridium from Ir and B to Ir and Os. Alloys of platinum from Pt and S to Pt and Ir. An alphabetic index of alloys for Part A, Sections 5 and 6, is included at the end of the volume. - Literature closing date: 1949. 1951. 74 figs. XXVIII, 136 pages (in German). Cloth ISBN 3-540-93162-7

Part B: The Element

Section 1: Physical Properties of the Metal, up to Thermal Properties

Includes the properties of the atomic nucleus and of the atom, and the crystallographic, mechanical, and thermal properties of the metal. - Literature closing date: August 1938. 1939, reprint 1963. 7 figs. VII, 72 pages (in German). Cloth ISBN 3-540-93163-5

Section 2: Physical Properties of the Metal (up to Electrical Properties)

Continues the description of the physical properties of platinum, and includes thermal, optical, magnetic, and electrical properties. - Literature closing date: April 1939. 1939, reprint 1963. 4 figs. VIII, 108 pages (in German). Cloth ISBN 3-540-93164-3

Section 3: Electrochemical Behavior of the Metal (Overvoltage Phenomena)

Section 1: Compounds up to Platinum and Iridium
Concludes the platinum compounds. From compounds with Be, with the alkaline earth metals, etc., through to "Platinum and Iridium". - Literature closing date: October 1939. 1940, reprint 1962. 1 fig. XXV, 92 pages (in German). Cloth ISBN 3-540-93169-4

Part D: Complex Compounds of Platinum with Neutral Ligands
The introduction deals with the "trans" effect, which has been especially investigated in the Pt complexes. The major subsections deal with platinum(II) and platinum(IV) compounds: complex compounds of platinum with neutral ligands, arranged by type of compound, and inner-complex compounds. The organoplatinum compounds are covered in an appendix. There is a ligand index. - Literature closing date: end of 1953. 1957, reprint 1979. 25 figs. LVIII, 638 pages (in German). Cloth ISBN 3-540-93268-2

Supplement Volume
Part A
Section 1: Technology of Platinum Metals
This volume on the technology of platinum metals and their compounds contains, inter alia, chapters on catalytic applications of Pt metals and on the use of cytostatic platinum compounds in medicine. - Literature closing date: 1983. 1986. 37 figs. XVI, 340 pages. Cloth ISBN 3-540-93583-5

Section 2: Isotopes, Atoms, Molecules, and Clusters of Platinum Metal Elements
Describes the isotopes, atoms, molecules, and clusters of the six platinum metal elements Ru, Rh, Pd, Os, Ir, and Pt: preparation, separation, and properties of the isotopes. Properties of the atoms and the atomic ions: atomic levels, optical spectra, X-ray and Auger spectra, ionization energies, and electron affinities. Also covered are the formation and properties of platinum metal molecules and clusters. - Literature closing date: 1986. 1989. 34 figs. XIII, 353 pages. Cloth ISBN 3-540-93585-0

Main Volume

Supplement Volume
Section 1: History, Cosmochemistry, Geochemistry
Opens with a brief review of the history of radium since 1928 and the cosmochemistry of the element. The bulk of the volume deals with the geochemistry of radium. - Literature closing date: end of 1975. 1977. 1 fig. XIV, 131 pages (in German). Cloth ISBN 3-540-93333-6

Section 2: Element Compounds
Presents the chemistry of radium with chapters on isolation and preparation of the natural 226Ra, preparation of other natural and artificial radium isotopes, nuclear properties, metallic radium, all radium compounds known in 1976, emanating radium sources, the behavior of aqueous Ra, and the procedures for safely handling radium. - Literature closing date: end of 1975. 1977. 79 figs. XIV, 305 pages. Cloth ISBN 3-540-93335-2

Radium - Ra

Rubidium - Rb
Main Volume
Covers the element and its compounds with H, alkali metals up to K (including NH4), B, C, Si, nitrogen-group elements, chalcogens, halogens, and noble gases. Recovery of rubidium and caesium compounds is the subject of a special chapter. - Literature closing date: August 1937. 1937, reprint 1973. 7 figs. XXVI, 250 pages (in German). Cloth ISBN 3-540-93179-1

Rhenium - Re
Part 1: Mononuclear Compounds 1
Contains mononuclear compounds with the organic ligand bonded to the Re through one C (1L ligands). The Re may be attached to as many as four CO groups. Contains an empirical formula index and a ligand formula index. - Literature closing date: 1987. 1989. 89 figs. XIV, 612 pages. Cloth ISBN 3-540-93580-0

Organorhenium Compounds
Part 2: Mononuclear Compounds 2
Continues the description of mononuclear rhenium carbonyl compounds with those having five or six CO ligands, contains compounds formed with isonitriles and concludes with 1L to 4L compounds. Contains an empirical formula index and a ligand formula index. - Literature closing date: 1987. 1989. 59 figs. XIV, 474 pages. Cloth ISBN 3-540-93587-8

Part 3: Mononuclear Compounds 3
Describes all 1L.Re(CO)n compounds with n = 0, 1 and those 1L.Re(CO)3 compounds which do not contain additional "L" ligands. Compounds may contain H, halogen, NO, metal-containing groups, and D ligands. Contains an empirical formula index and a ligand formula index. - Literature closing date: 1987. 1992. 32 figs. XII, 259 pages. Cloth ISBN 3-540-93659-9
Part 4: Mononuclear Compounds 4
Concludes the series on mononuclear organorhenium com-
 pounds by coverage of compounds of the types 5LRe(CO)21L,
 5LRe(CO)3, 5LRe(CNR)(CO) with 5L = C5H5, C5H5RenL with n =
 2 to 4, (C5H5 )2Re, 5LRe where 5L is a mono- up to penta-
 substituted cyclopentadienyl or a six-membered or larger ring,
 and 1LRe. Empirical formula index, ligand formula index,
 transition metal cross reference. - Literature closing date: end
 of 1987. 1996. 45 figs. XII, 296 pages. Cloth
 ISBN 3-540-93734-X

Part 5: Binuclear Compounds
Covers binuclear 1LRe2 compounds, 1L = alkyl, aryl, and
 (CO)nRe2 type compounds, n = 1 to 10 (except (CO)10Re2 itself),
 which may contain additional X, nD, and bridging ligands.
Contains an empirical formula index, a ligand formula index,
 and a transition metal cross reference. - Literature closing date:
 ISBN 3-540-93695-5

Part 7: Binuclear Compounds 3
Covers all binuclear organorhenium compounds with organic
 ligands bonded by two up to twelve carbon atoms to rhenium.
Empirical formula index, ligand formula index, transition metal
 131 figs. XIII, 391 pages. Cloth
 ISBN 3-540-93740-4

Rhodium - Rh

Main Volume
The element, including its physical properties, electrochemical
 behavior, and chemical reactions. The compounds, up to those
 of rhodium and gold. A special chapter, "Complex Ammines of
 Rhodium", describes the complexes with neutral ligands. In
 this chapter, the material is arranged by type of complex, e.g.,
 1938, reprint 1971. 1 fig. XX, 124 pages (in German).
 Cloth
 ISBN 3-540-93180-5

Rhodium Alloys, see under "Pt" Platinum Part A, Section 5

Supplement Volume
Part A: The Element
Rhodium Atoms, see under "Pt" Platinum Supplement Volume
 Part A, Section 2

Section 1: Metal, Alloys
Covers the physical properties of the metal such as
 crystallographic structure, mechanical, and thermal properties.
 pages. Cloth
 ISBN 3-540-93639-4

Section 2: Coordination Compounds
Covers complexes of rhodium with ligands containing O and N. -
 Literature closing date: 1982.
 1984. 24 figs. XX, 323 pages. Cloth
 ISBN 3-540-93496-0

Section 3: Coordination Compounds
Covers the coordination compounds of rhodium with ligands
 which contain S, Se, Te, P, As, and Sb as well as metals. -
 Cloth
 ISBN 3-540-93507-X

Ruthenium - Ru

Main Volume
Physical properties of the metal, its electrochemistry, and
 chemical reactions. Compounds up to those of ruthenium and
 silver. Complexes with neutral ligands are covered under the
 compound from which they are derived; e.g., [Ru(NH3 )4 Br2 ]Br
 is discussed immediately following the simple bromide. -
 Literature closing date: end of 1937.
 1938, reprint 1968. 1 fig. XX, 124 pages (in German).
 Cloth
 ISBN 3-540-93182-1

Ruthenium Alloys, see under "Pt" Platinum Part A, Section 5

Supplement Volume
Updates coverage of ruthenium and its alloys and compounds.
 Special subsections deal with nitrosyl compounds, complexes
 with neutral and inner-complex-forming ligands, carbonyl
 compounds, and organometallic compounds. Includes an
 alphabetical subject index and a ligand formula index. - Literature
 closing date: end of 1968. 1970. 86 figs. XXVI, 586 pages (in
 German).
 Cloth
 ISBN3-540-93183-X

Sulfur - S

Main Volume
Part A: History, Occurrence, The Element

Section 1: History
The history of sulfur is covered from antiquity, through the
 period of the alchemists, and into modern times. -
 Literature closing date: end of 1939.
 1942, reprint 1969. 11 figs. VII, 60 pages (in German).
 Cloth
 ISBN 3-540-93392-9

GMELIN Complete Catalog 1997/98 41
Section 2: Occurrence. Technology of Sulfur and Its Compounds. Colloidal Sulfur. Toxicity
Most of this volume deals with the technology of sulfur and its compounds, especially H₂S, SO₂, SO₃, and H₂SO₄. Other chapters cover colloidal sulfur and the toxicity of sulfur, hydrogen sulfide, sulfur dioxide, sulfurous acid, etc. - Literature closing date: end of 1949. 1953, reprint 1969. 76 fgs. XXIV, 450 pages (in German). Cloth ISBN 3-540-93193-7

Section 3: The Element. Preparation in Pure Form. Properties

Part B: The Compounds

Section 1: Hydrides and Oxides of Sulfur

Section 2: Sulfur-Oxygen Acids
Particular emphasis is on sulfuric acid. Sulfurous acid and its ions, thiosulfuric acid and its ions, the lower sulfur-oxygen acids, polythionic acids, peroxosulfuric acid, etc., are also reviewed. - Literature closing date: end of 1949. 1960. 146 fgs. XLIV, 758 pages (in German). Cloth ISBN 3-540-93195-3

Section 3: Compounds (Continued)
Reviews the solubility of SO₂ in water, and in aqueous solutions of acids and salts. Other chapters deal with oxidation of aqueous sulfur dioxide and sulfite solutions by oxygen or ozone. The remainder of the volume covers the compounds of sulfur with nitrogen and with the halogens. - Literature closing date: end of 1949. 1963. 245 fgs, and 9 fold-out charts, XLVI, 745 pages (in German). Cloth ISBN 3-540-93196-1

Supplement Volume

Section 1: Thionyl Halides
Describes SOF₂, SOC1₂, SOClF, SOBr₂, SOBrCl, and SOI₂. Thionyl chloride is an important additive and chlorinating agent. - Literature closing date: end of 1974. 1978. XVI, 72 pages (in German). Cloth ISBN 3-540-93369-7

Section 2: Sulfur Halides
There are several sulfur fluorides: SF₂, S₂F₂, S₂F₄, SF₆, and S₆F₁₆. The chlorides are SC1₂, S₂Cl₂, S₂Cl₄, and SC1₄. There are only a few bromides - SBr₂, S₂Br₂, and S₂Br₂ - and even fewer iodides - S-I, and, in solution, S-I₂. All mixed sulfur halides are also described. - Literature closing date: end of 1976. 1978. 16 fgs. XXIV, 310 pages (in German). Cloth ISBN 3-540-93381-6

Section 3: Sulfur Oxides
The major portion of this volume is devoted to the two principal oxides, SO₂ and SO₃. Lower oxides such as SO and S₂O₂ are also covered, as are the sulfur peroxides. Aqueous solutions of the sulfur oxides are not included. - Literature closing date: end of 1977. 1980. 31 fgs. XXIV, 344 pages (in German). Cloth ISBN 3-540-93408-1

Section 4a/b: Sulfanes

Sulfur-Nitrogen Compounds

Part 1: Compounds with Sulfur of Oxidation Number VI (New Suppl. Ser. Vol. 32)
Deals with sulfur-nitrogen compounds containing hexavalent sulfur. The first chapter describes cyclic compounds, such as sulfanuric chloride, S₅N₃Cl₂O. Six subsequent chapters cover the chain-forming S₅⁻N compounds. The three final chapters treat S-N compounds derived from hydrogen azide, hydrazine, or hydroxylamine. A formula index is included. - Literature closing date: end of 1975. 1977. 6 fgs. XII, 268 pages (in German). Cloth ISBN 3-540-93328-X

Part 2: Compounds with Sulfur of Oxidation Number IV
Describes sulfur(IV)-nitrogen rings and cages with four to eleven atoms in the ring systems; for example S₄N₄, S₅N₅, S₄N₄Cl, S₅N₅Cl. - Literature closing date: end of 1984. 1987. 43 figs. XVII, 325 pages. Cloth ISBN 3-540-93512-6

Part 3: Compounds with Sulfur of Oxidation Number IV (Continued)
Describes cyclic sulfur(IV)-nitrogen compounds containing O, Se, P, As, Si, Sn, and Pb atoms in the ring. In addition, four and five atom S-N-C and S-N-C-O rings are described. A great part deals with derivatives of 1,2,5-thiadiazole. - Literature closing date: end of 1984. 1987. 36 fgs. XVI, 272 pages. Cloth ISBN 3-540-93544-4

Part 4: Compounds with Sulfur of Oxidation Number IV (Continued)

Part 5: Compounds with Sulfur of Oxidation Number IV (Continued)
Describes the acyclic S⁵⁻N compounds. In particular the molecule SN, salts of SN⁺, metal complexes of SN, the superconducting solid (SN)X, the thiazylhalides XS², XS⁻ and XS²⁺. In addition, four and five atom S-N-C and S-N-C-O rings are described. - Literature closing date: 1988. 1990. 69 fgs. XVI, 268 pages. Cloth ISBN 3-540-93599-1

Part 6: Compounds with Sulfur of Oxidation Number IV (Continued)
Part 7: Compounds with Sulfur of Oxidation Number IV (Continued)
Continuing the treatment of acyclic SIV-N compounds, this volume describes the numerous sulfur diimides, RN=S=NR', with inorganic and organic substituents, and salts of [N=S=N]2-. In addition, the metal complexes with these ligands and ions which are derived from the sulfur diimides are described. - Literature closing date: 1989. 1991. 29 figs. XXII, 338 pages. Cloth
ISBN 3-540-93624-6

Part 8: Compounds with Sulfur of Oxidation Number IV (Continued)
Completes the treatment of acyclic SIV-N compounds and describes classes with 3- and 4-coordinate sulfur like X2S=NR and R2NS(O)X (X = halogen, OR', NR', etc.; R = organyl), as well as (R2N)3S+ salts, F3SNR2, and F3S(NR2)2. Formula index for Parts 5 to 8. - Literature closing date: end of 1989. 1991. 17 fgs. XXXI, 486 pages. Cloth
ISBN 3-540-93637-8

Part 9: Compounds with Sulfur of Oxidation Number II
Describes monocyclic and the few known bicyclic three-to thirteen-membered SII-N compounds. Cyclic SII-N-X compounds (X = Se, Te, P, Si, B, and above all C) as well as SII-N-X-Y compounds (X-Y = B-Se, B-Si, C-O, C-P, and C-B) are included. Contains an empirical formula index. - Literature closing date: 1990. 1993. 47 fgs. XXIV, 336 pages. Cloth
ISBN 3-540-93664-5

Part 10a: Compounds with Sulfur of Oxidation Number II
ISBN 3-540-93701-3

Part 10b: Compounds with Sulfur of Oxidation Number II
Continues the description of acyclic SII-N compounds with the class of sulfur diamide derivatives which has numerous examples. - Literature closing date: 1991. 1994. 11 fgs. XXV, 296 pages. Cloth
ISBN 3-540-93707-2

Part 11: Compounds with Sulfur of Oxidation Number II
Describes the numerous examples of the following classes of compounds: amino-disulfanes, R'S,NR'R'; diamino-disulfanes, R'R'NS,NR'R'; amino-polydisulfanes, R'S,NR'R'; and diamino-disulfanes, R'R'NS,NR'R', where n ≥ 3 and R's are arbitrary substituents including H. The volume concludes the series on sulfur-nitrogen compounds. Empirical formula index for volumes 10 a/b and 11. - Literature closing date: 1991. 1996. 14 fgs. XXXIII, 362 pages. Cloth
ISBN 3-540-93737-4

Section 2: Occurrence (Continued)
Completes the description of the antimony minerals. Major topics are sulfides and sulfates, antimonites and antimonates, tantalates and niobates, and silicates. - Literature closing date: end of 1939. 1943, reprint 1970. X, 76 pages (in German). Cloth
ISBN 3-540-93014-0

Section 3: Commercial and Laboratory Preparation
Enrichment and recovery methods; industrial preparation by dry and wet methods; laboratory preparation of the various forms of elemental antimony. - Literature closing date: mid-1949. 1950, reprint 1973. 6 fgs. VIII, 49 pages (in German). Cloth
ISBN 3-540-93015-9

Part B: Properties of the Element and Compounds

Section 1: Physical Properties of the Element (Including Electrical Conductivity)
Starts with the properties of the atomic nucleus, the atom, and the molecule; then covers crystallographic, mechanical, thermal, optical, and magnetic properties, and begins coverage of the electrical properties. - Literature closing date: January 1940. 1943, reprint 1970. 4 fgs. XI, 128 pages (in German). Cloth
ISBN 3-540-93016-7

Section 2: The Element (Continued). Compounds up to Antimony and Iodine
Completes coverage of the electrical properties of the element and updates the physical properties given in Section 1. Then describes the electrochemical behavior, chemical reactions, and detection and determination, and the compounds with H, O, N, halogens. - Literature closing date: mid-1948. 1949. 50 fgs. XVIII, 368 pages (in German). Cloth
ISBN 3-540-93017-5

Section 3: Antimony Compounds (Continued)
Antimony compounds with S, Se, Te, B, C, Si, P, and As. - Literature closing date: mid-1948. 1949. 4 fgs. XXXVII, 68 pages (in German). Cloth
ISBN 3-540-93018-3

Organooantimony Compounds

Part 1: Compounds of Trivalent Antimony with Three Sb-C Bonds
Contains the organooantimony compounds of trivalent antimony that have three Sb-C bonds. In a few cases the organic groups are cyclic; bonded at both ends to the antimony atom. Empirical formula index. - Literature closing date: end of 1978. 1981. X,217 pages. Cloth
ISBN 3-540-93431-6

Part 2: Compounds of Trivalent Antimony with Two and One Sb-C Bonds. Stibabenzenes. Stibacarboranes
Describes compounds of the type R2SbX and RSbX2, where R is an organic radical bonded to the antimony atom by carbon and where X is an inorganic atom or group, or an organic group bonded by an atom other than carbon. Also briefly describes the polynuclear compounds (two or more antimony atoms), stibabenzenes, and stibacarboranes. Formula index. - Literature closing date: end of 1978. 1981. 3 fgs. XI, 182 pages. Cloth
ISBN 3-540-93440-5

GMELIN Complete Catalog 1997/98   43
Part 3: Compounds of Pentavalent Antimony with Six, Five, and Four Sb-C Bonds
Presents Sb\(^5\) compounds of the types SbR\(_5\), SbR\(_4\)X, ions Sb(C\(_6\)H\(_5\))\(_3\), SbR\(_2\)X, and SbR\(_3\), anitmony ylides, and some birnuclear complexes. - Literature closing date: end of 1978. 1982. 12 figs. XI, 204 pages. Cloth ISBN 3-540-93462-6

Part 4: Compounds of Pentavalent Antimony with Three Sb-C Bonds
Compounds of the types R\(_3\)SbX\(_2\) and R\(_2\)Sb\(^\circ\)X. The X atoms in R\(_3\)SbX\(_2\) may be part of a ring system. In the case of bidentate X ligands like O\(^2-\), S\(^2-\), SO\(_4\)\(^-\), CO\(_3\)\(^-\), and others, the compounds are placed with the mononuclear R\(_3\)SbX\(_2\) compounds. - Literature closing date: end of 1983. 1986. 19 figs. XII, 250 pages. Cloth ISBN 3-540-93535-5

Part 5: Compounds of Pentavalent Antimony with Three, Two, and One Sb-C Bonds
Among the compounds with three Sb-C bonds, those of the types R\(_3\)SbXY, R\(_2\)R'SbX\(_2\), R\(_2\)R'SbXY, and RR'R'SbX\(_2\) together with the corresponding bi- and trinuclear compounds are treated. In addition, all of the compounds with one or two Sb-C bonds are covered. - Literature closing date: 1988. 1990. 43 figs. XIII, 406 pages. Cloth ISBN 3-540-93613-0

Section 4: Y, La, and the Lanthanides: Crystal Chemistry
The first part of the volume treats minerals that have a rare earth element in their formula. The second part treats minerals with variable rare earth content. - Literature closing date: end of 1977. 1979. 2 figs. XII, 242 pages (in German). Cloth ISBN 3-540-93386-7

Section 5: Y, La, and the Lanthanides: Geochemistry. Total Earth. Magmatic Cycle
Beginning with compilations of the content of Y, the rare earths, and their isotopes in the total earth and in the earth's crust and mantle. The largest chapter provides a geochemical treatment of Y and the rare earths during the magmatic cycle. Chapters cover the transport of these elements, their deposition in time and space as minerals, and the chemical and physical factors influencing their fractionation. - Literature closing date: 1979. 1981. 56 figs. XXIV, 475 pages (in German). Cloth ISBN 3-540-93439-1

The first main section (Sedimentary Cycle) describes the behavior of Y and the rare earth elements during weathering, as well as the distribution of these elements in sedimentary rocks. Subsequently, the mobilization, migration, and precipitation of these elements during the diagenetic conversion of sedimentary rocks are treated. The second main section deals mainly with the behavior of Y and the rare earth elements during the contact-metamorphic processes between magma and adjacent rocks, as well as the behavior of these elements in regional metamorphic processes and conversions. - Literature closing date: through 1983. 1988. 4 figs. XI, 424 pages. Cloth ISBN 3-540-93571-1

This volume describes origin, mode of occurrence, and behavior for Y and RE elements in the hydrosphere and atmosphere. The cosmochemical cycle and balance are outlined, and the processes governing the geochemical cycle are described. Data relevant for a geochemical balance are given. - Literature closing date: 1983. 1988. 2 figs. XI, 207 pages. Cloth ISBN 3-540-93548-7

Section 7: Y, La, and the Lanthanides: Minerals

Section 8: Y, La, and the Lanthanides: Minerals (Silicates). Deposits. Mineral Index
There are rare earth silicate minerals in nearly all structure classes in which silicate minerals can occur. The most important here are the rare earth nesosilicates, which can also contain B, Be, or C as additional constituents, as well as the soro-, triorthosilicates, and dinylosilicates. More rare are the cyclos-, iino-, and phyllosilicates. The description of the deposits contains a general section and one organized by regions. - Literature closing date: 1982. 1984. 11 figs. XV, 413 pages. Cloth ISBN 3-540-93505-3
Part B: The Elements

Section 1: History. Position in the Periodic System.
Separation from Raw Materials
Contains chapters dealing with history and with atomic weight and isotopic abundance, as well as a chapter (in English) on the comparison of atomic and ionic properties along the lanthanide series. Laboratory preparation and industrial recovery of scandium, yttrium, lanthanum, and the lanthanides are also covered, with sections on the beneficiation of raw materials and the separation of the elements as a group. - Literature closing date: end of 1974.
1976. 15 figs. XVI, 184 pages (142 pages in German).
Cloth ISBN 3-540-93313-1

Section 2: Separation of the Rare Earth Elements from One Another. Preparation of the Pure Metals. Uses. Toxicology
Separation of the rare earth elements from one another, mainly by ion exchange and by liquid-liquid extraction. Preparation, refining, and preparation of the metals. Uses of the metals and alloys. Toxicology. - Literature closing date: end of 1974. 1976. 6 figs. XX, 238 pages (in German). Cloth ISBN 3-540-93320-4

Section 3: Physical Properties of the Metals

Section 4: Nuclear, Atomic, and Molecular Properties
Describes the Sc, Y, La, and lanthanide atoms. Includes optical terms and spectra, ionization energies, and electron affinities. Also covers X-ray and Auger electron emission, X-ray and gamma ray absorption, and atomic and ionic radii. - Literature closing date: end of 1975. 1976. 60 figs. XXI, 427 pages (178 pages in German).
Cloth ISBN 3-540-93317-4

Section 5: Preparation, Enrichment, and Separation of Isotopes (Sc to Lu).
Detection and Determination of Isotopes. Chemical Reactions of the Elements
Treats nuclides of the rare earths through Sm and begins with separation of the stable isotopes. But most of the volume is devoted to the unstable isotopes: uses, separation of the nuclides from other elements and from each other, special preparative nuclear reactions, and enrichment and separation procedures for individual nuclides. Altogether there are 350 nuclides for the 17 elements. - Literature closing date: end of 1976. 1978. XVIII, 152 pages (in German). Cloth ISBN 3-540-93371-9

Section 6: Preparation, Enrichment, and Separation of Isotopes (Eu to Lu).
Detection and Determination of Isotopes. Chemical Reactions of the Elements
Continues the previous volume with nuclear reactions used to prepare unstable isotopes of the rare earth elements from Eu to Lu. Also covers the associated procedures for enriching and separating the individual nuclides. There are two chapters which cover all the rare earths: one on the analytical chemistry of the isotopes, and the other on the chemical behavior of the rare earth metals. - Literature closing date: end of 1976. 1978. 4 figs. XVI, 184 pages (in German). Cloth ISBN 3-540-93380-8

Section 7: Reactions of the Ions in Solution. Electrochemical Behavior
Opens with solvation and diffusion of rare earth ions in aqueous and nonaqueous solutions. Then there are sections on hydrolysis, precipitations, coprecipitations, and redox reactions. The chapter on electrochemical behavior has sections on scandium and yttrium and then treats lanthanum through lutetium in a single section. - Literature closing date: end of 1977. 1979. 23 figs. XXIV, 240 pages (in German). Cloth ISBN 3-540-93392-1

Part C: The Compounds

Section 1: Hydrides. Oxides
Systems and compounds with hydrogen; systems and compounds with oxygen. In view of the similarities among analogous rare earth compounds, both the hydride and the oxide chapters are introduced by "Comparative Data" sections which describe general properties and trends. - Literature closing date: end of 1972. 1974. 218 figs. XXVIII, 437 pages (in German). Cloth ISBN 3-540-93201-1

Section 2: Compounds with H and O, Alkali Metals and O, N, as well as the Related Alkali Double Salts
Compounds are first described which contain both H and O, such as the hydrido oxides and the hydroxides. Peroxides are then covered, followed by alkali oxometallates and hydroxyoxometallates. Binary and quasi-binary compounds (nitrates, imides, amides, azides, nitrites, and nitrates) are discussed in the chapter dealing with the nitrogen compounds. The related alkali double salts are covered at the end of the volume. - Literature closing date: 1973. 1974. 52 figs. XXI, 299 pages (in German). Cloth ISBN 3-540-93281-X

Section 3: Fluorides, Fluoride Oxides, and the Related Alkali Double Salts
Covers fluorine compounds of the rare earth elements, specifically: fluorides, fluoride oxides, fluoride hydrides, fluoride nitrates, and alkali metal double fluorides (the alkali fluorometallates). The solid trifluorides are presented in most detail since they are of such industrial and scientific importance. - Literature closing date: end of 1973. 1976. 98 figs. XXXIV, 439 pages (in German). Cloth ISBN 3-540-93321-2

Section 4a: Chlorides. Comparative Data
Comparative data for the chlorides and chloride systems. Rare earth chloride molecules, gas-phase and matrix-isolated ions, and melts. The fascinating properties of the lower oxidation state halides are covered, as are the anhydrous and hydrated trichlorides and the trichloride solutions. - Literature closing date: end of 1980. 1982. 51 figs. XIV, 272 pages. Cloth ISBN 3-540-93422-7

Section 4b: Data on Individual Chlorides
Data for the individual rare earth chlorides, giving information on preparation, physical properties, and chemical reactions. Phase diagrams and solutions are also discussed. - Literature closing date: mid-1981. 1982. 113 figs. XVIII, 324 pages. Cloth ISBN 3-540-93457-X
Section 5: Oxide Chlorides, Hydroxide Chlorides, Salts of Oxooxacids of Chlorine, and Alkali Chlorometalates
Discusses hydride chlorides, oxide chlorides, hydroxide chlorides, and oxide hydroxide chlorides of the elements Sc, Y, and La through Lu. Additional chapters contain chlorides, chlorates, perchlorates, chloride fluorides, and oxide chloride fluorides. A comprehensive closing chapter covers the alkali metal-rare earth metal double chlorides (alkali chlorometalates). For most classes of compounds, the general properties and trends are brought out first and then the specific compounds and systems are discussed. - Literature closing date: end of 1976. 1977. 78 figs. XXVI, 259 pages (in German). Cloth ISBN 3-540-93346-8

Section 6: Bromides, Iodides. Corresponding Basic Halides. Salts of Halogen Oxoacids and Alkali Double Salts
Presents the rare earth metal bromides, oxide bromides, hydroxide bromides, oxide hydroxide bromides, bromates, bromide fluorides, the alkali metal double bromides (alkali bromometalates), the rare earth metal iodides, basic iodides, iodates, periodates, and the alkali metal double iodides (alkali iodometalates). - Literature closing date: end of 1977. 1978. 68 figs. XXVII, 274 pages (in German). Cloth ISBN 3-540-93370-0

Section 7: Sulfides, Oxide Sulfides, Alkali Thiometalates
Covers the sulfides, oxide sulfides, and alkali metal thiometalates of the rare earth elements. Principal topics are SmS and its solid solutions. The mixed valence state of SmS, which is affected by pressure, alloying, and in the case of films by polishing, has been the topic of numerous publications. - Literature closing date: 1982. 1983. 345 figs. XXV, 607 pages. Cloth ISBN 3-540-93479-0

Section 8: Sulfide Halides, Sulfates, Salts of Other Sulfur Acids, and Corresponding Alkali Double Salts
Describes the rare earth metal sulfide halides, sulfites, sulfates, alkali metal double sulfates (alkali sulfometalates), ethylsulfates, basic sulfates, and salts of the less well known oxoacids and of the sulfuric acid derivatives. - Literature closing date: mid-1980. 1981. 49 figs. XL, 416 pages (362 pages in German). Cloth ISBN 3-540-93434-0

Section 9: Compounds with Se
Compounds of the rare earth elements with selenium: mainly selenides, also oxide selenides and selenates as well as the corresponding double salts with alkali metals. - Literature closing date: 1984. 1986. 233 figs. XXV, 528 pages. Cloth ISBN 3-540-93525-8

Section 10: Compounds with Te, Po
Deals with the rare earth tellurides, oxide tellurides, tellurates, telluride halides, tellurate halides, sulfide tellurides, selenide tellurides, and alkali rare earth tellurates. Another topic of this volume are the compounds of the rare earth elements with polonium. - Literature closing date: end of 1985. 1987. 149 figs. XX, 362 pages. Cloth ISBN 3-540-93547-9

Section 11a: Compounds with Boron

Section 11b: Compounds with Boron

Section 12a: Compounds with Carbon

Section 12b: Compounds with Carbon

Part D: Coordination Compounds

Section 1: Coordination Compounds
Begins the description of the rare earth element complexes with a survey of the pertinent properties of the elements and the general behavior of the complexes. Describes complexes with ligands containing pure nitrogen donors and ligands with both nitrogen and oxygen donors, including amino acids, amine N-polycarboxylic acids, and hydrazinecarboxylic acids. There is a ligand formula index. - Literature closing date: end of 1977. 1980. 16 figs. XV, 256 pages. Cloth ISBN 3-540-93407-3

Section 2: Coordination Compounds (Continued)
Continues treatment of complexes containing ligands with oxygen and nitrogen donor sites. Many of these complexes such as the 8-hydroxyquinolinate and the azo and oxime complexes are useful in the analysis and separation of rare earth elements. Major chapters are devoted to complexes with Schiff bases, N-oxides, amidoximes, and pyridazines. Empirical formula index. - Literature closing date: end of 1980. 1982. 20 figs. XIII, 352 pages. Cloth ISBN 3-540-93449-9

Section 3: Coordination Compounds (Continued)
Continues the description of the coordination compounds: the complexes with water, alcohols, phenols, aldehydes, ketones, quinones, ethers, and O-heterocycles. The alcoholates and phenolates are also included. The largest section covers the 1,3-diketonates, which have received attention as pseudocontact NMR shift reagents and as vehicles for separating the metals by gas chromatography. There is a ligand formula index. - Literature closing date: mid-1979. 1981. 42 figs. XIV, 324 pages. Cloth ISBN 3-540-93432-4

Section 4: Coordination Compounds (Continued)
Complexes with ligands containing S, Se, Si, P, As (e.g., sulfoxides, sulfonamides, tri- and tetrathioformic acids, mercapto compounds, thiocarboxylic acids, dithio-carbamic acids, thiourea and derivatives, thioformamides, thioformazones, and semicarbazones, thioacetates, S-heterocycles, dimethyl selenoxide, bis(trimethyl)-silylamides, phosphines, phosphate oxides, phosphinic and phosphonic acids and their esters, esters of phosphoric acid, amides of phosphinic and phosphoric acids, tri- and tetrathiomorphinphonic acids, thiophosphinic acids, esters of thiophosphoronic acids, arsines, arsine oxides, biologically important ligands). Formation and properties of MX3 complexes with inorganic anions in solution. - Literature closing date: 1984. 1986. 42 figs. XVIII, 377 pages. Cloth ISBN 3-540-93529-0
Section 5: Complexes and Salts of Carboxylic Acids, Hydroxycarboxylic Acids, and Esters of Carboxylic Acids

Contains the complex compounds of the rare earth elements with carboxylic acids, hydroxy- and oxoacarboxylic acids, sulfonic acids, and the esters of these acids. - Literature closing date: 1982.

Section 6: Ion Exchange and Solvent Extraction Reactions. Organometallic Compounds

Concludes this series and treats ion exchange and extraction, methods important in the separation and analytical chemistry of rare earth elements. The second part describes the organometallic compounds: first ligands bound by one carbon atom to the metal, then carbocyclic anions including substituted cyclopentadienides and heptamethylenide. The volume is completed with an empirical formula index for the organometallic compounds. - Literature closing date: 1981.

Part E: Optical Spectra

Section 1: Optical Spectra of Ce and Pr

Contains a phenomenological description of the spectra arising from 4f-electron transitions in Ce and Pr ions in solid rare earth compounds, host crystals, and glasses. Appropriate energy level diagrams are included. Especially Pr3+ spectra have attracted much experimental and theoretical interest. – Literature closing date: January 1991.

Selenium - Se

Main Volume

Part A: History. Occurrence. The Element

Section 1: History. Occurrence. The Element (Excluding Electrical Properties)

A section on colloidal selenium is included. In addition, the volume covers properties of the nucleus, crystallographic, mechanical, thermal, optical, and magnetic properties of the element, electrochemical behavior and chemical reactions, and a section dealing with detection and determination. - Literature closing date: end of 1979.

Section 2: Electrical Properties I (Including Photoresistive Selenium Cells)

The main emphasis is on the electrical conductivity of selenium and its changes under illumination. - Literature closing date: mid-1949.

Section 3: Electrical Properties II (The Selenium Rectifier. The Selenium Photocell)

The technology of selenium rectifiers and selenium photocells is reviewed exhaustively, together with the relevant physical data. - Literature closing date: end of 1952.

Part B: The Compounds

Hydrogen selenide, selenium oxides, the corresponding oxoacids, the nitride, and the halides. The Se-S system, selenium sulfides, and mixed compounds of selenium and sulfur with oxygen (includes the oxoacids), with nitrogen, and with halogens. - Literature closing date: end of 1947.

Supplement Volume

Part A: The Element

Section 1: Technology. Formation and Preparation of the Element. Preparation, Enrichment, and Separation of the Isotopes


Section 2: Atom. Molecule. Crystallographic Properties

The mass, spin, and decay of the selenium nuclides 34Se to 91Se, the spectra of the atom and atomic ions, and the properties of the molecules and molecular ions are presented. But the bulk of the volume is devoted to the crystallographic properties of the several allotropes and to the crystallization processes. Thin layers, an amorphous or glassy phase, and the melt are also described. - Literature closing date: end of 1978.

Section 3: Physical Properties. Electrochemical and Chemical Behavior

Of special interest are: the electrical conductivity of selenium under various conditions, the numerous oxidation processes involved in the polarography of selenium, and the dissolution of selenium in sulfite, sulfide, and cyanide solutions which plays a large role in wet processing of raw materials and in selenium purification methods. - Literature closing date: end of 1979.
1981. 60 figs. XX, 335 pages (in German). Cloth ISBN 3-540-93435-9

Part B: The Compounds

Section 1: Compounds with Hydrogen, Oxygen, and Nitrogen

Major topics: H2Se, including molecular properties, optical spectra, and chemical behavior; selenium oxides and oxoacids and anions of the oxoacids; SeN4 and the radical SeN. - Literature closing date: mid-1980. 1981. 41 figs. XVII, 343 pages. Cloth ISBN 3-540-93437-5

Section 2: Compounds with Halogens and Sulfur

Fluorine compounds include the binary compounds such as SeF4 or SeF3, and compounds with fluorine and oxygen. Less extensive chapters on the chlorine and bromine compounds and the even scarcer iodine compounds. The chapter on selenium sulfides covers the diatomic molecule, chains of various lengths, and rings of various sizes, as well as S and Se containing oxoacids. - Literature closing date: 1982. 1984. 54 figs. XXI, 369 pages. Cloth ISBN 3-540-93499-5
Section 1: History, Occurrence

The discovery of the element did not proceed nearly as simply as it is usually portrayed. There were uncounted investigations and numerous erroneous interpretations before Berzelius was able to interpret the results correctly. Only recently has it been possible to prepare the element in high purity, so that the important electronic applications are possible. The second part of the volume treats the history of several selected Si compounds (with H, O, N, F, Cl, Br, I, S, and C). - Literature closing date: 1983. 1984. X, 168 pages. Cloth ISBN 3-540-93508-8

Section 2: The Compounds

Part B: The Element and Its Inorganic Compounds


Part B: The Compounds

Section 1: Silicon and Noble Gases. Silicon and Hydrogen (Including SiH4 - Oxygen Compounds)

Opens with the system silicon-hydrogen; the SiH4 molecules and ions with n = 1 to 5 follow. The major parts of the volume deal with monosilane, SiH4, with linear and branched SiH2n-1, and with cyclic SiH2n species. A discussion of siloxanes containing Si-H bonds, e.g., H1SiO,SiH3 and siloxene, (Si1O1)H1, constitutes the third main section of the volume. - Literature closing date: 1980. 1982. 22 figs. XII, 259 pages. Cloth ISBN 3-540-93461-8


Contains the crystallographic, mechanical, thermal, electrical, magnetic, and optical properties of silicon carbide. Then come sections concerning the surface properties, SiC diodes, molecular species in the gas phase, and amorphous SiC films, which also can contain H, F, or O. - Literature closing date: mid-1983. 1984. 106 figs. XVI, 314 pages. Cloth ISBN 3-540-93504-5


This volume, devoted almost exclusively to silicon carbide, first presents the Si-C system, and then covers the terrestrial and extraterrestrial occurrence of SiC. The extensive chapter on the formation contains sections on the thermodynamics of formation, the preparation of special forms (single crystals, whiskers, etc.), manufacturing processes (such as sintering and hot-pressing), and chemical reactions of SiC and its uses. - Literature closing date: end of 1983. 1986. 87 figs. XVI, 546 pages. Cloth ISBN 3-540-93526-6


The current volume describes the compounds of silicon with nitrogen. Si3N4 will be treated in separate volumes. Following the binary Si-N compounds is a treatment of molecules and polymers of Si-N-H in which H may be bound to Si, or N, or both. About 60% of the compounds described in the present volume include nitrogen with substituents containing S, B, or C. - Literature closing date: end of 1987. 1989. 25 figs. XXII, 353 pages. Cloth ISBN 3-540-93582-7

Section 5: Silicon Nitride: Mechanical and Thermal Properties; Diffusion

The mechanical properties of silicon nitride-based products are of great practical interest in new technologies, and many efforts have been made to optimize these properties. The influence of the manufacturing and processing procedures on mechanical as well as thermal properties are outlined. Data on self-diffusion and heterodiffusion are given. - Literature closing date: December 1992. 1996. 70 figs. XVI, 414 pages. Cloth ISBN 3-540-93733-1

Section 5c: Silicon Nitride in Microelectronics and Solar Cells

Describes the application of silicon nitride to microelectronic device fabrication and use in standard and advanced microelectronics. Applications for solar cells are also described. - Literature closing date: January 1990. 1991. 52 figs. XV, 400 pages. Cloth ISBN 3-540-93630-0

Section 5d: Silicon Nitride: Electrochemical Behavior, Colloidal Chemistry and Chemical Reactions

Describes the electrochemical behavior and colloidal chemistry of Si3N4, its thermal decomposition, the effects of radiation on Si3N4, as well as the tribocchemical reactions. The mayor part covers the chemical reactions of Si3N4 with metals, metal nitrides, and metal oxides. - Literature closing date: December 1992. 1995. 32 figs. XIII, 255 pages. Cloth ISBN 3-540-93711-0

Section 5e: Non-Electronic Applications of Silicon Nitride. SiN1, SiN2, H2

Describes the first part the various applications and uses of Si3N4 in the broad area of engineering ceramics. The second and third parts describe the investigations on nonstoichiometric SiN1, and SiN2, H2, alloys. - Literature closing date: December 1992. 1994. 9 figs. XIV, 386 pages. Cloth ISBN 3-540-93716-1

Section 7: Binary Silicon-Fluorine Compounds

Describes all known binary silicon-fluorine compounds and ions such as SiF2, SiF6, SiF3, SiF4, SiF5, and SiF2-, and higher perfluorosilanes SiF2n, or SiF2n, SiF2n, Emphasis is on the well-known physical and chemical properties of SiF4 and with SiF2 with its interesting chemistry. - Literature closing date: January 1992. 1992. 14 figs. XIX, 348 pages. Cloth ISBN 3-540-93651-3
Section 1: Ternary Silicon-Fluorine-Hydrogen Compounds
Describes all known ternary silicon-fluorine-hydrogen compounds. SiH₃F, SiH₂F₂, SiHF₃, and hexafluorosilicic acid are the best known examples of the monosilicon compounds covered. A few disilicon and acyclic tri- and tetrasilicon compounds are also known. - Literature closing date: end of 1972.

Main Volume

Part C: Organic Silicon Compounds
Alkyl silanes, silicic acid esters, and silicones, among others, are treated in this volume. - Literature closing date: end of 1953. 1958, reprint 1970. 41 figs. XXX, 501 pages (in German). Cloth

ISBN 3-540-93212-7

Section 2: Compounds with Hydrogen, Oxygen, Nitrogen, and the Halogens
Inorganic systems and compounds of tin. Emphasis is given to the complex anions (e.g., [SnX₄]²⁻), including those with mixed anionic ligands. - Literature closing date: end of 1970. 1972. 44 figs. XXXI, 503 pages (in German). Cloth

ISBN 3-540-93057-4

Part B: The Element
Includes commercial preparation, preparation of special forms of tin, properties of the Sn atom, atomic ions, and molecules, crystallographic and physical properties of the element, chemical reactions, and electrochemical behavior. - Literature closing date: end of 1969. 1971. 32 figs. XIX, 451 pages (in German). Cloth

ISBN 3-540-93066-3

Section 3: Compounds with Alkali and Alkaline Earth Metals
Covers the double and complex salts of tin with alkali and alkaline earth metals, salts in which O, OH, halogen, iodate, etc., occur as the anionic ligand or acid radical. The so-called "onium salts" and salts of the type Y₂SnX₆ (X = F, C1; Y = O₂, NO, NO₂, ClO₂, C1F₂, etc.) are included. - Literature closing date: end of 1972. 1975. 32 figs. XXVIII, 206 pages (in German). Cloth

ISBN 3-540-93284-4

Section 4: Compounds with Zn, Cd, Hg, Al, Ga, In, Ti, the Rare Earth Elements, Ti, Zr, Hf, Th, and Ge
Completes treatment of the inorganic systems and compounds of tin. - Literature closing date: end of 1973. 1976. 139 figs. XXIV, 246 pages (in German). Cloth

ISBN 3-540-93305-0

Section 5: Complex Compounds of Tin
Complexes are grouped first by the oxidation number of tin and then by the ligand. Contains all Sn¹ complexes, those Sn²⁺ complexes bonded through oxygen to ligands, and some Sn³⁺ complexes bonded through nitrogen. - Literature closing date: end of 1973. 1977. 14 figs. XXIV, 246 pages (in German). Cloth

ISBN 3-540-93345-X

Section 6: Complex Compounds of Tin (Continued)
Completes the treatment of Sn¹⁺ complexes with neutral and inner-complex-forming ligands. Covers complexes with amino compounds, Schiff bases, oximes, carboxylic acid amides and hydrazides, nitriles, and with ligands containing S, Se, B, Si, P, As, Sb, Al, Ti, Ge, and Sn. Contains a ligand index for sections 5 and 6. - Literature closing date: end of 1973. 1978. 5 figs. XX, 236 pages (in German). Cloth

ISBN 3-540-93115-5

Organotin Compounds
In each of these volumes, a formula index offers rapid access to the compounds described.

Part 1: Tin Tetraorganyls SnR₄ (New Suppl. Ser. Vol. 26) Begins a three-volume coverage of the mononuclear tin tetraorganyls - compounds containing four Sn-C bonds. This volume describes such compounds with four identical organo groups. - Literature closing date: end of 1973. 1975. 1 fig. XIV, 182 pages (in German). Cloth

ISBN 3-540-93291-7


ISBN 3-540-93303-4


ISBN 3-540-93307-7

Part 4: Organotin Hydrides (New Suppl. Ser. Vol. 35) Mononuclear organotin hydrides with hydrocarbon groups bound by 3,2, or 1 carbon atoms, and with 1,2, or 3 hydrogen atoms as ligands, on tetravalent tin. - Literature closing date: end of 1974. 1976. 1 fig. XIX, 134 pages (in German). Cloth

ISBN 3-540-93319-0

GMELIN Complete Catalog 1997/98   49
Part 5: Organotin Fluorides. Triorganotin Chlorides
This initial volume on organotin halides and pseudohalides covers the mononuclear organotin fluorides and begins coverage of organotin chlorides with treatment of R₃SnCl, R₂R'SnCl, and RR'R"SnCl. - Literature closing date: end of 1975 for the fluorides, end of 1976 for the chlorides. 1978. 3 figs. XX, 252 pages (in German). Cloth ISBN 3-540-93362-X

Part 6: Diorganotin Dichlorides. Organotin Trichlorides
Completes the treatment of the organotin chlorides by presenting the types R₂SnCl₂, R₂SXXXXCl, R₂SnCl₃, and R₂SnX₂Cl. - Literature closing date: end of 1976. 1979. 2 figs. XX, 314 pages (in German). Cloth ISBN 3-540-93388-3

Part 7: Organotin Bromides
The bulk of the volume is devoted to the triorganotin bromides and the diorganotin dibromides. The relatively few tribromides are also covered. - Literature closing date: 1978. 1980. 5 figs. XII, 211 pages. Cloth ISBN 3-540-93424-3

Part 8: Organotin Iodides. Organotin Pseudohalides
Triorganotin iodides, diorganotin diiodides, organotin triiodides, and mixed halide compounds. Corresponding pseudohalides such as cyanides, isocyano and isocyanato, and azides are also described. - Literature closing date: end of 1979. 1981. 9 figs. XII, 226 pages. Cloth ISBN 3-540-93442-1

Part 9: Triorganotin-Sulfur Compounds
Most of the organotin-sulfur compounds described here are of the R₃SnSR type, where R and R' may be the same. Also included are the limited number of heterocyclic tin-sulfur compounds and compounds of the types R₂R'SnSR' and RR'R"SnSR" that have been prepared. - Literature closing date: end of 1980. 1982. 12 figs. XII, 276 pages. Cloth ISBN 3-540-93456-1

Part 10: Mono- and Diorganotin-Sulfur Compounds. Organotin-Selenium and Organotin-Tellurium Compounds
Continues the treatment of organotin-sulfur compounds with the diorganotin compounds of types R₂Sn(SR')₂, R₃Sn(SR')₃, and RR'R"Sn(SR")₃, including heterocyclic species, and the monoorganotin species of types RSn(SR')₃ and RSn(SR")₃. Other compounds treated in this volume are of the types R₂Sn(X)SR, R₂Sn(X)SR'SnSR₂, R₂SnX₂(SR), and RSnXX(SR'). The few organotin-selenium and organotin-tellurium compounds are described in the final chapter. - Literature closing date: 1980. 1983. 12 figs. XI, 352 pages. Cloth ISBN 3-540-93468-5

Part 11: Trimethyltin- and Triethyltin-Oxygen Compounds

Part 12: Tripropyltin- and Tributyltin-Oxygen Compounds
Continues the description of the mononuclear tin compounds with a tin-oxygen bond. Only compounds with propyl or butyl groups as the alkyl groups bound directly to tin are covered here, i.e., (C₃H₇)₃SnO' and (C₄H₉)₃SnO'. - Literature closing date: 1982. 1985. 1 fig. X, 264 pages. Cloth ISBN 3-540-93521-5

Part 13: Other R₃Sn-Oxygen Compounds, R₂R'Sn- and RR'R"Sn-Oxygen Compounds
Continues the description of the mononuclear organotin compounds with tin-oxygen bonds. It contains all R₃Sn-oxygen compounds with R other than methyl, ethyl, propyl, and butyl as well as R₂R'Sn- and RR'R"Sn-oxygen compounds. - Literature closing date: 1982. 1986. 15 figs. XII, 374 pages. Cloth ISBN 3-540-93533-9

Part 14: Dimethyltin-, Diethyltin-, and Dipropyltin-Oxygen Compounds
Begins the description of the mononuclear organotin-oxygen compounds containing R₃Sn groups where R is methyl, ethyl, and propyl. - Literature closing date: 1985. 1987. 15 figs. XIV, 248 pages. Cloth ISBN 3-540-93551-7

Part 15: Dibutyltin-Oxygen Compounds
Continues the description of mononuclear R₂Sn-oxygen compounds where R is exclusively n-, i-, and t-butyl. Large parts of the volume deal with dibutyltin dialurate because of its practical importance and the tremendous amount of literature and patents concerning its use as a polymer stabilizer and a catalyst for the production of various polymers. - Literature closing date: 1985. 1988. 5 figs. XIV, 442 pages. Cloth ISBN 3-540-93561-4

Part 16: Diorganobutyltin-Oxygen Compounds with R₂Sn, RR'Sn, or R-Sn Units and with Identical or Different Oxygen-Bonded Groups
Continues the description of the mononuclear R₂Sn-oxygen compounds containing R groups larger than butyl, and with RR'Sn, R-Sn, and RO-Sn-OR units, including compounds containing different oxygen-bonded groups such as R₃Sn(OR')₂OR" or RR'Sn(OR')₃OR". - Literature closing date: 1985. 1988. 8 figs. XV, 290 pages. Cloth ISBN 3-540-93581-9

Part 17: Organotin-Oxygen Compounds of the Types RSn(OR')₃ and RSn(OR')₂OR", R₃Sn(X)OR', RSnX(OR'), and RSnX₂(OR')
Concludes the description of the organotin compounds with Sn-O bonds. In addition to monoorganotin compounds of the types RSn(OR')₃ and RSn(OR')₂OR", compounds of the type R₃SnX(OR'), RSnX(OR')₂, and RSnX₂(OR') are treated with X = H, halogen, or pseudohalogen. Contains also a ligand index. - Literature closing date: 1987. 1989. 6 figs. XIV, 345 pages. Cloth ISBN 3-540-93596-7

Part 18: Organotin-Nitrogen Compounds. R₃Sn Nitrogen Compounds with R = Methyl, Ethyl, Propyl, and Butyl
Treats triorganotin-nitrogen compounds containing only R₃Sn groups with R = methyl, ethyl, n- and iso-propyl, and n-, iso-, and tert-butyl. The N-containing parts of the described compounds are mostly the amine group or its derivatives. - Literature closing date: 1988. 1990. 12 figs. XIV, 297 pages. Cloth ISBN 3-540-93617-3

Part 19: Organotin-Nitrogen Compounds (Continued), Organotin-Phosphorus, -Arsenic, -Antimony, and -Bismuth Compounds
Describes a large variety of mononuclear tri-, di-, and monoorganotin-nitrogen compounds and their derivatives with additional bonds to H, chalcogens, or halogens. Organotin-phosphorus compounds are still numerous but the number of organotin compounds with Sn-As, Sn-Sb, or Sn-Bi bonds decreases in that order. - Literature closing date: end of 1988 (nitrogen compounds); end of 1989 (others). 1991. 12 figs. XIV, 316 pages. Cloth ISBN 3-540-93632-7
Part 20: Compounds with Bonds between Tin and Main Group IV to Main Group I Elements
Covers mononuclear organotin compounds which in addition to Sn-C bonds contain Sn-M bonds where M = Si, Ge, Pb; B, Al, Ga, In, Ti, Mg, Ca; Li, Na, K, or Cs. R(SnM compounds with M = Li, Na, or K are widely used as synthetic tools. - Literature closing date: end of 1991. 1993. 10 figs. XIII, 193 pages. Cloth ISBN 3-540-93667-X

Part 21: Compounds with Bonds between Tin and Transition Metals of Groups III to VII
Describes mononuclear organotin compounds which contain Sn-M bonds, where M = Y, La, lanthanides; U; Ti, Zr, Hf; V, Nb, Ta; Cr, Mo, W; Mn, Re. Contains also a ligand formula index. - Literature closing date: end of 1992. 1994. 37 figs. XIII, 309 pages. Cloth ISBN 3-540-93690-4

Part 22: Compounds with Bonds between Tin and Transition Metals of Groups VIII, I and II
Describes mononuclear organotin compounds which contain Sn-M bonds, where M = Fe, Ru, Os; Co, Rh, Ir; Ni, Pd, Pt; Cu; Zn, Cd, Hg. Contains also a ligand formula index. - Literature closing index: end of 1993. 1995. 30 figs. XIII, 304 pages. Cloth ISBN 3-540-93710-2

Concludes the series on mononuclear organotin compounds. The major part deals with the numerous Sn(II) compounds. Contains also a ligand formula index, and transition metal cross references. - Literature closing date: end of 1993. 1995. 76 figs. XII, 239 pages. Cloth ISBN 3-540-93713-7

Part 24: Dinuclear Compounds Containing Only Tin-Carbon Bonds: R,Sn-G-SnR₂, with Various Organic G Units and R = Alkyl, Cycloalkyl, and Alkenyl
Gives all chemical and physical data on about 650 dinuclear organotin compounds of the R₂Sn-G-SnR₂ type where tin is exclusively bonded to carbon. There is a great variety of different organic G groups (including a few organometallic groups) while R includes CH₃ (the majority of compounds), C₂H₅, C₃H₇, and C₄H₉. A few species with other alkyl, cycloalkyl, or vinyl groups for R are known. Transition metal cross references. - Literature closing date: end of 1994. 1996. 11 figs. XIV, 292 pages. Cloth ISBN 3-540-93738-2

Supplement Volume

Tantalum - Ta

Main Volume
Part A: History. Occurrence. The Element
Section 1: History. Occurrence (Tantalum and Niobium)
Technology
Covers history, cosmochemistry, geochemistry, and useful deposits of niobium and tantalum, as well as the minerals, industrial treatment of the ores, preparation of metallic tantalum, uses, and toxicity. - Literature closing date: end of 1965. 1969. XVI, 276 pages (in German). Cloth ISBN 3-540-93219-4

Part B: The Compounds
Section 1: Compounds and Systems from Tantalum and the Noble Gases to Tantalum and Bismuth

Section 2: Alloys. Compounds with Metals and Nonmetals. Complex Compounds
Begins with the alloys of tantalum. Then covers Ta-M-X systems and compounds, where M is a second metal and X is one or more of the following: O, N, halogen, S, Se, Te, B, C, Si, P, As, Sb, and Bi. - Literature closing date: end of 1967. 1971. 185 figs. XXXII, 383 pages (in German). Cloth ISBN 3-540-93222-6

Combined Formula and Headings Index for System Nos. 48,49, and 50, as well as for New Suppl. Ser. Vol. 2
Technetium - Tc

Main Volume 1)
Bound together with System No. 70 Rhenium
Covers the relatively few available citations on the history and occurrence of technetium and discusses the preparation, physical properties, and chemical reactions. - Literature closing date: end of 1981. 1983. 144 figs. XVI, 395 pages. Cloth, together with Rhenium, ISBN 3-540-93179-1

Supplement Volume
Section 1: General Properties, Isotopes, Production, Biology
Includes chapters on the history, occurrence, nuclear properties and synthesis of the technetium isotopes, the separation, isolation and purification of the most important isotopes, and the uses, handling and analytical chemistry of technetium. Other chapters address the effects of radioactivity on chemical properties, Tc in biology and medicine, and the properties of the atom and ions. - Literature closing date: end of 1980. 1982. 136 figs. XV, 335 pages. Cloth
ISBN 3-540-93460-X

Section 2: Metal, Alloys, Compounds, Chemistry in Solution
Describes the metal and its alloys and compounds as well as chemistry in solution. Contains sections on separation methods such as liquid-liquid extraction, ion exchange, and chromatography. - Literature closing date: mid-1981. 1983. 66 figs. XVI, 307 pages. Cloth
ISBN 3-540-93472-3

Tellurium - Te

Main Volume
History and occurrence. Physical properties of the element (including nuclear properties), electrochemical behavior, chemical reactions, detection, and determination. Compounds and systems of tellurium with H, O, N, the halogens, S, and Se. - Literature closing date: September 1939. 1940, reprint 1969. 4 figs. XXI, 363 pages (in German). Cloth
ISBN 3-540-93223-2

Supplement Volume
Part A: The Element
Section 1: Recovery, Uses, Preparation, Nuclides, Atom, Molecule
Commercial recovery of Te with sections on enrichment, dissolution, recovery from solutions, refining, and purity controls. Formation, preparation, and purification in the laboratory; preparation of special forms, such as single crystals or films. Properties of the nuclides, molecules, and molecular ions. - Literature closing date: end of 1980. 1982. 33 figs. XII, 273 pages. Cloth
ISBN 3-540-93458-8

Footnote 1) The volume - originally published in 1941 - was designated "Masurium", which was the former name for the element technetium.

Thorium - Th

Main Volume
Chapters on making pure thorium preparations and on the industrial preparation and the uses of Th compounds. Discussion of the element, its alloys (with Na, Be, Zn, Hg, Ti, and Zr), its compounds, and the naturally occurring radioisotopes of thorium. - Literature closing date: end of 1949. 1955, reprint 1978. 35 figs. XXXV, 406 pages (in German). Cloth
ISBN 3-540-93358-1

Supplement Volume
Part A: The Element Section 1a: Natural Occurrence. Minerals (Excluding Silicates)
Begins with short sections on the chemical and geochemical characteristics of thorium, on the distribution and abundance of thorium in the earth, and general statements on thorium in minerals, e.g., its mode of occurrence, distribution between minerals, diadochity and metamictization, and the extended table of Th contents as an accessory element in minerals. The description of the Th minerals covers most of this volume and comprises oxides (simple and complex), carbonates, phosphates, silicophosphate. - Literature closing date: 1987. 1990. 14 figs. XV, 391 pages. Cloth
ISBN 3-540-93611-4
Section 2: History, Isotopes, Recovery of Thorium
Covers the history of thorium and the preparation of its scientifically and technologically important isotopes, as well as the nuclear properties (including fission properties) of all its isotopes. - Literature closing date: end of 1984. 1986. 134 figs. XV, 233 pages. Cloth
ISBN 3-540-93352-0

Section 3: Technology, Uses, Irradiated Fuel, Reprocessing
Contains chapters on the industrial production of thorium compounds, such as ThO$_2$, ThF$_4$, ThCl metallic Th, thorium carbide, and Th$_n$H$_{2n}$, and a section on the purification of thorium concentrates. Both nuclear and non-nuclear uses of thorium are included: e.g., uses as high-temperature reactor fuel elements (the production of which is described), uses in thermal reactors, in refractory materials, in glasses, as catalyst components, and as components of alloys. The behavior of thorium-containing fuel elements in reactors and their reprocessing are covered in the final chapter. - Literature closing date: mid-1987. 1988. 71 figs. XVIII, 215 pages. Cloth
ISBN 3-540-93572-X

Section 4: General Properties, Spectra, Recoil Reactions
Properties, such as electronic structure, ionic radii, ionization potentials, etc., spectra, and energy levels. There are thermodynamic properties as well as a chapter on the effects of ionizing radiation on Th alloys and compounds, as well as on recoil reactions. - Literature closing date: mid-1987. 1989. 54 figs. XVI, 248 pages. Cloth
ISBN 3-540-93589-4

Section 5: Analysis, Biological Behavior
Gravimetric, volumetric, electrochemical, spectrophotometric, spectrometric, and radiometric analytical methods are treated. The chapter on pharmacology and toxicology treats the very detailed examination of the way the intravenously injected X-ray contrast material Thorotrast (ThO$_2$) affects the body. In the concluding chapter there is a detailed review of health physics, safety, and monitoring measurements. - Literature closing date: 1986. 1990. 45 figs. XVI, 226 pages. Cloth
ISBN 3-540-93598-3

Part C: The Compounds

Section 1: Compounds with Noble Gases, Hydrogen, Oxygen
The only noble gas compound is K$_3$ThXeO$_6$ - Th$_4$H$_2$O. Binary hydrides ThH$_2$ and Th$_4$H$_{15}$, and the corresponding deuterides are discussed. The hydrides of thorium with one or more additional elements conclude the chapter. Important oxides are ThO and ThO$_2$. The latter compound is useful in dispersion-hardened alloys, as a catalyst, and in nuclear fuels. - Literature closing date: end of 1976. 1978. 170 figs. XVIII, 256 pages (in German). Cloth
ISBN 3-540-93367-0

Section 2: Ternary and Polynary Oxides of Thorium
A unified presentation - unrestricted by the "System of Last the Position" - of all ternary and higher oxide systems of thorium, other than those which had been treated in recent Gmelin volumes. Of special interest is the ThO$_2$-UO$_2$ system, a fertile material used in high-temperature nuclear reactors for the manufacture of $^{233}$U. - Literature closing date: end of 1975. 1976. 114 figs. XVIII, 145 pages (in German). Cloth
ISBN 3-540-93318-2

Section 3: Compounds with Nitrogen
Covers nitrides, amides, imides, nitride oxides, nitrates, and the corresponding double salts. Due to the decreasing technical importance of the nuclear thorium fuel cycle, especially with the advanced fuels like the nitride ThN, in recent years, the thorium compounds with nitrogen have been investigated much less extensively than the corresponding uranium compounds. - Literature closing date: mid-1986. 1987. 38 figs. XVI, 125 pages. Cloth
ISBN 3-540-93554-1

Section 4: Compounds with F, Cl, Br, I
Describes the binary and ternary halides and oxide halides, the iodate, perchlorate and periodate, and nitride fluoride and nitride iodate. The binary halides of tetravalent Th are treated in great detail. - Literature closing date: end of 1990. 1993. 63 figs. XVI, 175 pages. Cloth
ISBN 3-540-93666-1

Section 5: Compounds with S, Se, Te, B
Includes sulfides, sulfites, sulfates, and their double salts, as well as the corresponding selenium and tellurium compounds. In addition, borides and double borides are treated. - Literature closing date: 1984. 1986. 58 figs. XIX, 149 pages. Cloth
ISBN 3-540-93531-2

Section 6: Thorium Carbides
Describes binary and ternary thorium carbides which found technological interest for being used in advanced nuclear power reactors. Also due to recent scientific interest the Th-C system including ThC$_{1-x}$, and ThC$_2$ is one of the best known binary systems. Ternary carbides are either stoichiometric compounds or they form solid solutions with more or less broad ranges of composition. - Literature closing date: end of 1991. 1992. 97 figs. XVI, 136 pages. Cloth
ISBN 3-540-93645-9

Section 7: Compounds with Carbon: Carbonates, Thiocyanates, Alkoxides, Carboxylates
Contains the carbonates, the Th salts of carbon-containing pseudohalogenides, such as cyanides and thiocyanates, as well as thorium alkoxides and aryl oxides. The salts of organic acids take up the greatest portion of the volume. In the section on organic acids, the simple thorium salts together with the acido thorates, such as acetato complexes like (NH$_4$)$_2$[Th(CH$_3$COO)$_4$] or carbonato oxalate thorates like (CN$_3$H$_6$)$_2$(NH$_4$)[Th(C$_2$O$_4$)$_2$(CO$_3$)$_2$] - 3H$_2$O (CN$_3$H$_6$ = guanidinium) are treated. - Literature closing date: mid-1986. 1988. 12 figs. XIV, 162 pages. Cloth
ISBN 3-540-93570-3

GMELIN Complete Catalog 1997/98 53
Section 3: Compounds with Si, P, As, Sb, Bi, and Ge
Treats the binary compounds with the elements above. Included are ternary compounds mostly with other metals. Among the ternary and polynary compounds with oxygen, only those with phosphorus are included (e.g. phosphates, hypophosphates, etc.). - Literature closing date: end of 1991. 1993. 151 figs. XXIII, 301 pages. Cloth
ISBN 3-540-93675-0

Part D: Chemistry in Solution
Section 1: Properties of Thorium Ions in Solutions Covers the general properties of the thorium ions - mainly Th4+ - in solution. The topics span a wide range: physical and electrochemical properties in aqueous and nonaqueous solutions, hydrolysis, complex formation with inorganic and organic ligands, and precipitation and coprecipitation of thorium. - Literature closing date: mid-1986. 1988. 54 figs. XV, 171 pages. Cloth
ISBN 3-540-93563-0

Section 2: Solvent Extraction of Thorium
The solvent extraction of thorium is the most important method of separating thorium from other elements, both in the laboratory and on an industrial scale. Examples of industrial applications are the separation of thorium from minerals and its ultrapurification for use in nuclear technology. The most important extractants for thorium are tributyl phosphate (TBP), di(ethylhexyl) phosphoric acid (HDEHP), amines and ammonium salts, and thenoyltrifluoroacetone (TTA). - Literature closing date: 1983. 1985. 79 figs. XIV, 260 pages. Cloth
ISBN 3-540-93520-7

Section 3: Ion Exchange
Treats the ion exchange behavior of thorium in two parts: one on anion exchange and one on cation exchange. Subchapters on anion exchange are characterized by the applied solution medium, i.e., fluoride, chloride, pseudohalogenede, sulfate, nitrate, phosphate, carbonate, and organic complexing media. In the cation exchange part, the material is organized as "Sorption of Th on strongly acidic organic cation exchangers", "Sorption of Th on weakly acidic exchangers", and "Inorganic Ion Exchangers". Ion exchange in sulfate medium has been used for purification and isolation of thorium after the ore leaching process. - Literature closing date: 1988. 1990. 125 figs. XVI, 307 pages. Cloth
ISBN 3-540-93612-2

Section 4: Chromatography. Chemistry in Nonaqueous Solutions
Describes reversed-phase extraction-, paper-, thin-layer-, and gas chromatography as well as electromigration methods. Reactions in nonaqueous solvents are the basis for some industrial processes such as the recovery of Th by extraction. - Literature closing date: end of 1990. 1991. 72 figs. XIV, 215 pages. Cloth
ISBN 3-540-93636-X

Part E: Coordination Compounds
Contains the isolated solid complex compounds of thorium as well as the organothorium compounds. In most compounds the thorium central atom has the oxidation number four. These compounds very often resemble the corresponding U(VI) complexes. - Literature closing date: 1983. 1985. 40 figs. XVIII, 322 pages. Cloth
ISBN 3-540-93515-0

Titanium - Ti
Main Volume
ISBN 3-540-93228-3

Organotitanium Compounds
Describes mononuclear organotitanium compounds with 1L to 4L ligands. Included are species which have been postulated in connection with nitrogen fixation or olefin polymerization on soluble Ziegler-Natta catalysts. - Literature closing date: end of 1975. 1977. 6 figs. XIV, 212 pages (in German). Cloth
ISBN 3-540-93334-4

Part 2: Mononuclear Compounds 2
Mononuclear organotitanium compounds having two 5L (e.g. cyclopentadienyl) ligands; complete coverage of the TiI through TiVI compounds, and partial coverage of the TiV compounds. The key compound from which the majority of the compounds in this volume were prepared was (η-C5H5)2TiCl2. - Literature closing date: end of 1977. 1980. 17 figs. XII, 258 pages (in German). Cloth
ISBN 3-540-93412-X

Part 3: Mononuclear Compounds 3
Continues the mononuclear organotitanium compounds with dicyclopentadienyltitanium compounds. - Literature closing date: end of 1979. 1984. 25 figs. IX, 268 pages. Cloth
ISBN 3-540-93494-4

Part 4: Mononuclear Compounds 4
Concludes the treatment of mononuclear organotitanium compounds with a final treatment of compounds with two 6L groups, followed by complexes containing 7L ligands where x > 5. Contains an empirical formula index and a ligand formula index for volumes 1 to 4. - Literature closing date: end of 1979. 1984. 17 figs. IX, 242 pages. Cloth
ISBN 3-540-93502-9

Part 5: Di- and Polynuclear Compounds
Describes di- and multinuclear titanium complexes. While a (mononuclear) titanocene Ti(C5H5)2 appears not to exist, the common preparation process gives a dinuclear Ti compound, the so-called stable titanocene. In addition other multinuclear Ti compounds are described that are called reactive, unstable, and "very unstable" titanocene. Contains an empirical formula index and a ligand formula index. - Literature closing date: 1987. 1990. 93 figs. XIII, 418 pages. Cloth
ISBN 3-540-93592-4
Section 2: Alloys. Compounds up to Thallium and Iodine
Covers the alloys of thallium with Sb, Bi, alkali and alkaline earth metals, Zn, Cd, Hg, Al, and In and begins the description of the compounds: thallium compounds with H, O, N, and the halogens. - Literature closing date: November 1939.

Section 3: Compounds (Continued), Natural Isotopes
The remaining thallium compounds are covered, from thallium and sulfur up to thallium compounds with aluminium, gallium, and indium. The naturally occurring radioisotopes of thallium (radium C\textsuperscript{[sic, C2 ?]}, thorium C\textsuperscript{2}, and actinium C\textsuperscript{3}) are described in a separate section. - Literature closing date: end of 1939.

Section 4: Behavior of Uranium Fuels in Nuclear Reactors. Reprocessing of Spent Nuclear Fuels
Properties of oxide, nitride, and carbide fuel elements in the nuclear reactor, particularly mechanical, thermal, and electrical changes. Reprocessing of spent fuel elements, including those of highly enriched uranium, especially used in research reactors, and of UO\textsubscript{2}/ThO\textsubscript{2} from high-temperature reactors. Processing of UO\textsubscript{2}/PaO\textsubscript{2} wastes is described in "Transuranium Elements" Part A 1, II. - Literature closing date: mid-1980.
1982. 173 figs. XIII, 359 pages. Cloth

Section 5: Spectra
Deals with the various types of absorption and emission spectra of uranium atoms and uranium compounds: e.g., optical, X-ray, photoelectron, NMR, ESR, and Mossbauer spectra. - Literature closing date: end of 1979.
1982. 269 pages. Cloth

Section 6: General Properties. Criticality
Opens with a chapter on general properties of uranium and uranium ions. The properties of the UO\textsubscript{2}\textsuperscript{2+} ion are presented in a separate chapter. The chapter "Photochemistry of Uranium" emphasizes the behavior of the UO\textsubscript{2}\textsuperscript{2+} ion in the presence of organic and inorganic compounds. Effects of ionizing radiations, uranium recoil reactions, selected values of thermodynamic properties, and criticality control and safety are the topics of the remaining chapters. - Literature closing date: mid-1981.
1983. 73 figs. XVI, 251 pages. Cloth

Section 7: Analytical Chemistry. Determination of the Isotopic Composition. Biological Behavior. Health Protection and Safety Control
Chemical methods. Nondestructive and remote-control methods of uranium analysis, including determination of isotopic composition (such as neutron activation analysis and mass spectrometry). The chapter on biological effects emphasizes uranium metabolism, the effects of uranium incorporation, and the therapeutic removal of uranium from the body. The final chapter is devoted to health protection and safety measures. - Literature closing date: end of 1979.
1982. 37 figs. XV, 370 pages. Cloth

Part B: The Alloys
Section 2: Alloys of Uranium with Alkali Metals, Alkaline Earths, and Elements of Main Groups III and IV
Describes the alloys and intermetallic compounds of uranium with the main group elements. The binary systems are prominently treated and also those derived ternary systems, when specific reactions or important compounds arise. Among the alloys with alkaline earth metals the heavy fermium compound UBe\textsubscript{13} plays an important role. Its physical properties were therefore extensively studied. Cermet and alloys of the system U-Al are important as nuclear fuel, especially for high-neutron-flux research reactors. - Literature closing date: mid-1988.
1989. 198 fgs. XXII, 333 pages. Cloth

ISBN 3-540-93591-6
Section 1: Compounds with Noble Gases and Hydrogen. The Uranium-Oxygen System

U-noble gas systems. The U-H system, UH₃, compounds with deuterium and tritium, ternary and polynary hydrides. The U-O system, UO₂, U₂O₃, U₃O₈ phases; U₂O₈₂⁻ to U₂O₈⁴⁺; U₂O₇ phases between U₂O₇ and U₂O₅. - Literature closing date: end of 1975. 1977. 85 figs. XX, 206 pages (in German). Cloth ISBN 3-540-93344-1

Section 2: Oxides UO₂ and UO₃, Hydroxides, Oxide Hydrates, and Peroxides

UO₂ is formed by thermal decomposition of many U compounds. UO₃ exists in at least six modifications with different colors and stabilities. Known hydrates or hydroxides include 2UO₂ • H₂O, UO₂ • H₂O, UO₂ • 2H₂O, and UO₂ • xH₂O. Peroxidic compounds include both anhydrous and hydrated U₂O₇, U₂O₅, 2H₂O and UO₂ • 4H₂O. - Literature closing date: end of 1975. 1978. 115 figs. XVIII, 321 pages (in German). Cloth ISBN 3-540-93365-4

Section 3: Ternary and Polynary Oxides of Uranium

The wide range of nonstoichiometric ternary and polynary oxide phases of uranium surpasses that of virtually any other element. Ternary uranium oxides are of eminent importance in nuclear technology. All relevant systems are covered except for those with Ag, Mn, and the transuranium elements, which may be found in the Main Volumes on silver (Part B4, published 1974), manganese (Part C3, published 1975), and transuranium elements (Part C, published 1972). - Literature closing date: end of 1973. 1975. 151 figs. XX, 360 pages (in German). Cloth ISBN 3-540-93290-9

Section 4: Uranium Dioxide, UO₂, Preparation and Crystallographic Properties

Deals with the preparation and production of uranium dioxide, UO₂, as well as its crystallographic properties. UO₂ is the most important uranium compound in nuclear technology; it finds application as a nuclear fuel in nearly all light and heavy water reactors. - Literature closing date: 1982. 1984. 107 figs. XII, 140 pages. Cloth ISBN 3-540-93509-6

Section 5: Uranium Dioxide, UO₂, Physical Properties, Electrochemical Behavior

Physical properties of UO₂. Besides the classical information on topics such as density, electrical conductivity, etc., various additional data are given here, e.g., thermal conductivity, creep behavior, which are important in the use of uranium dioxide in nuclear reactors. The last chapter is on electrochemical behavior. - Literature closing date: 1983. 1986. 178 figs. XVI, 317 pages. Cloth ISBN 3-540-93524-4

Section 6: Uranium Dioxide: Chemical Behavior

Numerous reactions of UO₂ have been extensively studied because of the extraordinary importance of UO₂ as a nuclear fuel. The oxidation in air and the solubility behavior in aqueous solutions are important for the disposal of spent fuel. The compatibility with metals, the behavior in salt melts, and the behavior under irradiation are likewise of importance. - Literature closing date: 1995. 1996. 55 figs. XII, 199 pages. Cloth ISBN 3-540-93742-0

Section 7: Compounds with Nitrogen

UN is a potentially important nuclear fuel. Uranyl nitrate is one of the most important commercial forms of uranium; it is the basis for the reprocessing of spent nuclear fuels. This volume also covers other binary, ternary, and polynary nitrides, oxide, nitrides, amides and imides, nitrites, and other nitrides. - Literature closing date: mid-1979. 1981. 134 figs. XIV, 213 pages (92 pages in German). Cloth ISBN 3-540-93430-8

Section 8: Compounds with Fluorine

Describes the fluorides, double fluorides, and oxide fluorides. UF₅, the only readily volatile compound of uranium, is of dominant importance in separation of the isotopes. Its physical properties have been thoroughly investigated. UF₅ is an intermediate product in the production of UF₆ and the metal. It has been tested extensively in molten salt reactors. - Literature closing date: end of 1977. 1980. 96 figs. XXXII, 301 pages (in German). Cloth ISBN 3-540-93406-5

Section 9: Compounds with Chlorine, Bromine, Iodine

Describes the binary and ternary chlorides, bromides, and iodides, the oxide chlorides, perchlorates, N-containing chlorides, chloride fluorides, corresponding bromine and iodine compounds, and mixed halogen compounds. Uranium chlorides have been extensively studied in connection with nonaqueous reprocessing techniques for spent nuclear fuel. - Literature closing date: end of 1977. 1979. 50 figs. XII, 187 pages. Cloth ISBN 3-540-93393-X

Section 10: Compounds with Sulfur

Out of the binary uranium sulfides US, U₂S₃, U₃S₇, US₂, and U₃S₇, US has been intensively investigated in view of a possible use as a nuclear fuel. There are compounds with sulfur and oxygen (UOS) as well as sulfur and nitrogen (U₁N₂S). The ternary sulfides (with additional metallic components) have been intensively studied with regard to their structure and their thermal, electrical, and magnetic properties. Uranium sulfite and sulfido complexes as well as the sulfate and sulfite complexes are described in the second part of the volume. The latter complexes in particular have been thoroughly investigated due to their significance for uranium leaching processes and the like. - Literature closing date: mid-1983. 1984. 131 figs. XVIII, 233 pages. Cloth ISBN 3-540-93503-7

Section 11: Compounds with Selenium, Tellurium, and Boron

Binary and mixed selenides, tellurides, and borides, and related ternary and polynary compounds with other metals, oxygen, sulfur, nitrogen, and halogens. The compounds described are of greater interest to science than to technology, although properties of UsSe, UTe, and the uranium borides suggest their use as nuclear fuels, and certain phases of the U-Se and U-Te systems show good electronic properties. - Literature closing date: 1979. 1981. 144 figs. XIV, 213 pages. Cloth ISBN 3-540-93433-2
### Section 1: Carbides

Covers the binary and polynary carbides of uranium, including ternary carbides with nonmetals like the carbide oxides and carbide nitrides. The binary carbide UC and especially the mixed carbide (U₃₆Pu₂₃)C are of special importance due to their potential as fuel for advanced "Fast Breeder Reactors"; the dicarbide UC₂ is of interest for "High-Temperature Reactors". Because of the technological importance, a lot of data concerning the phase relations, the physical, physicochemical, and chemical properties rare published. - Literature closing date: 1984. 1987. 246 figs. XVII, 279 pages. Cloth

ISBN 3-540-93539-8

### Section 3: Carbonates, Cyanides, Alkoxides, Carboxylates, Compounds with Silicon

Treats the solid uranium-carbon compounds, with the exception of the carbide and the carbon-containing coordination compounds, as well as the uranium-silicon compounds. Treated are the compounds of uranium with alcohols, phenols, organic acids, thiols, dithiols, and the carbon-containing inorganic acids, such as H₂CO₃, HCN, HSCN, and HOOCN. In the uranium-silicon chapter the binary and ternary silicides and the uranium trialkylsilyl oxides are described. - Literature closing date: 1981. 1983. 67 figs. XVIII, 388 pages. Cloth

ISBN 3-540-93480-4

### Section 14: Compounds with Phosphorus, Arsenic, Antimony, Bismuth, Germanium

Because of their interesting and sometimes unique electrical, electronic, and magnetic properties much information exists for these binary compounds, especially for the antiferromagnetic NaCl-type "monopnictides" and their solid solutions with isomorphous ferromagnetic monochalcogenides. The numerous uranium compounds with the phosphorus oxide acid anions are also noteworthy. - Literature closing date: end of 1979. 1981. 106 figs. XVII, 252 pages. Cloth

ISBN 3-540-93444-8

### Part D: Chemistry in Solution

#### Section 1: Properties of Uranium Ions in Solutions and Melts

There are general chapters about electrochemical behavior, redox reactions, hydrolysis, complex formation, and coprecipitation in solutions; the properties of melts are also described. - Literature closing date: 1980. 1984. 108 figs. XVII, 380 pages. Cloth

ISBN 3-540-93493-6

#### Section 2: Solvent Extraction of Uranium

Solvent extraction from aqueous media into immiscible organic phases has many industrial and laboratory applications as in processing of spent nuclear fuels or recovery of uranium from mining leach liquors. The volume is divided into three parts: extraction by solvation, by complex formation, and by ion pair formation. - Literature closing date: end of 1979. 1982. 77 figs. XIII, 390 pages. Cloth

ISBN 3-540-93454-5

#### Section 3: Anion Exchange of Uranium

Ion exchange, especially anion exchange, is an important method for separation, isolation, and purification of uranium. The material on this topic is arranged according to the oxidation number of uranium and the nature of the medium (most often aqueous halide, sulfate, nitrate, phosphate, or carbonate). - Literature closing date: end of 1980. 1982. 132 figs. XIV, 405 pages. Cloth

ISBN 3-540-93463-4

### Section 4: Cation Exchange and Chromatography of Uranium

Included are chapters on cation exchange, inorganic ion exchangers, chelating exchangers, uranium isotope separation by ion exchange, and uranium transfer through membranes. Further chapters discuss extraction chromatography, paper chromatography, electrophoresis and thin-layer chromatography. - Literature closing date: end of 1980. 1983. 59 figs. XVIII, 519 pages. Cloth

ISBN 3-540-93474-X

### Section 5: Properties in Nonaqueous Solutions (Conductivity, Molecular Weight, Solubility)

Summarizes in a tabular representation the conductivity data and electrolyte behavior of uranium compounds in nonaqueous solutions as well as the molecular weight determinations in these solvents. Included are solubility data in nonaqueous solvents, in organic solvents mixed with water, and thermodynamic data of these solutions. - Literature closing date: end of 1993. 1995. 23 figs. XII, 204 pages. Cloth

ISBN 3-540-93721-8

### Section 6: Chemistry in Nonaqueous Solutions (Formation of Complexes and Redox Reactions)

Summarizes the data on the formation of uranium complexes in nonaqueous solutions and in mixtures of organic solvents with water. Stability constants and thermodynamic data are presented in a compact tabular form. The chapter on redox reactions covers chemically and photochemically induced reactions as well as electrochemical redox reactions in nonaqueous solutions. - Literature closing date: end of 1994. 1996. 12 figs. XII, 227 pages. Cloth

ISBN 3-540-93735-8

### Part E: Coordination Compounds

#### Section 1: Coordination Compounds

The complexes of uranium are important in analytical chemistry and in the extraction of uranium from minerals or spent nuclear fuel. Complexes with neutral ligands such as ammonia, amines, pyridine, alcohols, ethers, urea, amine oxides, phosphines, phosphine oxides, arsine oxides, and sulfoxides are described. - Literature closing date: end of 1977. 1979. 11 figs. XI, 224 pages. Cloth

ISBN 3-540-93394-8

#### Section 2: Coordination Compounds (Including Organouranium Compounds)

Most nonsolvated coordination compounds with nonneutral ligands are formed from UO₂²⁺, and are only sketchily characterized in the literature. The relatively few known organouranium compounds are for the most part characterized with precise physical-chemical data. An index of ligands covers volumes EI and E₂. - Literature closing date: 1977. 1980. 56 figs. XII, 266 pages (66 pages in German). Cloth

ISBN 3-540-93405-7

### Vanadium - V

#### Main Volume

**Part A: The Element**

**Section 1: History, Occurrence, Technology, Preparation of the Element**

History of vanadium, geochemistry, commercial deposits, ore dressing, chemical enrichment, enrichment as a by-product, attack of raw materials, and preparation of V₂O₅ and of metallic vanadium. - Literature closing date: end of 1963. 1968. 18 figs. XXI, 320 pages (in German). Cloth

ISBN 3-540-93232-1
Section 2: The Element

Describes elemental vanadium including its isotopes, physical properties, electrochemical behavior, and chemical reactions of the metal. Also described are reactions of the various vanadium ions (general reactions, chemical behavior, and redox reactions), analysis, and toxicity. - Literature closing date: end of 1964.

1968. 81 figs. XXXVII, 408 pages (in German). Cloth

ISBN 3-540-93233-X

Part B: The Compounds

Section 1: Compounds up to Vanadium and Bismuth

Contains vanadium hydrides, oxides (most of the text is devoted to V₂O₅), as well as the compounds with elements N, F, Cl, Br, I, S, Se, Te, Po, B, C, Si, P, As, Sb, and Bi. Carbon compounds include carbonyls, carbides, carbonates, formates, acetates, oxalates, tetrates, cyanides, and thiocyanates. - Literature closing date: end of 1963.

1967. 56figs. XXVIII, 368 pages (in German). Cloth

ISBN 3-540-93234-8

Section 2: The Compounds (Continued). Alloys. Coordination Compounds

Compounds and alloys containing alkali metals (including salts with NH₄ and organic bases), alkaline earth metals, elements Al, Ga, In, Ti, Ge, Sn, Pb, Ti, Zr, Hf, Zn, Cd, Hg, rare earth elements, and Th. The concluding chapter treats the complex compounds of vanadium with neutral and inner-complex-forming ligands, classified by oxidation state of the vanadium atom. Contains an empirical formula index of the organic ligands and an alphabetic ligand index. - Literature closing date: end of 1963.

1967. 110figs. XXXIV, 471 pages (in German). Cloth

ISBN 3-540-93235-6

Tungsten - W

Main Volume

History, occurrence, minerals, and the recovery of tungstic acid from ores are covered in introductory chapters. The major portion of this volume is devoted to preparation, physical properties, electrochemical behavior, and reactions of the element, to analysis, and to the tungsten alloys and compounds. Alloys covered contain Sb, Bi, Zn, Hg, Al, Ti, Zr, Hf, Sn, Pb, V, Ta, Cr, and Mo. Compounds include all elements except Mn to Cu, Ag, Au, platinum group elements, Te, Re, U, and transuranium elements. Tungsten heteropoly acids and their salts are described in a special chapter. - Literature closing date: March 1933.

1933, reprint 1969. 30 figs. XXIX, 397 pages (in German). Cloth

ISBN 3-540-93239-9

Supplement Volume

Part A: The Element

Section 1: Technology of the Metal

Described are the significant changes that have taken place since 1933. These include improved ore preparation, enlarged production facilities, and new pressing techniques for the metal. - Literature closing date: end of 1978. 1979. 40 figs. XX, 241 pages (in German). Cloth

ISBN 3-540-93391-3

Section 2: Physical Properties

After a brief compilation of the nuclear properties, the first major chapter deals with the atomic properties, especially the X-ray spectrum. The description of the properties of bulk tungsten begins with electronic structure and bonding. Then, after a short section on lattice dynamics, data on the crystallographic properties are reported, e.g., the polymorphism, the crystal structures, and the various types of lattice imperfections. - Literature closing date: end of 1985. 1987. 46 figs. XIV, 309 pages. Cloth

ISBN 3-540-93552-5

Section 3: Chemical Properties

The description of the crystallographic properties is continued. There follow mechanical, thermal, electrical, magnetic, and optical properties. - Literature closing date: 1987. 1989. 61 figs. XIV, 274 pages. Cloth

ISBN 3-540-93594-0

Section 4: Surface Properties. Electron Emission

Continues the description of the physical properties of the metal with that of surface-related phenomena: atomic structure, lattice dynamics, and electronic structure of W surfaces; surface free energy; surface tension; surface self-diffusion; work function; electron emission; field evaporation. - Literature closing date: 1992. 1993. 53 figs. XV, 277 pages. Cloth

ISBN 3-540-93677-7

Section 5a: Electrochemistry

Deals with the potential and the cathodic and anodic reactions of tungsten electrodes in aqueous and nonaqueous solutions and in melts. Moreover the polarographic and voltammetric analysis of the equilibrium between inert electrodes and W ions in different media are described as well as relevant kinetic investigations. Further chapters deal with electrolytic deposition as well as electrolytic etching and polishing. - Literature closing date: 1987. 1990. 42 figs. XV, 207 pages. Cloth

ISBN 3-540-93605-X

Formula and Heading Index, see under "Ta" Tantalum

Organovanadium Compounds.
Organochromium Compounds

(bound in a single volume)

(New Suppl. Ser. Volumes 2 and 3)

All compounds of V and Cr with at least one V-C or one Cr-C bond are described (except for the CN compounds). Some 3600 individual compounds are covered in the chromium volume. Contains an empirical formula index and a ligand formula index for each element. - Literature closing date: end of 1970.

Organovanadium Compounds: 1971. 22 figs. VIII, 70 pages (in German).
Organochromium Compounds: 1971. 55 figs. XIV, 452 pages (in German).
Bound together, cloth

ISBN 3-540-93244-5

Formula and Heading Index, see under "Ta" Tantalum
Section 1: 

Cloth date: end of 1977. 1979. 60 figs. XVIII, 225 pages (in German).

oxides intermediate between WO2 and WO3. - Literature closing tungsten, the lower oxides W3O and WO, and the series of gaseous tungsten oxide ions, the solid solution of oxygen in oxide is the stoichiometric WO2. Several short chapters treat the modifications and its use in producing the metal. The other major

The oxide WO3 has been studied most because of its many described in Volume B2. - Literature closing date: end of 1976. 1978. 159 figs. XX, 426 pages. Cloth

Section 2: 

Describes the tungsten systems with the noble gases, hydrogen, and oxygen, and includes all physical and chemical processes which occur at appropriate temperatures. Added is the phase diagram of the tungsten-oxygen system. Tungsten oxides are being a refractory metal which can very easily be obtained with a surface of controlled purity. - Literature closing date: 1986. 1988. 89 figs. XIX, 338 pages. Cloth

Section 3: Compounds of Tungsten with Oxygen and Additional Metals

Describes the systems of tungsten and oxygen with Sb, Bi, and the alkali metals. The ammonium compounds are included. Tungsten bronzes, tungstates, and polytungstates form in these systems. There is also a short chapter on tungstate ions. - Literature closing date: 1978. 1979. 128 figs. XX, 267 pages (in German). Cloth

ISBN 3-540-93492-8

Section 4: Compounds of Tungsten with Oxygen and Group II A and II B Metals

Describes the anhydrous tungstates of the alkaline earth metals and of the zinc subgroup. There is a great variety of tungstates, e.g., Ca, Sr, and Ba form bronzes of the type M,W03 and there are several types of alkaline earth tungstates(VI): M2WO4, M3WO5, M4W2O9, M3W6O19, and MWO4. It is the latter type, the monotungstates, which has been most thoroughly investigated. - Literature closing date: 1978. 1980. 95 figs. XX, 237 pages (in German). Cloth

ISBN 3-540-93416-2

Section 6: Anhydrous Tungstates of Group IV A to VI B Metals

Contains the anhydrous tungstates of metals with the groups IV A to VI B and thus concludes the treatment of the anhydrous compounds. In addition to a multitude of tungsten-metal-oxygen compounds, numerous systems and solid solutions are treated. - Literature closing date: 1982. 1984. 113 figs. XX, 397 pages. Cloth

ISBN 3-540-93506-1

Water Desalting

See under "O, Oxygen, Appended Volume"

Part B: The Compounds

Section 1: Systems with Noble Gases, Hydrogen, and Oxygen

Describes the tungsten systems with the noble gases, hydrogen, and oxygen, and includes all physical and chemical processes which occur at appropriate temperatures. Added is the phase diagram of the tungsten-oxygen system. Tungsten oxides are described in Volume B2. - Literature closing date: end of 1976. 1978. 99 figs. XVI, 174 pages (in German). Cloth

ISBN 3-540-93379-4

Section 2: Oxides

The oxide WO3 has been studied most because of its many modifications and its use in producing the metal. The other major oxide is the stoichiometric WO2. Several short chapters treat the gaseous tungsten oxide ions, the solid solution of oxygen in tungsten, the lower oxides W2O and WO, and the series of oxides intermediate between WO2 and WO3. - Literature closing date: end of 1977. 1979. 60 figs. XVIII, 225 pages (in German). Cloth

ISBN 3-540-93385-9

Main Volume

Major sections on elemental zinc and zinc compounds. Short chapters on history and occurrence. The chemical reactions of the zinc ion are covered in a special chapter. - Literature closing date: end of 1923. 1924, reprint 1969. 14 figs. XXVI, 329 pages (in German). Cloth

ISBN 3-540-93240-2

Supplement Volume

Occurrence (including minerals), industrial preparation, preparation of special forms, properties of the element, electro chemical and chemical behavior, alloys, zinc ions, analysis, and the compounds of zinc. Alloys and compounds contain H, alkali metals (including NH4), alkaline earth metals, B, C, Si, nitrogen group elements, chalcogens, and halogens. Special chapters deal with the surface treatment of zinc and of zinc alloys. - Literature closing date: end of 1949. 1956, reprint 1979. 191 figs. LXIX, 1025 pages (in German). Cloth

ISBN 3-540-93241-0

Zinc - Zn

ISBN 3-540-93385-9
Zirconium - Zr

Main Volume
History, occurrence, geochemistry, economic deposits, minerals, recovery of zirconium compounds from ores, and uses of zirconium. The section on the element includes preparation, physical properties, electrochemical behavior, chemical reactions, toxicity, and analysis. Alloys covered contain Sb, Be, Ca, Zn, Cd, Hg, Ga, and Ti, in that order. Compounds include all main group elements (alkali metals also including NH₄), except noble gases and Ge, Sn, Pb, and further Zn, Cd, Hg, Ti, and rare earth elements. - Literature closing date: end of 1949. 1958. 57 figs. XL1II, 448 pages (in German). Cloth ISBN 3-540-93242-9

Organozirconium Compounds.
Organozirconium Compounds (bound in a single volume)
All compounds are covered which contain at least one Zr-C or Hf-C bond, except for CN and CNO compounds. Mononuclear compounds are followed by bi- and polynuclear compounds. Within each chapter, compounds are arranged by the number of carbon atoms involved in carbon-metal bonds. Contains an empirical formula index and a ligand formula index for each element. - Literature closing date: end of 1972. Organozirconium Compounds: 1973. 11 figs. VIII, 88 pages. Organozirconium Compounds: 1973. 2 figs. VI, 22 pages. Bound together, cloth ISBN 3-540-93251-8

Index Volumes to the Gmelin Handbook
Index (Formula Index)
The General Formula Index lists in alphanumeric order, with volume and page references, all elements and all defined compounds described in the 8th edition of the Gmelin Handbook. The Index is in English, and a user's guide is provided.


Other indexes appear in a number of the volumes of the Main Work and of the Supplement Volumes.
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